Sebastian Wedeniwski

The Mobility Revolution in the Automotive Industry

How not to miss the digital turnpike

Springer

The Mobility Revolution in the Automotive Industry

Sebastian Wedeniwski

The Mobility Revolution in the Automotive Industry

How not to miss the digital turnpike

Springer

Dr. Sebastian Wedeniwski
IBM
Tokyo, Japan

Translation from the German language edition "Mobilitätsrevolution in der Automobilindustrie",

ISBN 978-3-662-47787-8 ISBN 978-3-662-47788-5 (eBook)
DOI 10.1007/978-3-662-47788-5

Library of Congress Control Number: 2015955616

Springer Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer-Verlag GmbH Berlin Heidelberg is part of Springer Science+Business Media (www.springer.com)

Foreword

In 1886, Carl Benz and Gottlieb Daimler both invented the automobile – not together, but each on their own. How profound were the consequences of this invention? It changed the way how people work, how they travel, and how they interact with each other. About 130 years ago, Europeans traveled an average distance of about 20 km per year. Today they travel more than 20 km every day. And most of that travel is done by car. Commercial vehicles are an indispensable part of our lives, logistic supply chains are dependent on vans and trucks, and buses are commonly used around the globe for passenger transport. I think the automobile was one of the most important inventions of the last 130 years. But what is the future of the automotive industry?

Today, when we talk about new technologies that are transforming our lives from scratch, it's about **Digitalization** and **Information Technology**. More than 2 billion people use a smartphone. But next year, devices connected by the "Internet of Things" will outnumber the people living on this planet. And of course Digitalization and Information Technology has a growing – and changing! – importance for the automotive industry.

The automotive industry has used Information Technology to develop, build, sell, and service vehicles for more than 40 years. The digital designing and digital modeling of vehicles started in the early 1980s. Vehicles are ordered with fully IT-supported processes, which results in a just-in-time supply chain for production. The worldwide sales and service of vehicles is supported by IT systems, and without IT these processes couldn't be managed any more. Most of these processes are supported by systems running in their second or third generation. Java is substituting traditional COBOL for large-scale enterprise systems, packaged software plays a major role beside individual implemented IT systems, and IT Enterprise Architecture is governing thousands of IT systems to move the IT landscape to more agility and business flexibility.

Nowadays, IT inside a vehicle plays an important role for functionality and safety. In a modern car or truck, there are hundreds of processors with more than 100 million lines of code. Backend telematics systems deliver functionality to modern cars such as "lock the doors" and "identify the parking location", and fleet management platforms are supporting thousands of truck drivers for logistic companies.

Young people growing up today have more interest in sharing vehicles than owning them. To meet this trend, Daimler has started mobility services like car2go. Park2gether and myTaxi extend these Mobility Services; IT platforms using SMAC (**S**ocial networks, **M**obility, **A**nalytics, **C**loud) are at the heart of these new services. This year, Daimler got the driver license for the first autonomous driving truck in the US, and we expect that autonomous driving in cars and trucks will have a major impact on new business models in the future.

Let's look a little bit into the future where Digital Transformation (DT) is on the agenda of many industries. DT is organizational change through the use of digital technologies to materially improve performance. The use of digital technologies and SMACs, together with upcoming innovative trends like Internet of Things, cognitive computing, smart machines (smart robots, autonomous driving), and smart production (3D printing, smart factory, Industry 4.0) will enable major business improvements such as enhancing customer experience, streamlining operations, or creating new business models. The automotive industry is already in the middle of a "digital revolution" that will change the way in which Original Equipment Manufacturers (OEMs) and customers interact with automotive companies. Digital technologies enable the current and future mobility of people which designs for new metropolitan areas will need to consider. Connected cars connect the vehicle, the driver, and the environment to create new opportunities for all market players.

I've worked with many IT companies in the past 35 years of my business life. The IT industry has many outstanding people to support companies in designing business processes and developing large enterprise systems. But I never met someone like Sebastian from IBM, who has this deep profound knowledge across many technologies. Over the last 15 years, I have worked with him in many different roles. He helped Daimler as IBM's Chief Architect to develop the Java Enterprise platforms, which is the foundation of nearly all Java development in the company. As IBM's Client Enterprise Architect, he was the Daimler advocate at IBM to maximize the long-term customer value for Daimler's IT Architecture. I have really enjoyed working with Sebastian all these years. His practical approach to enterprise and business architecture is unique, and he represents the new kind of skilled person the automotive industry needs in future to solve the challenges of Digital Transformation.

Stuttgart, Germany
August 2015

Wilfried Reimann
Head of IT Enterprise Architecture & Innovation
Daimler AG

Foreword

The automotive industry is one of the most complex and technologically advanced industries. The creation of a new vehicle involves multiple phases, including design, engineering, pricing, manufacturing, distribution, selling, and servicing. Each phase consists of numerous complex processes and technologies that must be fully integrated into one seamless system; ensuring success at enterprise level is no small task.

Over the past few decades, the auto industry has gone through major technological transformations, yet many of its core automotive systems are three or more decades old. These systems will be modernized over the next decade, but these types of projects can drag on for much longer. The success of this modernization will greatly depend on the maturity level of an organization's enterprise architecture. Organizations with outdated building blocks, database models, software development, and integration patterns will see their projects take much longer than estimated, or perhaps even fail. Organizations with mature enterprise architecture systems that are agile and better able to adjust to changes will be able to quickly take advantage of today's rapidly changing technology.

The automotive industry is also seeing a shift in its customers' expectations. Today's customers are more informed than ever, and with information comes empowerment – customers are in the driver seat. Because of the consumerization of technology, internal customers are also expecting an enterprise system experience as seamless and enjoyable as consumer facing systems. If IT organizations allow rapid ideation and creation of efficient, user-friendly systems and applications, both internal and external customers will be happy, which will ultimately improve productivity, product development, quality, sales, and customer satisfaction. These changes will only happen when the enterprise architecture framework provides the kind of agility modern enterprises require.

Mobile technology and social media defined the past decade, and many industries struggled with how best to support and exploit the mobile and social revolution. How many people are still using navigation systems in their cars vs their favorite navigation maps on their mobile phones? There may be a few left out there, but not many. Yet auto companies still pump tons of money into outdated head unit systems. The focus needs to be on the technological advances of the next decade where everything will be connected: the car, the house, the work, wearables, and on and on. The Internet of Things (IoT) is here. Connectives will explode and define the next decade, and organizations that position themselves properly to support and exploit the next stage of digital revolution will benefit greatly.

Cars are amazing devices. Much more sophisticated than my smartphone. Yet smartphones have overwhelmingly captured consumer mindshare, with companies like Apple and Google creating fun, connected environments that have become the digital center of our lives. The connected car has the potential to become as integral to our lives as our smartphones are now. Future "smart cars" will offer not only a more enjoyable user experience, they will include advanced safety and productivity features. The modern head unit system will play a central role in connected cars. One day, I will be able to leave my house in the morning without worrying if I've locked the door or left the stove turned on – my connected car will alert me and I can adjust everything from inside my car. And as I head to the office, my car will know which route to take and how fast to drive and will remind me of my dinner reservations that evening. That's one scenario of many that will be made possible by organizations with mature enterprise architecture in place; they will be prepared to meet the core challenges of the future: improved integration, security, identity, and customer experience.

The IT industry is filled with brilliant people but seldom does one meet a person who not only understands the broad technological challenges that large automotive enterprises face and who has a depth of knowledge across many technologies but who also has the ability to translate that knowledge into a definable business value. I was encouraged to meet Sebastian by Martin Jetter, who was at that time the General Manager, IBM Japan. He assured me I would be meeting a fellow forward thinker. Ever since that first meeting, I have greatly enjoyed collaborating with Sebastian. His practical approach to enterprise and business architecture is refreshing; it represents the new kind of engagement and value IT can bring to the automotive industry.

Torrance, CA, USA
June 2015

Ned Curic
Chief Technology Officer and Vice President
at Toyota Motor Sales

Foreword

This is a significant book in many perspectives. It clearly marks the turning point where we are facing challenges regarding our experience with the automobile and with life as we've known it. We have been fascinated with automobiles, seeing them as a success symbol, and our lives have evolved around them. Who hasn't looked at the automobile with anticipation believing that the car of their dreams would change their lives just by owning it? For generations now, automobile ownership has stood at the center of the building blocks of life.

Automobile manufacturers have designed their products around this premise while also taking business and technology elements into consideration. The industry had its golden years during the 1950s and 1960s and then faced the 1970s' reality check with the "oil crisis"; the 1980s and 1990s then brought about a different focus leading all the way to the twenty-first century with major paradigmatic changes. From legacy OEMs EV trial products to Tesla Motors, things were shifting. The automobile as we knew it was getting better and better. This was clear. The connected car has is now a reality, and mobile devices with content digitalization have brought about a new wave of progress and reset consumer expectations.

The economic shake-up in 2008 coupled Elon Musk assuming the leadership of Tesla Motors established the company as a "respected EV" player and changed the automotive industry forever. This was coupled with the advent of Uber followed by speculations of Google Car and Apple Car. Mobility as we knew it had been transformed, and a new era had begun in the automotive industry – an era in which the relationship between humans and the automobile has changed.

Sebastian takes this a step forward and plays with the word "automobile" to describe the age of *mobility*. He depicts the shift showing the change of emphasis from "AUTOmobile" to "autoMOBILE" and captures the essence brilliantly. Sebastian has been clearly positioned in his career to see this paradigm shift, and he has also played an important role in the automotive domain to make this happen. His experience in the automotive domain has enabled him to capture the elements of this paradigm shift accurately.

One can safely say that the automobile has shifted from being an object that one aspired for to being part of the service industry today.

Terms such as "autonomous vehicle," "car share," and "multimodal transportation" are creeping into our daily conversations, and economics are driving this shift.

Sebastian captures this development and importantly maps this shift into automotive industry legacy institutional organizations and clearly defines the challenges the automotive industry faces.

The shift in the organizational mindset of the automotive industry will unleash new possibilities, and this will drive innovation in mobility to meet consumer demands. This book clearly defines this path.

Clearly today, we have very few capital and technology barriers to innovate and meet diverse challenges, with mobility being one of the principal ones. We are on the verge of redefining mobility and its impact on our lives. Sebastian's book will definitely be one of the building blocks of the future, redefining mobility and the automobile.

Cupertino, CA, USA
September 2015

Hakan Kostepen
Executive Director
Product Planning Strategy & Innovation
Panasonic Automotive Systems Company of America – Silicon Valley Center

Acknowledgments

It was a fun challenge fitting in the creation of this book into my day job demands. My day has 24 hours, as does everyone else's. (Though I'm sometimes not so sure, due to all the time zone changes.)

Before I receive all the "Ahhs" and "Ohhs" now, I want to direct the attention to some people who supported me during the process of working on the book. And they supported me a lot.

First of all, there are Stephen Perun, John Cohn, and Hakan Kostepen – they reviewed and commented on the script. Then my best friend Tilman Rau – he provided guidance as expert writer.

And of course all that wouldn't have been possible without the support and the patience of my family – especially my wife Lakkhana Wedeniwski who had to cope with this crazy guy Sebastian doing all the things at the same time.

Thanks to all of you.

And now you can "Ahh" and "Ohh" – and of course read the book.

Contents

1 Introduction 1
- 1.1 Significance of Digitalisation 3
- 1.2 Structure of the Book 5
- 1.3 What Does the Framework of the Automotive Industry Include? 8
- 1.4 Tomorrow's Mobility Industry 12
- 1.5 Who Should Read This Book? 15
  - 1.5.1 Those Responsible for New Business Models and Innovations 17
  - 1.5.2 Chief Information Officer 17
  - 1.5.3 Chief Technology Officer 17
  - 1.5.4 Chief Analytics Officer/Chief Data Officer 18
  - 1.5.5 Vehicle Development Manager 18
  - 1.5.6 Vehicle Production Manager 19
  - 1.5.7 Managers in Distribution, Sales and Customer Services 19
- 1.6 Information Sources and Newsletters 19
- 1.7 Enterprise Architecture 21
- References 26

2 Enterprise Architectures: Surrounded by Historical Structures 29
- 2.1 Transformation in the Transport Sector 31
- 2.2 Product Development 35
- 2.3 Vehicle Architectures Are Established During the Industrial Era 36
  - 2.3.1 Vehicle Bill of Materials 39
  - 2.3.2 Network Architecture 53
  - 2.3.3 Product Documentation 59
- 2.4 Digital Methods in Product Development 63
- 2.5 Development of New Vehicle Architectures 66
  - 2.5.1 Modular Vehicle Architecture 67
  - 2.5.2 Telematics is the Latest Addition to Vehicle Architecture 68
- 2.6 Changing Enterprise Architecture 71
- References 72

3 Strategy, Business Model and Architecture in Today's Automotive Industry ... 75
3.1 Strategy ... 76
3.1.1 BMW Corporate Strategy ... 79
3.1.2 Audi Corporate Strategy ... 82
3.1.3 Daimler Corporate Strategy ... 85
3.1.4 Comparison with Japanese Companies ... 87
3.2 Business Model ... 88
3.3 Business Domains ... 91
3.4 Business Competences and Components ... 95
3.5 Reference Models for Business Processes ... 100
3.6 Business Competences in the Automotive Industry ... 102
3.6.1 Corporate Leadership ... 103
3.6.2 Research and Development ... 116
3.6.3 Procurement and Inbound Logistics ... 134
3.6.4 Production ... 145
3.6.5 Marketing and Communication ... 158
3.6.6 Sales and Outbound Logistics ... 167
3.6.7 Financial Service ... 178
3.6.8 After-Sales Support ... 185
3.6.9 Human Resources ... 193
3.6.10 Quality ... 202
3.6.11 Finance and Controlling ... 209
3.6.12 Infrastructure ... 221
3.6.13 Corporate Support Service ... 224
3.7 Reference Model of the AUTOmobile Business Competences ... 228
References ... 231

4 Digitalisation of the Industry from the AUTOmobile to the autoMOBILE ... 239
4.1 The Automotive Industry in Times of Change ... 245
4.1.1 Analysis of the Environment of the Automotive Sector ... 245
4.1.2 Competitive Forces and Imminent Market Developments ... 257
4.1.3 Evolution, Transformation and Creation ... 264
4.2 Business Architecture of the Mobility Industry for the autoMOBILE ... 266
4.2.1 Business Model of a Mobility Service Provider ... 267
4.2.2 Business Domains ... 269
4.2.3 Business Competences ... 273
4.3 Outlook ... 279
References ... 279

Index ... 283

List of Abbreviations

ABS	Anti-lock Braking System
APQC	American Productivity and Quality Center
APS	Advanced Planning and Scheduling
AUTOSAR	AUTomotive Open System ARchitecture
BOM	Bill of Materials
BPMN	Business Process Model Notation
CAD	Computer-Aided Design
CAE	Computer-Aided Engineering
CAM	Computer-Aided Manufacturing
CAN	Controller Area Network – bus system for linking control devices in vehicles
CAO	Chief Analytics Officer
CAS	Computer-Aided Styling
CDO	Chief Data Officer
CEO	Chief Executive Officer
CIO	Chief Information Officer
CFO	Chief Financial Officer
CMS	Content Management System
CNC	Computer Numerical Control
CRM	Customer Relationship Management
CTO	Chief Technical Officer
DIN	Deutsches Institut für Normung – German Institute for Standardization
DMS	Document Management System
DMU	Digital Mock-Up
DTP	Desktop Publishing
EBIT	Earnings Before Interest and Taxes
ECU	Electronic Control Unit
ERP	Enterprise Resource Planning
FMEA	Failure Mode and Effects Analysis
GPS	Global Positioning System
GTFS	General Transit Feed Specification
HGB	Handelsgesetzbuch – German Commercial Code
IFRS	International Financial Reporting Standards

ISO	International Organization for Standardization
IT	Information Technology
JasPar	Japan Automotive Software Platform and Architecture
LIN	Local Interconnect Network – integration of sensors and actuators into vehicle networks
MES	Manufacturing Execution System
MOST	Media Oriented Systems Transport – integration of multimedia data and applications into vehicles
NGTP	Next Generation Telematics Patterns
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacturer – manufacturers who bring products to market under their own brand name
OMG	Object Management Group
PAYD	Pay-as-you-drive – insurance model based on vehicle performance and level of vehicle use
PCF	Process Classification Framework
PDM	Product Data Management
PESTLE	Political, Economic, Socio-Cultural, Technological, Legal, Environmental (ecological)
PHYD	Pay-how-you-drive – insurance model based on driving behavior and type of vehicle use
PLC	Programmable Logic Controller
PLM	Product Lifecycle Management – concept for the management and controlling of product data and processes from product development to disposal
PPC	Production Planning and Controlling
RFI	Request for Information
RFP	Request for Proposal
RFQ	Request for Quotation
SCM	Supply Chain Management
SLA	Service Level Agreement
SOA	Service-Oriented Architecture
SOP	Start of Production
SOX	Sarbanes-Oxley Act
SRM	Supplier Relationship Management
TOGAF	The Open Group Architecture Framework
TSP	Telematics Service Provider
VDA	Verband der Automobilindustrie – German Association of the Automotive Industry
VDE	Verband der Elektrotechnik, Elektronik und Informationstechnik – Association for Electrical, Electronic and Information Technologies
VDI	Verein Deutscher Ingenieure – Association of German Engineers
VDMA	Verband Deutscher Maschinen- und Anlagenbau – German Association for Mechanical Engineering and Equipment Construction
VIN	Vehicle Identification Number

Introduction

1

Even today, Top Trumps is still a popular German card game with children – that is, at least, when there are no electronic devices within their reach. But if we take a closer look at the game, we will see that the concept behind such card games goes back a long time. To be precise, the first German car Top Trumps came out in 1952 (see Fig. 1.1), when many people could only dream of owning their first car. Ever since the first version, the trumps have remained the categories of performance, top speed, cylinder capacity or number of cylinders – all of which are vehicle properties with a clear mechanical focus. Even today, this has not changed. The only difference is that there are newer versions in which fuel consumption or CO_2 emissions have been added as new categories to encourage environmental awareness. However, due to the almost unlimited individualisation and permanent temptation of new innovations which characterise the digital age, these parameters are hardly in a position to create a long-term relationship between customer and product. Vehicles as products are undergoing a transformation, and users are demanding other properties. Why, in Top Trumps, do we not ask how many sensors a vehicle has, or how many database rows it creates per second? Because it isn't relevant for the user? How relevant are the cylinder capacity or the number of cylinders if you don't happen to have a passionate interest in mechanics?

Perhaps it would be more appropriate to have the number of buttons and controls in the vehicle as an extra category in Top Trumps? Vehicle users are certainly interested in these. Smartphones can function with just five mechanical switches, and their functionality changes during use thanks to constant software updates. In 2001, for example, BMW made a significant development in terms of comfort when it used just one rotary-push control [3] as an input device in the central console for functions such as navigation, telecommunications, audio and chassis settings. The rotary-push control is a crucial innovation which allows the number of mechanical buttons to be significantly reduced – even in vehicles which need to be able to withstand extreme heat, cold or humidity. At the same time, however, considerable care must be taken with the vehicle's core functions – and the diversity of a wide

S. Wedeniwski, *The Mobility Revolution in the Automotive Industry*,
DOI 10.1007/978-3-662-47788-5_1

Fig. 1.1 On the *left* is a card of the very first car Top Trumps by ASS in 1952, and on the *right* a card from the “new version in 1953” (Photos: ASS Altenburger)

range of different control concepts always involves drivers having to get used to new things when they change vehicles. The complexity of the matter is not only to be found in consolidating existing buttons, however, but also in those for new functions. In the BMW 5 series (year of construction 2013), for example, the rotary-push control is accompanied by two new buttons which can be used to alter the driving dynamics and switch the instrument display between sport, energy-saving and comfort modes. The crucial questions are: how critical the function is or how often the mode needs to be changed in order to create different driving experiences, and why it could not have been integrated into a sub-menu in the rotary-push control. There is always much criticism of new control concepts. Tesla Motors, for example, went even further in avoiding mechanical buttons and controls by replacing them with a single central screen. All that is needed to change the range of functions or the operation is flexible architecture and software updates. Mechanical interventions are no longer needed in a digital environment. In 2014, Google went even further by unveiling a new type of vehicle prototype which did not even have pedals or a steering wheel.[1] This led not only to improvements in existing technologies or the business models based on them, but also to the public testing of new technological breakthroughs.

So, what is the purpose of this introductory discussion about mechanical buttons and controls? What relevance does all this have for enterprise architecture in the automotive industry?

[1] “Google’s Next Phase in Driverless Cars: No Steering Wheel or Brake Pedals” http://www.nytimes.com/2014/05/28/technology/googles-next-phase-in-driverless-cars-no-brakes-or-steering-wheel.html. Accessed: 19 December 2014.

Primarily, it is a specific example in vehicle architecture to make us think of everyday interfaces which, nowadays, we only perceive subconsciously while using a vehicle. “Another way is possible” You only experience a eureka moment when you actually sit in a vehicle by Tesla Motors or Google. Personal opinions and habits can either contain historical burdens or can enthusiastically latch on to what can make things more comfortable in the digital age. And comfort means not only the product integration perfected in the traditional manufacturers’ sense of the word, but also the chance to continually connect and exchange equipment, peripheral devices and sensors according to the “plug and play” principle which was invented in the computer industry in the 1990s. At the same time, we must shed more critical light on which interfaces end users need during movement in a personally extendable “travel capsule”. The automotive industry is set in its ways in terms of the processes and thought patterns it is used to. Personality in travel should not be reduced to personalisation of the transport method alone.

This brings us to the second question of the relevance of an enterprise architecture – how it can be used to really implement even larger-scale changes. The idea of the enterprise architecture which the automotive industry continues to lack will be developed in more detail in this book.

A much more fundamental problem, to illustrate which we need to go back to the Top Trumps example, is the following: Not only does the lack of an enterprise architecture inhibit companies in terms of today’s processes – it also limits the original inventive spirit which made spatial mobility and the ability to change location possible in the first place. This book is not so much about new vehicle properties becoming trumps in the digital age. Instead, what is crucial is the role which the vehicle property will play in a game of Top Trumps featuring different types of mobility. The Trumps are only meant to clarify the visible elements of a larger-scale frame of reference. The automotive industry is still right at the very beginning of a larger-scale transformation as a result of digitalisation, connectedness and personalisation. We will go into this issue in more depth and detail as part of a new framework for a mobility industry.

1.1 Significance of Digitalisation

The influence and effects of digitalisation on our society are increasing every day. It is also possible that new digital media will lead to demand for travel to disappear in certain situations. These particular situations, however, do not necessarily mean that enterprise architecture has to change. Consumers’ new demands for comfort, which are often triggered by the new possibilities of digitalisation, are changing business landscapes in significant ways more and more often. Many pioneering companies have even failed for reasons linked to digitalisation. Kodak, for example, was a world-renowned pioneering company which had an almost total monopoly in the photography market in its heyday. However, this company did not manage to reinvent itself – because it simply did not want to undermine its lucrative business in analogue film materials. The effects of digitalisation on markets are often very difficult to predict. They do happen, however, and are frequently underestimated. Digitalisation not only changes companies and their sales types – it also transforms whole value creation chains. For example, digitalisation changed not only music and distribution in the entertainment industry, but also the whole of the value creation chain in the recording industry.

Now, the same is gradually happening with companies in the automotive industry, where it is only a matter of time before the lucrative market monopolies with vehicle-centric businesses will start to appear. Digitalisation has not yet penetrated far enough into the concept of the classic vehicle. And perhaps it will in fact never turn the classic combustion engine on its head, along with its architecture and particularly high investment costs in terms of product development and capital-intensive factories for manufacturing. This demands comprehensive preliminary work and high liability risks, which makes the barrier to entry into the automotive market a very high hurdle for ambitious young businesspeople with new ideas and visions. It is, however, a hurdle which it is possible to overcome. Tesla Motors, for example, which was established in 2003, seems to have been able to break into the automotive sector successfully using the electric car. Another example is the automotive manufacturer Local Motors, established in 2007, which focuses on small-scale production using unique techniques such as Open Source and Design in an open online community. In China too, many companies have entered the automobile market since 1994. This is why new business models should not only concentrate on building better cars for the future[2] or viewing vehicle manufacture as the central value creation process, but should consider the reasons that cars exist in the first place, and rethink mobility on this basis. At the end of the day, vehicles are originally just tools which are used to take us from A to B within an individually defined time period.

Digitalisation is bringing about a new era in the automotive industry, in which the focus is moving away from the manufacturing of the AUTOmobile[3] and towards the provision of mobility services.[4] We are still a very long way off being in a situation where all vehicle manufacturers recognise the relevance of digital business models. In Fig. 1.2 we outline our motivations for writing this book. This is a very simplified representation of the fundamental core processes of the product-oriented vehicle life cycle from development to production to sales.[5] Additionally, there are support functions for trader networks in terms of sales, and the provision of customer services for the vehicle. This business model does not set out a direct relationship

[2]Toyota Business Report 2013 – "What is essential to building the better cars of the future?" has an unchanged approach in terms of pursuing the systematically best way of manufacturing cars [11].

[3]We write *AUTOmobile* in order to emphasise 'Auto' – the German word for car.

[4]We write *AutoMOBILE* to emphasise the mobility of travelling from one place to another.

[5]The life cycle can also be defined in a more general way. This would begin with the extraction of the raw materials before the actual development and manufacture, and end with disposal after the sale and operation of the vehicle. Here, however, we will only concentrate on those sections of the vehicle life cycle which are part of the immediate core business of the automotive industry.

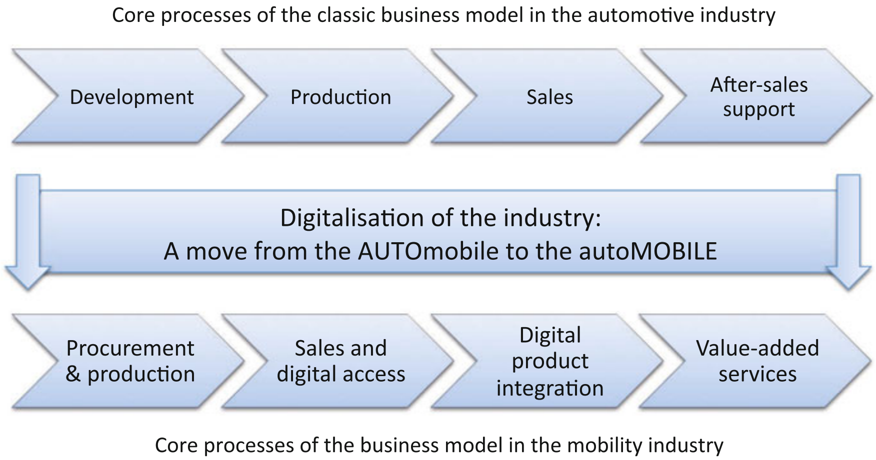

Fig. 1.2 Digitalisation shifts emphasis and broadens value creation and the limits of the automotive industry

between the driver and the vehicle manufacturer. It is precisely in this regard that we will create an enterprise architecture for a modern automotive industry, building on possible strategic alignments and extended digital business models. In order to do this, we will examine different possible models more closely.

In short, digitalisation is bringing about the start of a new era in the automotive industry. In the mid fifteenth century, the printing press drastically changed our communication. Now, digitalisation is set to change our mobility. And enterprise architecture is the foundation we need in order to implement these changes.

1.2 Structure of the Book

This book deals with the issues of strategy, business models and enterprise architecture from a business perspective. There are still no standard definitions and clear distinctions between these concepts in the literature. This is why we will summarise, analyse and discuss the four levels of Strategy, Business Models, Enterprise Architecture and Implementation as one unit specifically for the automotive industry – with as little overlapping as possible.

For the purposes of representation, we will structure the four levels of the overall picture as follows, with the help of these questions (see Fig. 1.3):

In which direction	does a company want to develop with its *strategy* in order to distinguish itself from the competition?
What	is the company's overall concept for value creation of a business alignment which is described in the *business model*?

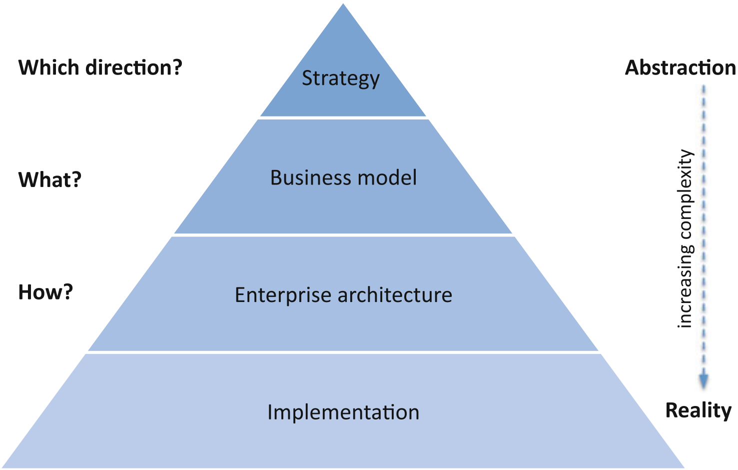

Fig. 1.3 The four levels Strategy, Business model, Enterprise architecture and Implementation, with abstraction at the top and reality at the base of the pyramid

How	does the *enterprise architecture* describe the framework for implementing the business?
Who	*implements* business as part of the enterprise processes when and using what?

The fourth (lowest) level, *Implementation*, summarises the actual implementation and represents the reality. It is usually too complex to be represented precisely in a diagram, and is always company-specific. This is why it cannot simply be summarised with one question. The first three levels, on the other hand, can be broadly generalised for the automotive sector. However, individual levels depend on each other – both upwards and downwards. The levels are dependent on each other because existing companies must first understand precisely where they are with their businesses before they decide how they can and want to use strategy to change. On the other hand, it is also helpful to take a look from the top down to the bottom in order to identify old historical burdens and, more independently from that, to prioritise a new direction.

The individual levels go step-by-step from abstraction, at the level of strategy, to the reality – with the actual implementation within the context of the company. Due to the history and global activity of each automotive company, the reality is very complex and cannot be documented in models in a way which is detailed enough. Even the business processes which provide the framework for implementation are always just models – which can never present all real situations. We will concentrate more on identifying the fundamental factors which significantly influence the implementation of the process to be looked at. Using as many examples as possible, we will attempt to make generalisations about reality.

Later, we will describe the business processes in more detail in the context of enterprise architecture as a part of the third level – something which is often looked at separately in the literature. This also leads to some disadvantages, however, which we will explain in more detail later. The three simple questions “Which direction?”, “What?” and “How?” are only supposed to clarify the individual levels of the overall picture. In the detail of each level, of course, there are many further questions, which themselves contain similar questions with a more precise focus and context.

Nowadays, the carrying out of supporting business processes in the management of the automotive industry (i.e. staffing and recruitment) is something which lends itself especially to generalisation and standardisation using software packages. The main focus is on cost reduction and the standardisation of businesses around the world – two things which are independent of the vehicle manufacturers’ main tasks. Such software standardisations do indeed also contribute significantly to the pervasiveness of digitalisation in companies, but they are not the primary focus of this book. There is plenty of other literature on ERP – Enterprise Resource Planning written by large software companies such as [14] or those with a technical focus, such as [4].

Throughout the whole book, our main focus will be on the level of enterprise architecture. We look at this level not only from the narrower perspective of information technology (IT) but also from the broader perspective of business. What is crucial here is the close interplay between the business architecture and the different levels of detail in the architectures and information systems. The three levels of strategy, business model and implementation set out the crucial context in which the enterprise architecture is discussed.

The book is made up of a total of four chapters:

- The introduction summarises the basics of enterprise architectures. While models and detailed studies of architecture frameworks do not play a central role in this book, we do provide references to relevant literature. These are important for a uniform structure, but can soon degenerate into replacements for action. An understanding of business in the automotive industry is fundamentally more important, because enterprise architecture must always be used in a business context in order to make successful implementation possible.
- In Chap. 2, we summarise the main development and product development phases in the automotive industry as the framework as part of which an enterprise architecture develops over many decades. The focus is on the core competence of vehicle architecture for highly-standardised mass-produced products, and the increasing significance of digitalisation due to electronics and software.
- In Chap. 3, our discussion focuses on potential enterprise architectures in the context of the automotive industry. For this purpose, we also introduce strategy and business models. Nowadays, companies in the core businesses of this industry are similar to such an extent that it is possible for us to abstract a uniform model. We discuss the enterprise architecture as the structure to be used for the implementation of the business model for the whole business alignment along with business competences in the automotive industry. The

methods and business processes are the fundamental cornerstones of a business-oriented enterprise architecture in the automotive sector. Existing architectures of vehicles or information technology in businesses are put into an overall context. From these, we create a reference model based on 89 business competences which describe the business architecture of today's automotive industry.

- In Chap. 4, we discuss potential ways of transforming the automotive industry into a mobility industry which brings together a broad spectrum of possibilities in order to make spatial mobility meet individual requirements. The autoMOBILE can be a central element of this – but this must be something that the automotive sector wants, and that is worked towards. We specify the strategy necessary for this in the context of today's competition, with the trends and market movements taking place in the automotive sector. We present methods for the analysis of sectors and rivalries among competition in the mobility industry, and in our analysis, we discuss both existing business competences and those which automotive companies still need to develop. Controversially, we will discuss why a vehicle manufacturer who only thinks about the AUTOmobile and orients his company accordingly, will not be successful in the long term. One of our central themes is data and data-based models, which are changing business in the digital era. We will not alter the entire reference model which we detailed in Chap. 3. We will concentrate on the crucial 15 % of business competences, and transform them into a reference model comprising 90 business competences for a potential mobility industry. Rather than representing a solution, it is meant to draw more attention to the challenges of tomorrow and bring potential possibilities to the fore so that they are addressed.

1.3 What Does the Framework of the Automotive Industry Include?

The companies which produce motor vehicles[6] are referred to collectively as the automotive industry. For the sake of simplicity, we will always refer to "vehicles" rather than "motor vehicles", and to "mechanics" rather than "motor vehicle mechanics" etc., as the whole book is to do with motor vehicles. Of the many different types of motorised vehicles around, a distinction can be made between the following three types of vehicles in the context of business architecture:

- passenger vehicles,
- lorries or commercial vehicles,
- construction machines and construction equipments.

In many situations, these can be grouped together in the context of the enterprise architecture – but in others we have to look at them separately. We often only con-

[6] Strictly speaking, a motor vehicle is a vehicle which is powered by a motor and is not track-guided.

centrate on companies which produce passenger vehicles for private use, because this market continues to be the sector with by far the highest turnover, and the primary focus for necessary changes in the field of consumption in the automotive industry. We will not be able to include all the numerous variants for all types of vehicle requirements in terms of private consumption in the enterprise architecture – because there are too many vehicle classes which differ in terms of design, dimensions, mass, construction type, emissions, equipment, aim of use, and the type of customers they are aimed at. Also, various organisations often create different classifications according to their own criteria. For example, governments focus on criteria for classification in terms of vehicle tax,[7] while car rental companies often use the ACRISS Car Codes[8] and insurance companies focus on assessing the risk of damage[9] of a particular vehicle category. In addition, the European Commission, for example, classifies passenger vehicles as follows [7]:

- Mini cars,
- Small cars,
- Medium cars,
- Large cars,
- Executive cars,
- Luxury cars,
- Sport coupés,
- Multi Purpose Cars,
- Sport Utility Vehicles (SUV) and Off-Road Vehicles.

Not only would such a level of detail be outside the scope of this book – it would also afford too much significance to the differences between various vehicle classes and market segments, which are rather minimal from the viewpoint of an enterprise architecture. This is why, in our discussion, we simply refer to them all collectively as vehicles. At the same time, it should be remembered that all these different vehicle classes feature significant differences in terms of vehicle architecture, which means they represent a feat of engineering which should be given high recognition accordingly as a core competency of the automotive industry. We will mention this core competency several times in Chap. 3 because the range of models, which includes many different vehicle classes, crucially defines what today's vehicle manufacturers can offer on the market. Table 1.1 brings together several examples of vehicles, classified in different categories. The variety of models offered by vehicle manufacturers is now much broader, however, so that many models can no longer

[7] §9 section 2 of the German Motorised Vehicles Tax Act (KraftStG): http://www.gesetze-im-internet.de/kraftstg/__9.html. Accessed: 19 December 2014.

[8] "Acriss – Industry standard vehicle matrix to define car models" http://www.acriss.org/car-codes.asp. Accessed: 19 December 2014.

[9] "50 models in category check" http://www.autobild.de/artikel/kfz-versicherung-typklassen-2015-1288049.html. Accessed: 19 December 2014.

Table 1.1 Some examples of vehicles, classified by the European Commission [7]

Vehicle class	Volkswagen group	Toyota motor	Daimler	BMW group
Very small cars	VW up!	Aygo	Smart Fortwo	–
Small cars	VW Polo	Yaris	–	Mini
Medium cars	VW Golf	Avensis	Mercedes-Benz A-Class	BMW 1 series
Upper-medium cars	Audi A4, A5	Lexus IS	Mercedes-Benz C-Class	BMW 3 series
Executive cars	Audi A6, A7	Lexus GS	Mercedes-Benz E-Class	BMW 5 series
	Audi A8	Lexus LS	Mercedes-Benz S-Class	BMW 7 series
Luxury cars	Bentley Mulsanne	–	Mercedes-Maybach	Rolls-Royce Phantom
Sports cars	Porsche Boxster	GT86	Mercedes-Benz SL	BMW Z4
Multi-purpose vehicles	VW Sharan	Sienna	Mercedes-Benz V-Class	–
Off-road vehicles	Porsche Cayenne	Land Cruiser	Mercedes-Benz G-Class	BMW X5

clearly be classified into a vehicle category. Furthermore, the number of different vehicles available is constantly increasing. In 1990, for example, there were 101 different vehicles on offer in Germany. In 2014, this figure had become 453.[10] The complexity of vehicle design is increasing continually, because nobody wants to abandon individual market shares to the competition.[11] In the category of "off-road vehicles" alone, each manufacturer already has many different models, and many more are already in the planning stages. In Chap. 4 in particular, we discuss why it is precisely this increasing complexity and the expenses associated with integration which are leading vehicle manufacturers into a dead end.

What is decisive about this book is the fact that it even goes beyond the framework set by us about vehicle manufacturers. This is because we want to look at the automotive industry as the industry sector which makes it possible to overcome spatial distances in order to meet individual requirements. These individual requirements may be related to time, location or the amount of luggage which needs to be transported. This means that we see not only vehicles as products, but also

- mobility services which offer added value services – not only those based on

vehicles. It is possible to imagine that a new industry sector may develop in future, which concentrates more on mobility. We will go into more detail on this in the next section.

In the extended context of the automotive industry and its established value creation chain,

- automotive suppliers and
- car dealers

are also very important. Larger suppliers in particular often serve other sectors in addition to the automotive industry. Some of them also belong to their own industry sector – such as mechanical engineering or equipment construction. Yet, suppliers in the automobile manufacturing are very relevant, because they have an extremely high value-added share. Furthermore, networks of suppliers and traders form an important system context in terms of business architecture and a critical environment in terms of changing societal models.

[10]"Brand cannibalism in the automotive sector: Increasing number of models causes angst." http://www.automobilwoche.de/article/20150224/AGENTURMELDUNGEN/302249990/1276/markenkannibalismus-in-der-autobranche-modelle-essen-seele-auf. Accessed: 24 February 2015.

[11]By the year 2020, for example, Mercedes-Benz is to bring 12 additional unprecedented models to market. http://www.autocar.co.uk/car-news/new-cars/mercedes-benz-confirms-12-all-new-models-2020. Accessed: 19 December 2014.

In the automotive industry, manufacturers are referred to as Original Equipment Manufacturers (OEMs) if they construct their products and bring them to market under their own brand name – even though most[12] individual parts are manufactured by other suppliers. For example, nearly all OEMs get brakes, tyres, steering wheels, headlights and navigation devices from specialised suppliers all over the world. This means that the knowledge about many key vehicle technologies and their manufacture is no longer in the hands of OEMs alone, but is increasingly concentrated in the hands of suppliers. A single supplier often serves several OEMs at the same time, with very similar or identical parts. Of course, there are still significant differences between the technology and materials used by different vehicle brands. It is becoming less and less easy, however, for the average users to attribute them to a certain brand.

What is crucial is the fact that new companies can design their own vehicles without OEMs more easily if they can have access to the network of suppliers. This is how Google, for example, went about developing its vehicle with Continental and Bosch in addition to further partners.[13]

1.4 Tomorrow's Mobility Industry

In the previous section, the provision of mobility services with the aim of value creation was added to our view of the automotive industry (also see Fig. 1.2). It would be appropriate to understand the mobility industry as a new branch of the industry, within which the automotive industry is a supplier – similar to the relationship between the automotive industry and mechanical engineering and equipment construction.

So, Why This Broadening into a Mobility Industry?

An industry is shaped by the architectures and approaches of the products and systems within it. Nowadays, the automotive industry is very strongly influenced by the way that engineers think: Products are only deemed to be complete when no other functions can be added to them. It is precisely this situation which is reflected in vehicles today. In this respect, a mobility industry can develop in a more goal-oriented way. Conversely, one could say that a product is only complete when no functions can be taken away without losing the ability to fulfil the original objective

[12] According to a study [13] from the year 2002, an average of two thirds of the parts of each vehicle came from suppliers rather than OEMs. Ten years later, a further study [23] showed that the proportion of work completed by OEMs and suppliers had changed even more, with the value-added share of OEMs dropping to 29 % .

[13] "Google partners with auto suppliers on self-driving car" http://www.reuters.com/article/2015/01/14/us-autoshow-google-urmson-idUSKBN0KN29820150114. Accessed: 15 January 2015.

Fig. 1.4 What is the goal a knife is meant to fulfil? A product can either be considered complete because no more functions can be added to it, or because no functions can be taken away without losing the ability to fulfil the original objective of the product (Photos: Victorinox)

of the product. These two completely different approaches are illustrated in Fig. 1.4 using the example of the knife.

What Would Be the Precise Aim of a Mobility Industry?

The terms 'services' and 'products' as frameworks and aims of spatial mobility are not used in a uniform way in the literature – the topic is still too new to our economy, and has been looked at in a way which is too one-sided. Fundamentally, it is about satisfying mobility needs in order to overcome spatial distances, so that persons or goods can change location. Individual traffic is defined as the sum of all movements of people and goods, as part of which a huge range of mobility needs are satisfied. Mobility services can be very simple information services – for example, those which provide information about the timetable of a form of public transport or the location of an available vehicle. Those which are more costly are booking services or different ticket and payment systems. Even more complex services extend further than the actual carrying out of travel – and products are necessary for this.

A further dimension involves combining the variety of travel options in an individual way. The following four terms have become established for mobility services:

Unimodal: For one journey, information about just one transport provider is given, and only one transport mode is used – for example, a single train connection with no changes. The vehicle makes a chain of unimodal journeys possible on a daily basis. For example: starting with the journey to work, followed by another journey out shopping in the late afternoon, then to a sports fields and finally the journey back home. Depending on the distances and fitness of the people involved, of course, the chain of unimodal journeys can also be completed using one's own muscle power.

Intermodal: This term is used when different transport modes from different transport providers can be booked and used together. This is what travel agencies for longer holidays involving trains and planes have specialised in. A travel agency, however, would find it difficult to include car-sharing in holiday plans.

The intermodal journey type is very common in our everyday lives. It may start with a journey by car or bike to the train station in the morning, parking of the passenger's own vehicle, then a change to the train for a journey to another town, followed by a taxi or rental car to a business appointment, and so on.

Multimodal: A multimodal journey, on the other hand, is only carried out by one transport provider. There are, however, several transport modes available for the same journey, in addition to information. For example, it is often the case with public transport in Germany that the bus and train are provided by a single provider, including a timetable with options on changing; and even the same parts of the journey can be completed using either the bus or the train.

Integrated: A journey often starts with a contribution by the passenger (by foot or in own transport) and is only planned in detail in advance in the case of longer journeys. Depending on the location and situation, offers and information from different transport providers can be combined and optimised to fulfil the needs and various requirements passengers have of the different types of transport. To do this, a platform for the integration of many services, products and their combined effect in the transport system is needed. Depending on preferences, the user is given a timetable, a time, a price, a booking etc. for the whole journey. What is fundamental in terms of integration is a seamless transition between the individual transport providers.

In Fig. 1.5 we have sketched examples of intermodal and multimodal journeys. From the various possibilities offered by mobility services, we can derive the following

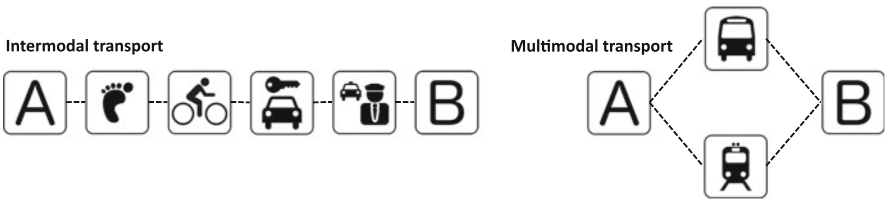

Fig. 1.5 An intermodal journey includes different transport modes from more than one transport provider. A multimodal journey, meanwhile, offers several possibilities from a single transport provider

definition for the mobility industry:

> Mobility industry companies make a platform of integrated products or services available, with which spatial distances can be overcome in accordance with individual needs, and billed for in a standardised way. Essentially, the satisfying of individuals' demand for mobility is optimised using the infrastructure available. A long-term goal of this industry branch is also to adapt infrastructure to meet demand.

The platform for the provision of integrated mobility has three challenges which need to be met in order to fulfil individual needs:

- The transport participants have *individual preferences* during the change of location which must be taken into account when combining journey possibilities. The focus here is on people who have habits which mean that they are not always looking for the cheapest or quickest option. The evaluation of preferences such as habit or how well a person knows a place are more difficult to take into account in a platform. We just have to imagine our journey to work in the morning – where knowing the route can be of paramount importance. The return journey, on the other hand, could be a different situation – in which the duration could be particularly relevant.
- The user's *location and situation* limit the range of alternative journey possibilities. In a business situation, for example, travel participants have to fulfil different requirements to those they would when out shopping in a private capacity.
- The *available transport modes* for overcoming spatial distance have different limitations in terms of their reach, speed, operating costs and effect on the environment, etc.

Of course, implementing the platform involves countless technical challenges in terms of integrating very different transport providers. Technical problems develop when a mobility concept is being set out in detail. In Fig. 1.6, we have sketched some examples of ways in which a platform for a journey can integrate users' preferences. In Chap. 4 we will go into more detail about evolutions in the market, and about how business architecture can be designed in such a way so that a mobility industry does not develop in complete isolation from the automotive industry.

1.5 Who Should Read This Book?

This book is primarily aimed at managers in the automotive industry who are developing an implementation plan for new or improved business possibilities, and who want to understand at least the basics of the role of enterprise architecture. The

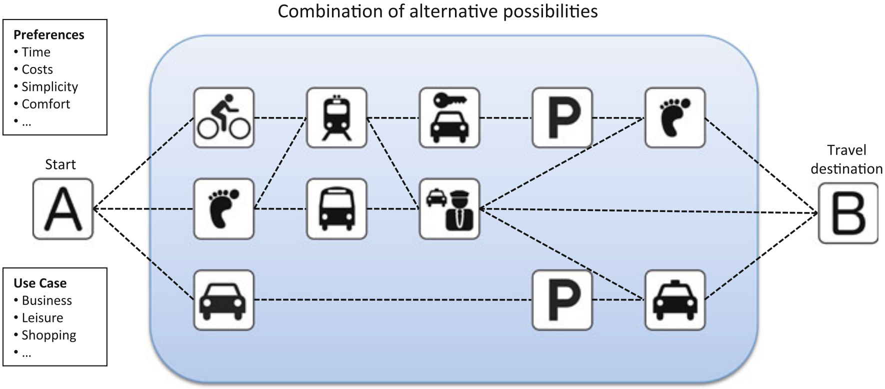

Fig. 1.6 An example platform for the provision of mobility services which integrates a number of possibilities for overcoming spatial distance, and which takes into account preferences of the transport participant

book can be useful to anyone, irrespective of their company role – but the language used is aimed in particular at company strategists, consultants and enterprise architects. Rather than going into great detail about the competence areas of vehicle development and manufacture which have existed until now, the book discusses the broader context of spatial mobility and potential transformations from the point of view of the automotive industry. It is intended to serve as a handbook with advice on inventing and implementing new business models which could help to structure a potential mobility industry. Efforts have been made to keep the language as simple as possible. Specialist jargon is avoided or used in a simplified way if background knowledge is needed.

Any good start is based on ideas, but only practical experiences and pragmatic implementations lead to producible value for a company. It is the intention of this book to provide the ideas for this – in an era when business in the automotive industry and information technology for new products and services need to be developed in ever closer collaboration. Due to the fact that, in complex, accumulated business structures such as the automotive industry, numerous ideas can only become success stories in this way, we will also discuss controversial approaches in several sections.

This book addresses seven roles in particular, the interplay between which is crucial for the success of an automotive industry which thinks about the long term – and which includes the mobility market. Certain chapters will be of particular interest for the following seven specialist groups of readers.

1.5.1 Those Responsible for New Business Models and Innovations

In different fields of business, new ideas for business models or innovations are always being inspired by various sources. The people responsible for developing these ideas are confronted with the question of how they can be used to create value for the company. The more the attitudes of the company need to be changed, the more difficult it becomes to focus on the "right" ideas.

For managers of automotive companies who are identifying and trying out new areas of growth with the help of business innovations, business architecture is a tool which takes some getting used to. This is why, in Chap. 4, we start off with more familiar tools such as market research, comparisons of organisations within a company, or across companies in the automotive sector. Later on, we will move on to particular ways in which processes can be improved – this will give an insight into an enterprise architecture.

Even if managers are only responsible for the initial commercialisations of new business models, in the case of more significant transformations, it is important to make it possible to implement business success in the long term. This is precisely what enterprise architecture is intended to bring about. At the same time, this book will not go into an excessive amount of detail about the process and implementation details of individual activity levels.

1.5.2 Chief Information Officer

The head of IT – often also referred to as Chief Information Officer (CIO) – generally takes on the roles of strategic and operational management of information technology within a company. The supervision of existing IT systems is a conservative role which is not considered a core competency in the automotive industry – instead, it is treated purely as a cost factor. Often, many IT systems have historically developed as part of so-called "Shadow IT", which is not visible to the CIO. In Chap. 4 in particular, we discuss the increasing relevance of digital products, which is inevitably changing the role of the CIO in the automotive sector. In Chap. 3, the book provides advice on developing strategies for enterprise architectures – as part of which CIOs can play a decisive role in new business models.

1.5.3 Chief Technology Officer

What exactly do we mean by the next generation of a type of architecture? In the automotive industry, it is no longer primarily about the next generation of purely technical equipment, and how this can be integrated into IT architecture alone. Business architecture in the industrial context is gaining ever increasing significance, as it allows technology to be used to achieve business successes. This is why the role and required skills of the Chief Technology Officer (CTO) are becoming broader – just as those of the CIO. As the CTO is responsible for the enterprise architecture, he or she has a crucial role to play in the next generation of the business's foundations. His or her insight into the broader business context is becoming more and more necessary in order to make it possible for the business architecture to make a valuable contribution to the business. It is precisely this insight that this book wishes to provide for the next generation of business architects and CTOs in Chap. 3. Additionally, the introduction to vehicle architecture provided in Chap. 2 is also very helpful. Nowadays, it is one of the most pronounced technical core competencies in the automotive industry. Of course, the core competencies of the IT business architects still apply as well. These are precisely the strengths which make it possible to develop an enterprise architecture further, in order to provide a strong foundation for the changing industrial context presented in Chap. 4.

1.5.4 Chief Analytics Officer/Chief Data Officer

The role of a Chief Analytics Officer (CAO) [16] in the automotive industry is still to a large extent unknown. A similar role is that of the Chief Data Officer (CDO) [9], who works in a comparable context by gaining added value from electronic data. Sometimes both roles can be found in one company. Correspondingly, a distinction is made between the responsibilities of systematic data analysis[14] and that of data processing alone. In the automotive industry, data is still a long way off being considered as important as oil. Due to the constantly increasing demands on data evaluation and the ever greater relevance of IT within companies, the role of the CAO is becoming more and more significant. Not only do data need to be correlated for reports – they now also need to be used in a more strategic way for new business models in the context of the whole business. Essentially, the CAO changes the way in which the company does business. Chapter 4 provides orientation suggestions for the roles of CAO or CDO in the automotive industry.

1.5.5 Vehicle Development Manager

Over many decades, vehicle development has come of age as part of a very structured development process which we can only begin to describe in Chap. 2. The business competences of vehicle development, which we discuss in Chap. 3, can no longer have the single primary goal of an optimally integrated whole package of a desirable vehicle. This is why, in Chap. 4, we emphasise that engineering precision should no longer concentrate solely on shaping vehicle properties such as safety, speed and comfort – instead, it must also become better connected, more socially-oriented and more digital in the broader context of mobility. As a result of this,

[14]In data analysis, the data is collected during different phases before being examined, evaluated and presented in such a way that it can be used for decision-making within the company.

properties develop – the presence of which in existing investment processes cannot be justified economically through their immediate function alone. The fundamental task of the development is to integrate vehicle architecture into a long-term mobility architecture.

1.5.6 Vehicle Production Manager

As is the case with vehicle development, product manufacturing and the automation thereof has also developed considerably over several decades. There is plenty of detailed literature available on this subject [6], which we are only able to touch on in Chap. 3 from the viewpoint of business competences. The discussion is focused more on the interconnection and standardisation of the manufacturing process – in order to make another type of individualisation of product manufacturing process possible in close collaboration with the provision of mobility services. This might sound slightly naive: As though there were no interconnections or standardisations within product manufacturing already! This also seems to be jumping the gun a little, because how should it be possible to make a short-term contribution in today's world of cost and automation pressure? In Chap. 4, we will discuss the need to change the monolithic control functions in the manufacturing architecture, and how they can become more closely interlocked with business architecture. In particular, Industry 4.0 takes on a pioneering role here.[15]

1.5.7 Managers in Distribution, Sales and Customer Services

How should an automotive company group align itself if it wants its customer relationships to be about more than just selling vehicles? Due to the information channels available nowadays, customers are often very well informed about products when they come to the dealer – so they have no desire to enter into a customer relationship. In Chap. 4, we will discuss the rapidly growing number of value-added services for individual mobility, and Chap. 3 will address the possible effects these may have on sales architectures as they are at the moment.

1.6 Information Sources and Newsletters

Throughout the whole book, we provide references not only to literature, but also to numerous information sources which are published on the internet. Many recent market developments can be found in newsletters which have specialised in different aspects of the automotive industry. When referring to specialised news items from the internet, we use short footnotes for the sake of brevity – because information

[15] "Platform Industry 4.0" http://www.plattform-i40.de. Accessed: 19 December 2014.

was taken from significantly more sources. Information from four main categories has influenced this book: the automotive industry in Germany and worldwide; both from a more traditional viewpoint and that of information technology.

We wish to draw attention to the following established news services of the automotive industry in Germany, the links from which were accessed before the end of 2014:

- Automobilwoche.de – The Bookmark of the Automotive Industry
  http://www.automobilwoche.de
- Auto-News – Latest news, tests and information – DIE WELT
  http://www.welt.de/motor
- MOTOR-TALK – Europe's biggest car and motor vehicle community!
  http://www.motor-talk.de

and especially for IT topics

- News – carIT – Connected Car
  http://www.car-it.com/category/news

Sources which look at the automotive industry as a whole:

- Automotive News
  http://www.autonews.com
- Telematics News
  http://telematicsnews.info
- Telematics IQ
  http://www.telematicsiq.com
- Automotive World – Information and networking for auto industry professionals
  http://www.automotiveworld.com
- Reuters – Autos
  http://www.reuters.com/subjects/autos
- Autoblog – We Obsessively Cover the Auto Industry
  http://www.autoblog.com

and especially for global IT topics

- Automotive IT News and Facts – automotiveIT International
  http://www.automotiveit.com

The categories and their content may overlap. Large announcements or news pieces often appear simultaneously in different categories of the news services listed above.

1.7 Enterprise Architecture

The term 'IT architecture' refers to a technical structure made up of several IT components in relation to each other, which is developed on the basis of standardised norms and design guidelines. In most cases, as economically independent organisational units, companies do not have to deal first and foremost with technical structures. This is precisely why we want to explore the relevance of this structure to a company. For the sake of simplicity, we will refer to it as the enterprise architecture.

Whether consciously or unconsciously, every company has its own architecture: This simply refers to the way in which business is done. Nowadays, in practice, consciously used enterprise architectures tend to originate in IT fields, and are often limited to IT. In larger companies which are focused on IT, holistic enterprise architectures are already common nowadays. In the automotive industry, the term 'enterprise architecture', which refers to more than just the relatively small IT departments,[16] is an unknown or still very young field, the spread of which is not standardised in any way. Gaining a holistic view of a company is made more difficult by the fact that IT is not just a minor aspect of automotive companies – it represents a block of costs which companies are very reluctant to invest in.

In short, enterprise architecture is still in its infancy in terms of development, if we measure it in terms of the business strategy and alignment of an industry. There is, however, very comprehensive literature which describes enterprise architectures from the point of view of IT, based on methodical approach models. Some examples are [10, 17]. During the past few years, countless frameworks for describing IT architectures have been published – over 50 different concepts were brought together in [12] alone. Even though there would be no harm in getting to know several frameworks and comparing them in terms of requirements [19], we only wish to refer to two works. What is surely the most frequently cited article about enterprise IT architecture was written by John A. Zachman [24]. More than 25 years ago, he formalised a holistic view of IT systems in enterprise-level architecture as the foundation of many works, which have been continually developed. The framework puts architecture components in perspective using the following fundamental questions: "What?" (Data), "How?" (Function), "Where?" (Network), "Who?" (People), "When?" (Time) and "Why?" (Motivation). We will use similar approaches to questions in several chapters.

The most commonly used[17] framework for enterprise architectures is TOGAF (The Open Group Architecture Framework) [21], which has little in common with that created by Zachman. In some sections, we use the following sub-architectures of an enterprise architecture model which are distinguished between in TOGAF,

[16]Depending on the type of vehicle manufacturer, IT staff make up around 1–2 % of the company staff.

[17]The actual use and benefit of frameworks in businesses is difficult to estimate, and can only be evaluated using surveys or frequencies of references in the literature [15].

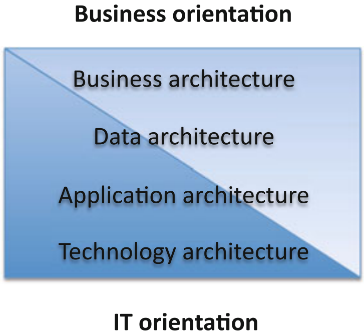

Fig. 1.7 A simplified overview of the enterprise architecture in order to build a linguistic bridge between business and IT orientations within a company

in order to create a linguistic bridge between business and IT orientations (see Fig. 1.7):

- Independently of technologies, the *business architecture* describes the most important business skills, functions and processes a company has. Its function is to keep the business organisation going in the right direction. A central example in the automotive industry is the product design process for controlling development and construction right up to production in the development phases of a series product from individual series to small batches and large-scale production. We will go into this in more detail in Sect. 2.2.
- As part of the information systems, the *data architecture* describes the connections between and classifications of all data in the company. Through digitalisation, data is gaining a greater role in new business potentials. Of central importance for vehicle architecture in the automotive industry is the bill of materials (BOM), which we will describe in more detail in Sect. 2.3.1.
- The *application architecture* describes another part of information systems – applications and their relationships to one another, as well as to business processes at a company level. The application landscape includes all IT systems and their interfaces. Many core applications in the automotive industry are establishing themselves in the field of Computer-Aided Engineering (CAE). We will go into more detail about this in Sect. 2.4.
- *Technology architecture* describes the standards which have been defined for the technical implementation of the information systems in an operational infrastructure. This involves a portfolio of technologies. For example, the technologies can consist of hardware, software and communication, and have hardly any relation to the business tasks of the automotive industry.

TOGAF, provides a detailed method via which to create an enterprise architecture – but is very abstract when it comes to business architecture. It is thought that business architecture cannot be modelled any more specifically unless the context is determined by the industry branch to be looked at. The context is important because companies – not to mention those in the automotive industry – cannot earn money with a framework alone. Customers and employees are hardly likely to notice whether services or products are made possible thanks to an enterprise architecture or not. They often only notice when, even after decades of success, companies suddenly cease production, axe jobs or even disappear completely. Famous companies such as Kodak, or Brockhaus and Quelle in the German-speaking world, have met the same fate. Not only had they missed the opportunity to get to grips with new business models from external environments early on – they were also unable to implement these effectively.

This book focuses on business architecture, as this is the key to the architecture of the entire company, and is the crucial linking element which is needed in order to implement the business model. There are many directive publications in the literature about this subject [18].

The reality of implementing architecture in larger companies cannot be presented as simply as has been done in Fig. 1.7, in layers. In Chap. 3, we will introduce enterprise architectures in the automotive industry – starting with strategies and business models. Essentially, we define the transition to enterprise architecture via the following three interfaces:

- Organisations *follow* business processes.
- Organisations *belong to* a business domain.
- Organisations *use* applications.

The three interfaces "follow", "belong to" and "use" form the basis for effective structure in any company. Meanwhile, business domains are modelled purely functionally, and independently of processes, organisations and applications. Business domains can be broken down into business skills, functions and services, which exist in relation to processes and applications. The more detail we go into, the more complex things become. Classification into different business details makes sense in larger company groups such as those in the automotive industry, because implementation via business processes alone does not make it possible to have a holistic view of all business units. With the simplified layers of Fig. 1.7 as our starting point, we summarise the framework of the enterprise architecture of Fig. 1.8 in the same way that we will do in even more detail for today's automotive industry and the potential mobility industry of the future. In short, enterprise architecture can be defined as follows:

> Enterprise architecture describes how business models can be implemented within the company by using organisations. It makes the three interfaces "follows", "belongs to" and "uses" available to an organisation. Organisations follow business processes, belong to a business domain and use applications. Within the enterprise architecture, the technologies make available the basis for the applications and data.

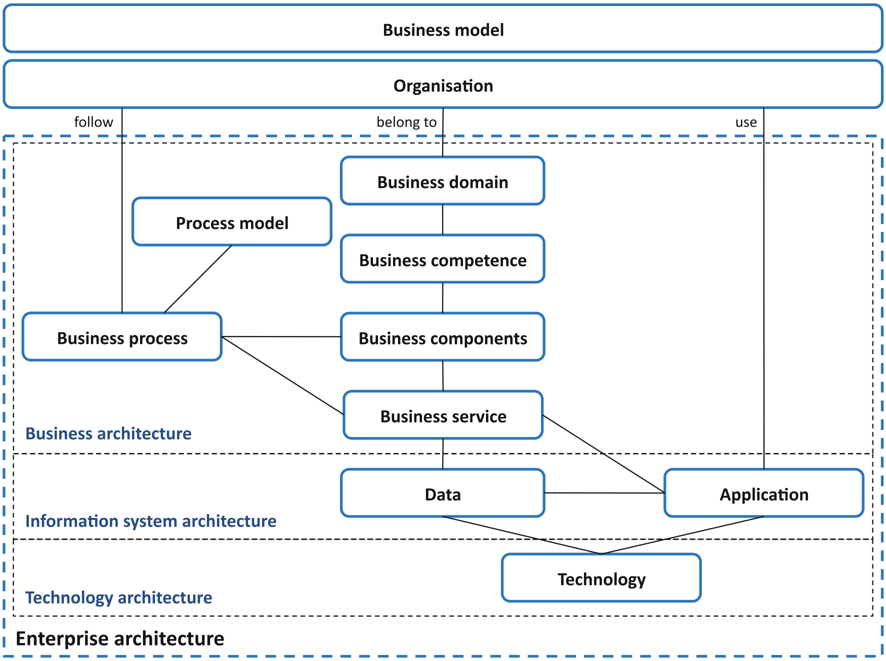

Fig. 1.8 The framework of the enterprise architecture, using the sub-architectures of TOGAF

We do not intend to shed any more light on the theoretical details of the architecture, but will start straight away with specific details of enterprise architecture for the automotive industry in general – which we will elaborate on in Chap. 3 in particular.

When defining the enterprise architecture, we purposely did not look at the timescale of the changes to be made. In the literature, this is referred to as Enterprise Architecture Management. Especially over long time periods, management faces significant challenges in terms of making the company alignment easy to understand, and supporting it efficiently. In the short term, it is often simpler and cheaper to add something to an enterprise architecture rather than removing something or changing its entire framework. For example, vehicle architectures (of a broad range of models and series) have featured as sub-aspects of enterprise architecture over 125 years – as a result of which countless complex changes and new framework conditions have been implemented very accurately, in addition to regulations with engineering procedure models. In Chap. 2, we look at several historical themes in the context of architecture. We will, however, not be able to go into any more detail about the use of methods and models in the development process, so we will refer instead to literature such as [22]. We will not touch on the management of the enterprise architecture either, because it can to a great extent be looked at independently from the automotive industry, and there is already plenty of literature on the subject, i.e. [1] or [8].

When Is It Helpful or Even Necessary to Have an Enterprise Architecture?
We limit our response to a few economic branches of the automotive industry. According to data published by the German Federal Statistical Office (Destatis) in May 2014 [20], at the end of September 2013, Germany was home to 1319 businesses with 20 or more employees for the manufacturing of cars and car parts, and 6138 such businesses in the field of mechanical engineering. Of course, not all mechanical engineering branches are active in the automotive sector. On the other hand, these figures do not even come close to including all automotive suppliers from other sectors of the economy, nor do they include the countless small businesses with fewer than 20 employees. More significant is the fact that a total of 7457 businesses can be classified according to the number of staff they employ, which means we can quantify the need for enterprise architecture as follows:

38 % of the businesses have fewer than 50 employees. They can often react to evolutions in the market in a more agile way. Having a documented enterprise architecture can represent more of an obstacle than a benefit to such businesses.

59 % of businesses employ between 49 and 1000 staff. It is possible to have a thorough overview of an enterprise architecture. It can be very helpful for large-scale restructuring or new company alignments.

3 % of businesses employ 1000 staff or more. A documented enterprise architecture which is put into practice is needed in order to be able to continually implement long-term transformations as necessitated by market evolutions.

Many companies grow over time. This is why it can never hurt to think about employing an enterprise architecture early on. The number of staff is not the only way to measure the complexity of a business, but nowadays it is one of the most important ways of determining its clout. For global companies, their reach in the market is decisive – which does not necessarily mean that they have to be big. Efficiency in the commodities markets can be achieved by decentralising the organisation. Risk in the service markets, on the other hand, can be controlled better by centralising organisation. Compared with OEMs, automotive suppliers tend to operate on a national level – except for a few global system suppliers. This may change, however, due to the growing services market for the autoMOBILE.

With its three interfaces as shown in Fig. 1.8, the enterprise architecture is closely aligned to the organisation, and provides a tool for structured implementation when companies need to reinvent themselves. Due to this close linkage, the organisation obviously shapes the enterprise architecture as well. For a detailed look at organisations' structures we refer to the following literature: [2, 5]. We will now concentrate primarily on enterprise architecture.

References

1. Ahlemann F, Stettiner E, Messerschmidt M, Legner C (2012) Strategic enterprise architecture management: challenges, best practices, and future developments. Springer, Heidelberg
2. Bach N, Brehm C, Buchholz W, Petry T (2012) Wertschöpfungsorientierte organisation: architekturen – prozesse – strukturen. Springer Gabler, Wiesbaden
3. BMW Technology Guide: iDrive Touch Controller. http://www.bmw.com/com/en/insights/technology/technology_guide/articles/controller.html. Accessed 7 June 2015
4. Böder J, Gröne B (2014) The architecture of SAP ERP: understand how successful software works. Tredition GmbH, Hamburg
5. Bullinger H-J, Spath D, Warnecke H-J, Westkämper E (Hrsg.) (2009) Handbuch unternehmensorganisation: strategien, planung, umsetzung, 3rd Aufl. Springer, Berlin
6. Clarke C (2005) Automotive production systems and standardisation: from Ford to the case of Mercedes-Benz. Physica, Heidelberg
7. Commission of the European Communities (1999) Case No COMP/M.1406 – Hyundai / Kia: Regulation (EEC) No 4064/89 merger procedure: Article 6(1)(b), Brussels
8. Hanschke I (2012) Enterprise architecture management – einfach und effektiv. Hanser, München
9. IBM Institute for Business Value (2014) The new hero of big data and analytics: the chief data officer. IBM Corporation, Somers, NY
10. Keller W (2012)IT-Unternehmensarchitektur – Von der Geschäftsstrategie zur optimalen IT-Unterstützung. Dpunkt.verlag, Heidelberg
11. Liker JK (2004) The Toyota way: 14 management principles from the world's greatest manufacturer. McGraw-Hill, New York, NY
12. Matthes D (2011) Enterprise architecture frameworks kompendium. Springer, Heidelberg
13. Mercer Management Consulting, Fraunhofer-Institut für Produktionstechnik und Automatisierung -IPA-, Fraunhofer-Institut für Materialfluss und Logistik -IML- (2004) Future automotive industry structure (FAST) 2015 – die neue arbeitsteilung in der automobilindustrie. Materialien zur automobilindustrie, vol 32. Verband der Automobilindustrie (VDA), Frankfurt
14. Monk EF, Wagner BJ (2008) Concepts in enterprise resource planning, 3rd edn. Course Technology, Boston, MA
15. Obitz T, Babu KM (2009) Enterprise architecture expands its role in strategic business transformation. Infosys Technologies Limited, Bangalore
16. O'Regan R (2014) Chief analytics officer: the ultimate big data job? Computerworld. http://www.computerworld.com/article/2688352/chief-analytics-officer-the-ultimate-big-data-job.html. Accessed 7 June 2015
17. Perks C, Beveridge T (2003) Guide to enterprise IT architecture. Springer, New York, NY
18. Ross JW, Weill P, Robertson DC (2006) Enterprise architecture as strategy: creating a foundation for business execution. Harvard Business School Press, Boston, MA
19. Sessions R (2007) A comparison of the top four enterprise-architecture methodologies. White paper, ObjectWatch. https://www.msdn.microsoft.com/en-us/library/bb466232.aspx. Accessed 7 June 2015
20. Statistisches Bundesamt (2013) Produzierendes Gewerbe: Betriebe, Tätige Personen und Umsatz des Verarbeitenden Gewerbes sowie des Bergbaus und der Gewinnung von Steinen und Erden nach Beschäftigtengrößenklassen. Fachserie 4 Reihe 4.1.2, published on 8 May 2014, Wiesbaden
21. The Open Group (2011) TOGAF® Version 9.1. Van Haren Publishing
22. Weber J (2009) Automotive development processes: processes for successful customer oriented vehicle development. Springer, Berlin

23. Wyman O, Verband der Automobilindustrie (2012) FAST 2025 – Massiver Wandel in der automobilen Wertschöpfungsstruktur. http://www.oliverwyman.de/who-we-are/press-releases/2012/fast-2025-_-massiver-wandel-in-der-automobilen-wertschoepfungsst.html. Accessed 7 June 2015
24. Zachman JA (1987) A framework for information systems architecture. IBM Syst J. doi:10.1147/sj.263.0276

2 Enterprise Architectures: Surrounded by Historical Structures

In simple terms, the enterprise architecture can be seen as the structure of a company. Not only is its purpose to make sure that organisational structure of its employees and their tasks are designed in such a way that they pursue shared company goals – it also serves to harmonise the numerous technologies and processes with the company strategy. It is important to understand that an enterprise architecture stipulates the organisational structure and not the other way around – just as on large construction sites, it is the plans given to the builders which determine how the architecture will turn out, and not the other way around.

It is well-known that companies need to redefine and restructure themselves time and again if they wish to remain successful in the long term. Sometimes these adaptations are so significant that the entire company alignment must be called into question. It is precisely in situations such as these that the enterprise architecture takes on significance – especially in larger companies, where it can be crucial for their ability to keeping running in the future. The enterprise architecture is not only meant to summarise what the company is actually like – it also helps us to gain a holistic view of the company in order to shape future goals.

Business architectures which are subject to great changes, especially due to digitalisation and interconnections – which are affecting and fundamentally changing more and more areas of business, are the main driving forces behind enterprise architectures. Digitalisation influences enterprise architectures on several levels. The focus is often on the product itself along with its development, manufacture or distribution. In these cases, however, only incremental or partial changes to the enterprise architecture are needed. On the other hand, there are situations which present a risk because the entire enterprise architecture and the business strategy it is based on need to be digitalised and fundamentally transformed.

This is why, in the context of the automotive industry, we will get straight to the fundamental questions. Who will build the cars of the future?

S. Wedeniwski, *The Mobility Revolution in the Automotive Industry*,
DOI 10.1007/978-3-662-47788-5_2

Will it be those automobile manufacturers with a sense of history, whose enterprise architectures still leave a lot to be desired and who have difficulty moving away from their strong focus on vehicle architecture, or will it be companies with new ways of thinking – which have already built up completely new enterprise architectures for the digital age and give vehicles a personality within a broader mobility cosmos for both people and technologies? After all, it is only once the product that is a "car" has been bought, that it can develop a long-term personality through personalisations which can be changed easily. This can be achieved not only through vehicle-oriented architecture but in 2014, for example, Google presented a new prototype vehicle with no pedals or steering wheel as part of the project "Google Self-Driving Car".[1] Many vehicle manufacturers did not take this project very seriously and therefore did not feel especially threatened. But then, over a century ago, the last German monarch – Kaiser Wilhelm II – could not have been more wrong when he famously said: "I believe in horses. The automobile is a temporary phenomenon." It is now clear that Apple and Google attract young engineers and inventors in exactly the same way that the pioneering companies of the automotive industry did decades ago[2] (see Table 2.1).

Table 2.1 According to a study carried out by the company Universum, as part of which more than 200,000 students were surveyed in 2014, the ranking of the automotive companies is as follows: 3rd BMW Group, 11th Volkswagen Group, 13th Ford Motor, 17th General Motors, 18th Toyota Motor, 20th Daimler/Mercedes-Benz, 30th Nissan, 40th Volvo Car (*Source*: http://universumglobal.com/wmae2014. Accessed: 19 December 2014)

Place	Business	Engineering
1	Google	Google
2	EY (Ernst & Young)	Microsoft
3	PwC (PricewaterhouseCoopers)	BMW Group
4	KPMG	Apple
5	Deloitte	GE
6	Microsoft	IBM
7	Procter & Gamble (P& G)	Intel
8	Goldman Sachs	Siemens
9	Apple	Sony
10	J.P. Morgan	Shell

[1]Google Self-Driving Car Project http://www.google.com/selfdrivingcar. Accessed: 26 July 2015.

[2]It is hard to provide a precise quantitative statement concerning the ranking of the most attractive employers for students. In other German surveys, German automobile manufacturers are leaders in terms of attractiveness for aspiring engineers. It would, however, be impossible to set precise criteria for a worldwide, standardised framework in engineering. In order to provide a basis for a controversial discussion, we should not limit ourselves to German surveys focusing on German companies.

2.1 Transformation in the Transport Sector

Ever since the dawn of humanity, people have sought ways in which to overcome spatial distances, and to make this easier by using transport modes. All around the world and for many millennia of human history, horses have played a significant role in transport. Even if we only see the horse as being an improved way of travelling, we cannot simply ignore the necessity of the personal relationship between human and horse. This is because a good connection, or partnership between human and horse, is vital for effective riding and therefore for effective travel over long distances. And even if we would tend to refer to this aspect in a less emotional way in today's industrial world, it is nonetheless significant that at that time, every product – in our case the horse – was individual, and differed from all others. In the selection, purchase and use of this product, the consumer is the main focus along with his personal character and individual wishes – and was therefore the primary driving force of the industry.

A significant change began in 1886, when the German engineer and automobile pioneer Carl Friedrich Benz patented his construction of a "vehicle powered by gas engine" (see Fig. 2.1). This was also the day on which the automobile was born. At the time, it was also referred to as a "horseless carriage" – in reference to the transport mode which was its main competitor. Although the first motorised vehicles were very expensive, rare and imperfect, more and more people turned away from the traditional power of personal horses towards the impersonal horsepower[3] of cars. In 1900, just 800 automobiles were painstakingly built by hand in the whole of the German Reich. This changed after 1913 Henry Ford's legendary "Model T" became

Fig. 2.1 Patent No. 37435 "Vehicle powered by gas engine" of 29 January 1886 is the birth certificate of the automobile

[3] Horsepower is a historical unit of power. It illustrates how many horses would be needed to replace the work done by a machine.

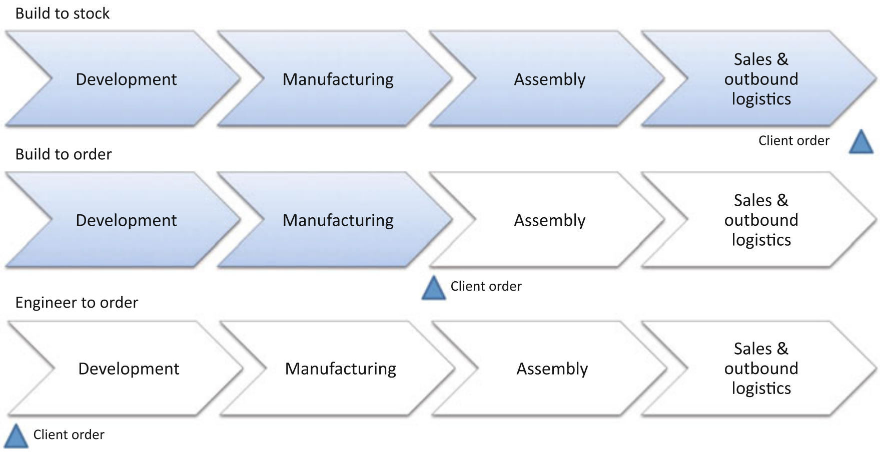

Fig. 2.2 Extent of individualisation: comparison of different decoupling points between the order-anonymous and order-related parts of the value creation chain

cheap enough[4] thanks to mass production so that during the years and decades which followed, the vehicle was accessible to a constantly growing section of the population. This changed the world, setting it on a path towards mechanics, and the use of horses decreased substantially.

In today's industrialised countries, horses tend only to take part in transport as something to be transported in the trailer of a vehicle, and not as the force powering a vehicle. Even comparisons can be found in advertising slogans, for example Daimler with its bold advertising campaign for the M class in 2011 which was later discontinued: "The power of more than 200 horses and lower emissions than a cow."

Since the times of Henry Ford, the economy has primarily been driven by product-producing firms rather than by the consumer, as was the case in the past. For example, between 1915 and 1925, the Ford "Model T" was produced in black only in order to simplify the manufacturing process, and buyers were not able to choose another colour.

Vehicle production was principally shaped by the following three production forms, which led to the establishment of restrictions on the individualisation of vehicles in their development (see Fig. 2.2):

1. *Build to stock* (or build to forecast) for mass production with low-level variability – in which manufacturing takes place without direct dependence

[4]Thanks to mass production, the sales price was reduced from US$ 850 (about US$ 22,311 in today's terms) to US$ 550 in 1913 and then to US$ 440 in 1915. Right into the 1920s, the price was finally lowered to US$ 260 thanks to continual improvements to manufacturing techniques and volumes.

on a specific customer order. Order processing is limited to the vehicles which are in stock.

2. *Build to order* for individually configured products, in which the order-oriented vehicle assembly reflects the personality and wishes of the customer. The individual parts, on the other hand, are manufactured without any personalisations and without knowledge of which order they are for. Build to order is particularly common in the case of premium vehicles. The customer decides how he wants the vehicle to be put together – in accordance with existing conditions.
3. *Engineer to order* means individually developed products – for which the whole value creation process, including development, is linked to customer orders. No systematic storage or warehousing takes place anywhere in the value creation chain. Engineer to order is common for specialised commercial vehicles or construction machines – often for military orders.

Japanese and American vehicle manufacturers still tend to focus on build to stock production. It is noticeable, however, that the German concepts for build to order are becoming more common in order to keep up with growing demand for personalised vehicles. An important interface for interaction with the client is the vehicle configuration tool. It helps the customer to put together the different building blocks in a personalised way, and blocks combinations which aren't permitted so that it is only possible to order vehicles which can actually be built. Thus, the vehicle configuration tool can only fulfil individual customer wishes to the extent permitted by the modular construction system in vehicle development.

The resulting possibilities for personalisation, however, are always based on assumptions which were met many years before the vehicle in question is to be sold. While it is possible to order a vehicle individually via engineer to order, it takes years before the finished product is delivered – and once this happens, it can no longer be altered by the manufacturer. When parents buy a new family car with a built-in screen display, the children's delight soon fades if they discover that instead of the usual touchscreen, they have to get used to another way of using it. Technology develops so rapidly nowadays that it is often difficult to implement new technologies straight away, as the integration services during years of vehicle development are very costly. Even changes to the software in the vehicle are only rare and difficult to implement.

To use the analogy once again: Of course, it is impossible to change a horse. Ironically, however, vehicle manufacturers are perfectly able to change and improve both engine control and performance – years after the vehicle has been completed and dispatched, and without the guarantee being affected in any way. Automotive companies are now talking about the transition to a new era, in which customers will be able to gain new functionalities in the vehicle by updating software – even after they have made their purchase.

The crucial question is whether it is actually possible to have mass production while also making bespoke production possible. It would be conceivable to combine all three forms: build to stock, build to order and engineer to order. Build to stock would be used for the majority of parts, build to order for the vehicle as a whole,

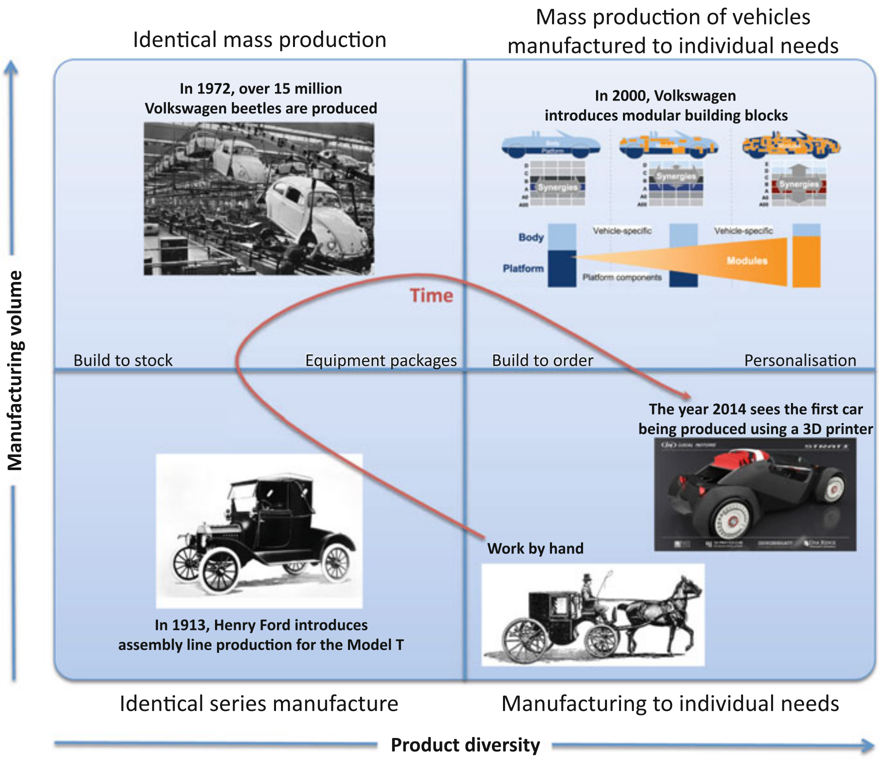

Fig. 2.3 The transformation of the transport modes industry in the twentieth century: The consumer, as the economic driving force in the original phase of work by hand, and the transition to the product manufacturer being the economic driving force with the aim of increasing the manufacturing volume. At the end of the day, however, digitalisation is now meaning that more individualised manufacturing is required (Photos: dpa Picture-Alliance, Volkswagen, Ford, Local Motors)

and engineer to order for very specific requests. Why, for example, should it not be possible to create a personalised seat to fit the customer's body measurements using a 3D printer?[5] Not only would this mean the best possible comfort – it would also provide an extra level of safety.

In short, this is about the transformation of transport modes in the twentieth century, and the transformation of their production via different phases. On the one hand, the volume of vehicles being produced continued to increase, but on the other hand the level of personalisation required led to a broader diversity of models to offer. In principle, we are coming back to manufacturing that is personalised for the customer (see Fig. 2.3).

[5] "Local Motors shows Strati, the world's first 3D-printed car" http://fortune.com/2015/01/13/local-motors-shows-strati-the-worlds-first-3d-printed-car. Accessed: 13 January 2015.

So why have we taken the time to look back at the past like this, and what does this all have to do with digitalisation and enterprise architecture? The answer is as follows: Digitalisation once again brings us back to a point where consumers expect individual bespoke manufacturing and dynamic interaction with the company.

The next logical step to take is to combine virtual mobility – i.e. communicating, using data and making payments from anywhere in the world – with the physical world, through the transformation from a product to a service. The AUTOmobile, as we know it today, is a product which was shaped by mechanical engineering and experienced a boom during the industrial age. With the autoMOBILE, however, the individual solutions which are possible for overcoming spatial distances will change. We will go into this in more detail in Chap. 4. The enterprise architectures needed for this will be different to those needed today, and not all existing ones will survive the transformation.

2.2 Product Development

There are several terms in the literature to describe the product development phases in the automotive industry, but they have no precise definitions. This is, in particular, due to the fact that a vehicle is not developed in a single, large step from planning to the finished product, but in a series of steps which each vehicle manufacturer divides into slightly different phases which are formalised through processes for which they also use their own terminology. Many processes take place in parallel, which means that the phases between product planning and production often run into each other. It is therefore not possible to make a clear distinction between development, engineering and production in the development phases of a series product – from one-off production to batches and mass production without knowing more about the company. Figure 2.4 shows the main phases of the product development process as we will refer to them in this book. This includes the phases of product and production development, which we define as follows:

- *Product development* includes the planning phase, the design/drafting phases and the series development phase. During the planning phase, product ideas and suggestions are taken into account which lead to a list of requirements. During continuous preliminary development, the ideas and impulses originate for the basic vehicle concept. This is followed by the design/drafting phase, during which work begins on the design of a new vehicle. After this, the aim of the series development phase is to bring together all the parts into a compatible configuration in compliance with the existing conditions. All phases overlap with each other. This is the case particularly in the production development phase, where series development, engineering and series launch flow into each other.
- The main focus of *production development* is on engineering and the series launch. During engineering, the vehicle and the necessary processes are worked

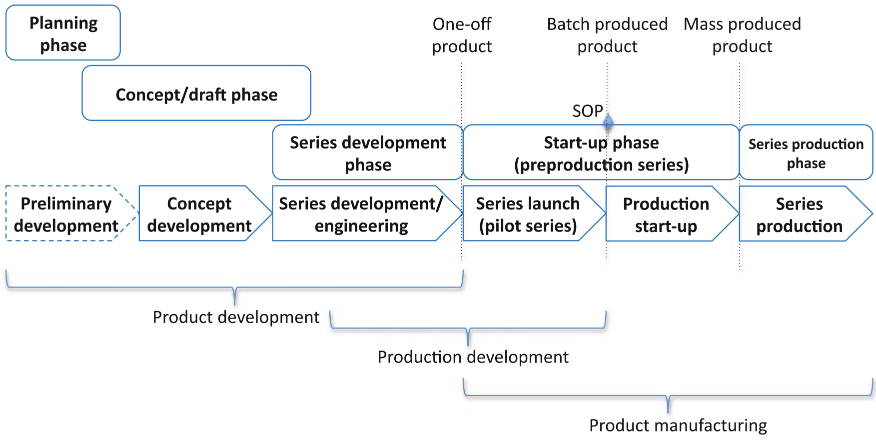

Fig. 2.4 The main phases of the product development process as we will refer to them in this book

on in such a way that series production is possible. The development and production of the production facilities are required take place during the series development phase. The series launch which follows makes the batch produced product possible, and pilots the production process with the production materials right up to the beginning of series production "start of production" (SOP). This completes the development of the product and the production which is needed for this.

- *Product manufacturing* begins with the production launch phase, during which the vehicles are produced in conditions similar to those of series production. At the same time as the SOP, production is scaled up and the first market-ready vehicles are produced. The scaling up process flows into series production – when planned criteria such as production volume, quality criteria and production cycle times are achieved by using a stable production process.

Materials procurement, which is divided into similar phases and backs up the product development process, will not be presented in detail here. The individual phases and the necessary competences will be discussed in more detail in Chap. 3.

2.3 Vehicle Architectures Are Established During the Industrial Era

The eras of our vehicle architecture, which has grown over several decades and lived through several phases of significant change, can be illustrated using the associated human senses.

Mechanics, at the beginning of the process, can be seen, felt, heard, smelled – and, in certain situations, even tasted. With such complex perception, an experienced car mechanic cannot simply be replaced by a diagnostic system when it comes to comments such as: "There's a rattling noise at the back on the left". In electrics, sensory perceptions are reduced to seeing and feeling, and in some situations hearing too. For electronics, one can still see – but usually using aids – especially in the case of microelectronics. In the case of software, however, human perception alone is not enough without tools. An electronic diagnostics system is an indispensable tool in the garage. Taking a look at sensory perceptions makes it clear which different skills and experiences come together in an architecture.

It was in this order – mechanics, electrics, electronics and software – that the evolution of the vehicle architecture and development occurred, and with it increasing complexity. The problem is with the very different eras which had an influence on vehicle architecture independently of each other. This all began with something very specific and tangible, which requires completely different training to that of the "invisible" software, which does not age or wear out in the same way that mechanical machinery does.

As early as 2002, the annual report of the German Association of the Automotive Industry showed a significant structural change due to the increasing value of electrics and electronics and, within this, an even more rapidly increasing market share of software. As shown in Fig. 2.5, the options made possible by combining electronics with software in the vehicle can be summarised as *mechatronics*, which continually shifts the relationship between the mechanics and the electr(on)ic components of a product. In terms of development costs and effort, in mechatronic systems, the share of software is already higher than that of mechanics. In areas such as entertainment, drive systems and safety systems, software has developed to become a driving force of turnover in the automotive industry.[6]

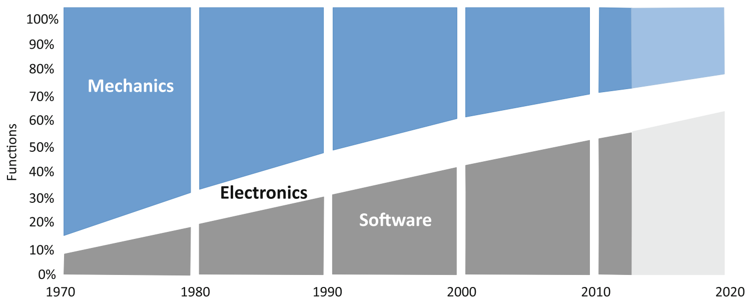

Fig. 2.5 Share of the development effort taken up by mechanics, electronics and software in the mechatronic development process, according to the German Engineering Association (VDMA) and future prognosis by the company ITQ GmbH on the basis of market data (*Source*: [15])

[6]"November 12, 2014 – rend Towards Sensor Fusion to Drive the Global Automotive Software Market, According to New Report by Global Industry Analytics, Inc." http://www.strategyr.com/pressMCP-6382.asp. Accessed: 19 December 2014.

While there are many norms in the context of the vehicle and its systems, in practice there is no standardised usage of the term “vehicle architecture”. It does not even exist in the technical product documentation in accordance with the norm ISO 10209:2012 [5]. In recent years, it has been used more and more frequently in the literature [3, 25] – without being defined precisely, however. The definition of vehicle architecture provided by us is as follows:

> The vehicle architecture forms the physical and functional basic structure for the overall vehicle concept. It links specific vehicle functions with components. Thus, it forms a technical structure made up of several physical components and functions which have a relationship to one another, and is developed on the basis of standardised principles and design guidelines.

Parts of the physical structure include, for example, the vehicle’s dimensions, the bodywork structure, control units, system buses, and the topology of the wiring system with its interfaces. Increasingly, the functional structure – as a logical architecture of the vehicle – is influenced by software systems, for example by active safety systems such as the anti-lock braking system ABS, comfort systems such as heating and air conditioning, driver assistance systems such as parking aids and, most intensively, by entertainment and information systems – known nowadays as “Infotainment” for short – such as GPS, news services or weather information.

This definition of vehicle architecture is similar to that of IT architecture (see Sect. 1.7). Correspondingly, we break down the vehicle architecture in accordance with the model by Zachman, in which the architecture components are placed in relation to one another using the three following fundamental questions:

What? The *bill of materials* describes what the vehicle is made of. Essentially, this is a list of materials according to the amounts and types of all parts of a vehicle. It lists all the parts needed to build the vehicle, and classifies them according to their properties. The function of each of the parts is, however, irrelevant for the bill of materials. In addition to physical parts, data can also be part of a vehicle – for example in the form of embedded software. The bill of materials established itself as a product structuring in several forms which we will go into in more detail in the next Sect. 2.3.1.

Where? In embedded software systems, the *technical drawing* [14] or the *interface model* [26] describes the location of parts for the design and engineering of the vehicle. The drawings of the construction and system structure, as well as their rules, norms and degrees of standardisation, are very different in mechanics and electrics. In mechanics, the focus is on geometry, while in technical drawing for the electrics of the vehicle, one concentrates on the circuit diagrams and the wiring system – which define the location of the electric parts. Software cannot be described in a technical drawing. In Sect. 2.3.2, we will go into greater detail about how all parts can work together in unison via the interfaces in the vehicle.

How? Functions describe how tasks can be fulfilled – independently of the type of solution. The tasks of a vehicle are described by *functional structures*, which make the vehicle less complex. Solutions are made easier to find by the fact that sub-solutions for sub-functions are possible within the structuring. The functional context of the sub-functions within the vehicle's function structure is fulfilled by the combined effects of physical, chemical or biological occurrences. A detailed functional description as a specification of the vehicle parts will be given in the product documentation, which we will come to in Sect. 2.3.3.

The answers to the three fundamental questions "What?", "Where?" and "How?" make up the three primary pieces of information which define the vehicle architecture. A similar definition of product architecture was introduced in [9]. For a more formal and thorough description of the product documentation, we refer you to the literature [6]. Figure 2.6 provides an example of an excerpt from a structural arrangement of the information from the technical drawings and bills of materials. The arrangement is inspired by a presentation by the German Institute for Standardisation (DIN) [4].

2.3.1 Vehicle Bill of Materials

The bill of materials is central to the manufacturing industry. It includes some of the most important information for the planning, development and preparation for the manufacturing of a product. It ensures that the product is made from the materials it was designed to be made from. There are many different types of bills of materials – and we will only refer to a few here, in a simplified way. A more detailed description of the management of the bill of materials can be found in further literature [28].

The simplest form is a materials index, such as that shown in Table 2.2. Yet, in practice, even this simple list would have more columns – such as item number, unit, material, mass, measurements. The bill of materials is not just the basis for calculating how many materials will be needed – it is also the guiding instrument in the development of a product – when ordering, stocking and making materials available, for manufacturing, for configuration in sales, and for maintenance in a workshop. All along the value creation chain, different types of bills of materials are needed in order to fulfil the different requirements.

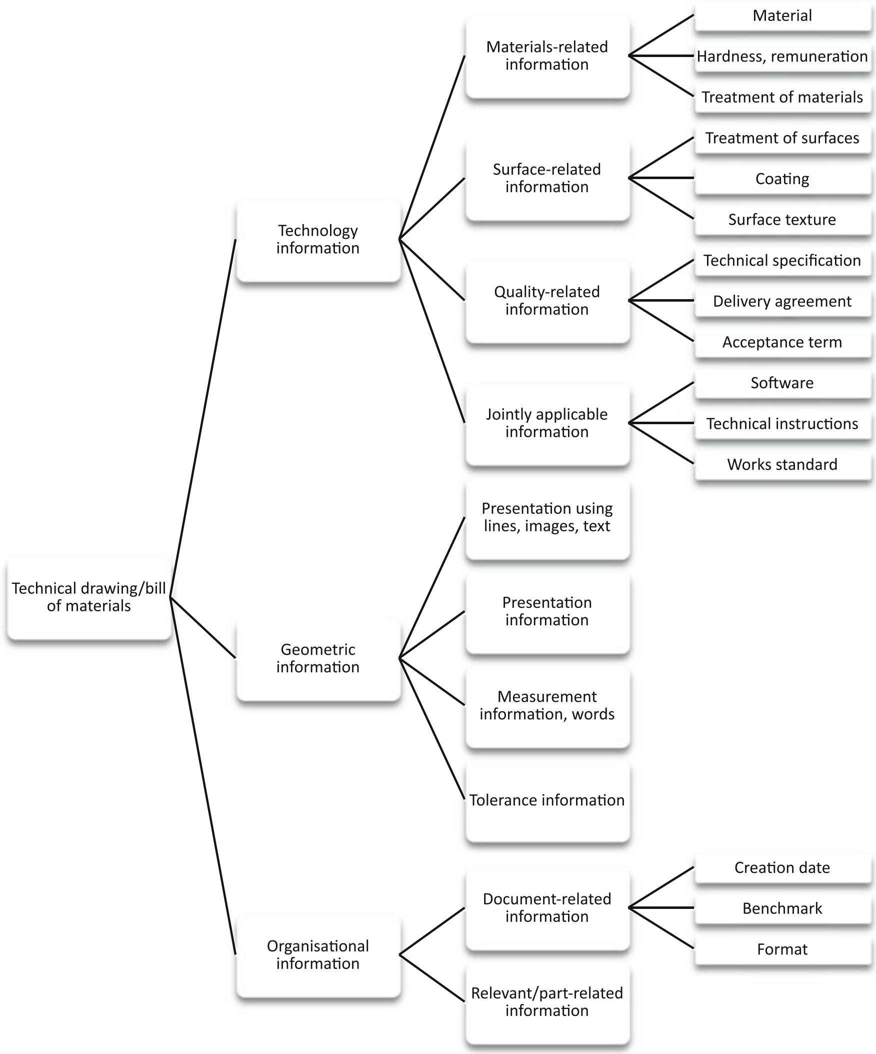

Fig. 2.6 Arrangement of the information in technical drawings and bills of materials in accordance with [4]

Beginning with the development of a vehicle, the type of the planned manufacture (see Fig. 2.2) is decisive for the product structuring and the form which the bill of materials will take. For the sake of simplicity, we are limiting ourselves to the most commonly used basic form of the *building block bill of materials*, in which combinations of the same parts which appear several times are grouped together.

Table 2.2 Example of a simple materials index, in accordance with the quantity and type of some parts of a car seat

Name	Quantity
Head rest	1
Arm rest (right)	1
Seat cushion	1
Seat shell	1
Seat cushion cover	1
Seat heating	1
Seatbelt anchor point	1
Seatbelt buckle	1
Torx screws	2
...	

In particular, components are formed which remain unchanged over a long period of time – in order to reduce the complexity of the different vehicle models [29]. The groupings occur in several levels in order to produce a hierarchical structure which begins with the manufactured product and is taken apart in levels of detail according to the different assembly steps.

Bill of Materials of Mechanical Parts

Since the invention of the vehicle, it has been made up of three subsystems: "drive system", "chassis" and "bodywork" (see Fig. 2.1). These subsystems can be broken down further into modules. The combustion engine most commonly used nowadays, and the gearbox, are examples of modules within the drive system. The chassis makes up the basic structure, with crucial modules such as the steering system, brake system and suspension system. The bodywork is the entire structure of a motorised vehicle. In practice, a distinction is nowadays made between the bodywork, as a kind of outer skin, and the inside of the vehicle, as its own subsystem with its corresponding equipment. Different manufacturers do, however, break down vehicles in very different ways.

We will simplify the breakdown in one possible representation, where the vehicle is broken down into five levels of subsystems, modules, components, subcomponents and individual parts. A simplified representation of the breakdown of an automobile right down to the individual parts such as the engine valve, is given schematically in Fig. 2.7.[7] In comparison to the materials index (see Table 2.2), this type of building block bill of materials has the advantage that complex product structures (such as the combustion engine) can be re-used in a standardised way

[7] In practice, there are several levels, different terms to refer to the levels, and different structures. For example, a valve control can also be part of an engine control group.

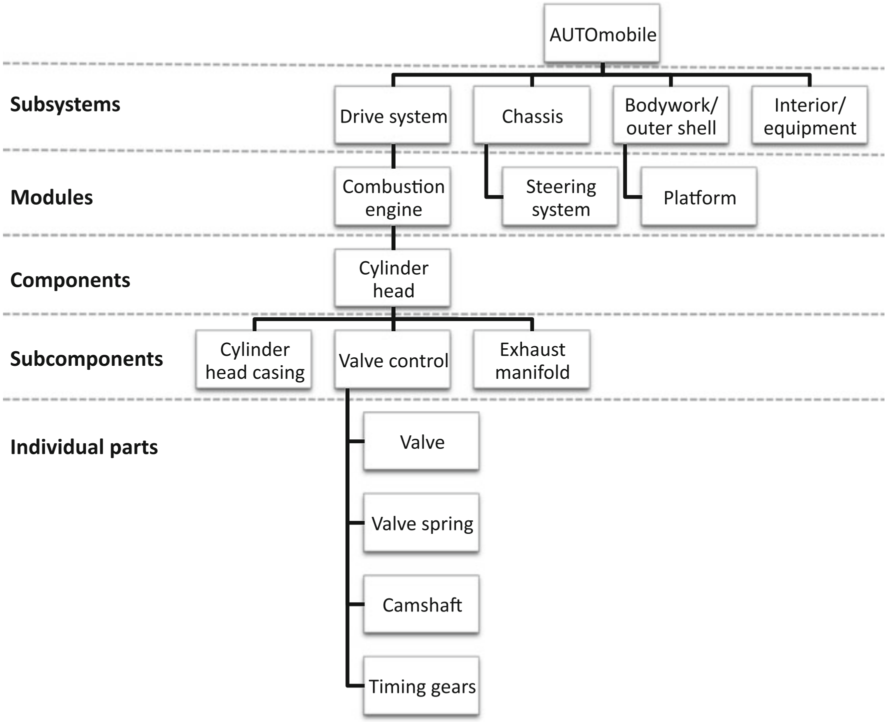

Fig. 2.7 Schematic representation of a possible mechanical breakdown of an AUTOmobile, right down to individual parts such as valves

over several models of vehicle. Vehicles consist of a great number of parts which fulfil a wide range of tasks in terms of performance, safety, reliability, economic viability, comfort, entertainment etc. Not only does the hierarchical breakdown have the advantage that it brings identical parts under the same umbrella – it also orders them according to the properties of the different task areas. In the past, vehicles tended to be made up of mechanical parts only. In this way, in the mid-1960s, a Volkswagen Beetle was made up of several thousand individual parts, as shown in Fig. 2.8. Nowadays, depending on the size of the vehicle and the equipment inside it, structures of over 10,000 metal and plastic parts can be made. The exact figures and details of these individual parts, however, are not given by the manufacturers. It is very clear that the automotive industry has been shaped by mechanics in a decisive way for decades. As today's vehicle architecture no longer consists solely of mechanical parts, however, the true complexity of the matter is not in the number of mechanical parts alone.

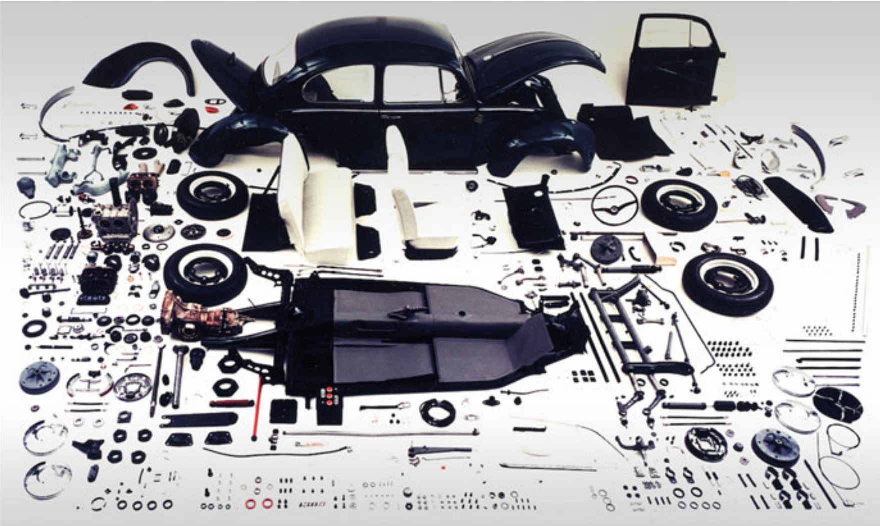

Fig. 2.8 In the mid-1960s, a Volkswagen Beetle was made up of several thousand individual parts (Photo: Volkswagen AG)

Table 2.3 Some of the electrical parts which made up a Volkswagen Beetle 1300 in the mid-1960s

Parts		
Battery	Generator	Fuses
Ignition	Ignition starter switch	Main light switch
Lighting system	Indicator switch	Indicator relay
Registration plate light	Dimmer/full beam/foot switch	Brake light switch
Horn	Horn actuator	Door contact switch
Windscreen wiper motor	Windscreen wiper switch	Oil pressure switch
Speedometer indicator lamps		
...		

Electrics and Electronics Are Found on All Levels of the Bill of Materials

When the first cable was introduced, heralding the start of the electrical era and later that of electronic, the bill of materials was recorded in its entirety and changed on all levels. A Volkswagen Beetle like that shown in Fig. 2.8 also consisted of some electrical parts. From today's perspective, however, around 30 parts and the associated cables are still relatively few. With fewer than 1 % electrical parts, their significance is minimal compared with that of mechanics. We have listed some electrical parts from the bill of materials in Table 2.3.

So, where should the electrical parts be added into the schematic breakdown in Fig. 2.7?

A door contact switch can be added to the “bodywork” subsystem, while the ignition can be added to the “drive system” and the speedometer indicator lamps can be added to the “interior” subsystem. At the latest when there is the first cabling between these electrical parts, lateral connections come about between the subsystems. This would result in an intense, network-like breakdown which can no longer be represented by a simple tree structure alone. Where would one place the battery or generator?

In the case of an electric car or hybrid vehicle, the battery would be part of the “drive system” subsystem. In the case of vehicles with combustion engines, most manufacturers have introduced the “electrics/electronics” subsystem, where they have put as many electrical components as possible – thus minimising a network structure as a result of lateral connections. Originally, this architectural decision made a lot of sense – in order to carry out the development of vehicle mechanics, electrics and assembly separately. However this separation now has more disadvantages than advantages due to the huge number of electrical functions. Let us take a look at the chassis, for example, in the case where development is increasingly moving away from the traditional, primarily mechanical orientation to suspension and damper systems, and towards a holistic, functional view. In modern vehicle technology, the whole of the dynamic behaviour of the vehicle is in focus. Alongside aerodynamic properties and bodywork stiffness, especially relevant here are the modern electronic regulation systems which are used to control the chassis components in a finely-tuned way. They make an important contribution to more comfort and safety in the vehicle, but lead to a complex structure in the bill of materials. For a more detailed look at the holistic functioning of a vehicle under the influence of electronics, see the literature [23].

Through electronics in particular, the additional subsystem of “communication and entertainment” was introduced. Some manufacturers classify it as a module in the subsystem “electrics/electronics”, but it is much more than just an electr(on)ic car radio, and is referred to as an infotainment system in today’s vehicles. This includes all devices which make it possible for passengers in the vehicle to create a link between the vehicle and the outside world. In the world of telecommunications, the technology standards change more quickly than vehicle development can implement them – because of its need for integration.

It is still not clear how the bills of materials will develop towards the connected vehicle. Until now, the manufacturers have classified it solely as a function of the “communication and entertainment” subsystem – which is apt, as it can be used to create a connection with the outside world using existing communication options. On the other hand, however, due to its wiring and bus systems, this subsystem has numerous data restrictions which stand in the way of personalised connectedness of the autoMOBILE, as we will discuss in Chap. 4. It is only possible to speculate about the product structure of the subsystem and the bill of materials in the project “Google Self-Driving Car” (see page 30).

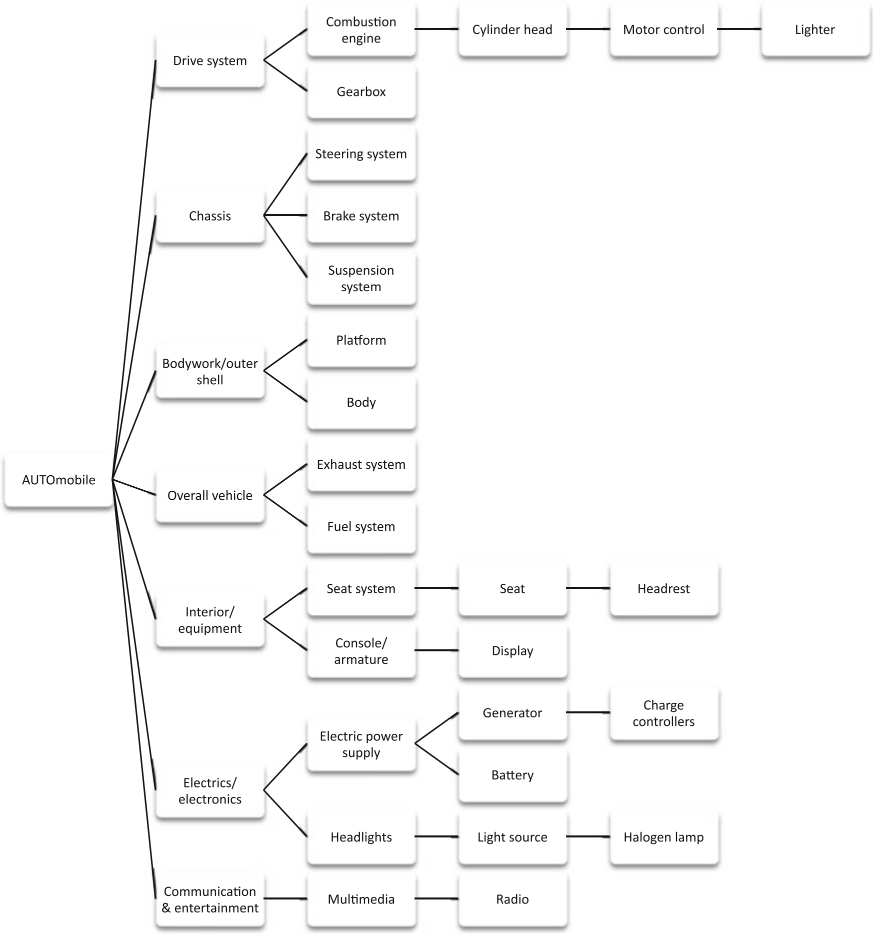

Fig. 2.9 Schematic representation of a potential mechanical, electrical and electronic breakdown of an AUTOmobile, including a generator, battery, halogen lamp, lighter and radio

In short, it is clear that the bill of materials has rapidly become much more complex, and will continue to do so. This is the case not only in terms of increasing numbers of parts, but also in terms of the range offered by new subsystems and modules, which have become necessary because of new functions. Figure 2.9 gives an impression of how the breakdown has developed through the extensions of the electrical and electronic parts. The bill of materials must not necessarily increase in complexity, however. In an electric car, for example, there is no combustion engine, gearbox, fuel system, exhaust system, starter motor or generator, which means that more parts are lost than are gained from the electrical drive system and electronics.

In this simplified representation, however, one must remember that both the lighter and the radio need a connection to the electricity supply. In this context, the architecture questions "Where?" and "How?" give us a better idea of the group of components than can be given by the question "What?" via the bill of materials. We will go into this in more detail in Sect. 2.3.3.

Software in Embedded Systems

Software is still a relatively young topic in the bill of materials, but it is seen as a central driving force for innovation in the vehicle [26]. Software tends to be looked at in conjunction with electronic systems for control and regulation, which are referred to as Electronic Control Units or ECUs. They belong to the embedded systems and play a central role in automobile electronics. These are specialised computers for a technical context, which are built into the vehicle where something needs to be controlled or regulated. For example, the ECUs collect environmental data via sensors and identify certain parameters such as temperature, fuel level, oil pressure or speed, of which some are displayed to the driver via the console. In order to guarantee safe driving, the output values and functionality of the sensors and ECUs are constantly checked using software. The Mercedes-Benz E-class (W212), for example, contains 62 ECUs.[8]

The included (embedded) software generally does not change the topology of the bill of materials, as is the case with electrics and electronics. One or several software applications are connected to an ECU, and to the hardware drivers. In situations with very high integration requirements in terms of safety, reliability and the ability to react in real time, it makes sense to only look at the software from within embedded systems. Individual developments are needed for this, and standardisation of the software in the whole vehicle is not possible. The result is that we see luxury vehicles which contain several million lines of programme code.[9]

From the point of view of information technology, the question soon arises as to how high the proportion of redundant and unused software is. As vehicle manufacturers use a wide range of their own embedded systems, for a long time it was not necessary to standardise the software or version updates – instead, it was always developed individually or purchased from elsewhere. The standardised separation of functions and data is still a very little known area of vehicle architecture and the bill of materials. This approach has caught on in large and complex IT projects thanks to object-oriented software development.

Over the past 20 years, there have been a number of efforts to standardise operational systems, bus systems, basic software and functional interfaces for the architecture of embedded systems. We will go into greater detail about bus systems in the next Sect. 2.3.2. The concepts were brought together and given a new

[8] "Electronics in the car: Development" http://www.automobil-industrie.vogel.de/elektronik/articles/367049. Accessed: 19 December 2014.

[9] "Software is in short supply" http://www.welt.de/print/wams/wissen/article109407823/Software-ist-ein-knappes-Gut.html. Accessed: 19 December 2014.

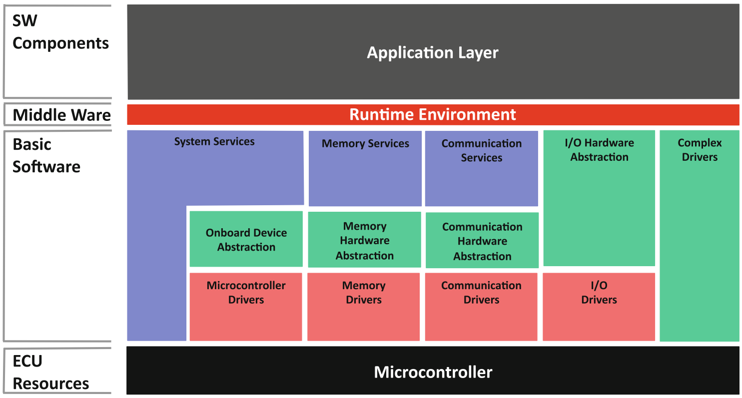

Fig. 2.10 AUTOSAR Electrical/Electronic architecture concept (*Source*: AUTOSAR)

direction in 2003 as part of the development partnership known as AUTOSAR[10] involving various manufacturers from the automotive industry and producers of development tools, basic software for ECUs and micro-controllers. Its aim is to develop a standardised electrical/electronic architecture concept in order to decouple the software in the embedded systems from the underlying hardware, thus making it easier to replace. This is why the architecture is divided into three areas: application, runtime environment and basic software (see Fig. 2.10):

Application: In the application layer, a distinction is made between software components for applications and for sensors and actuators. As such, the application's functionality is abstracted from the sensors and actuators which are built into the vehicle. A light sensor, for example, sends a message about brightness to the brightness control application. Independently of the function logic, it can send the order to "switch on the light" to the light actuator. The sensors, actuators and ECUs are situated in different places in the vehicle.

Runtime environment: The runtime environment integrates the application layer with the basic software. It implements the data exchange and controls interaction between the two layers. All software components may only communicate with each other and the basic software via the runtime environment, and never directly.

[10]Stands for AUTomotive Open System ARchitecture http://www.autosar.org. Accessed: 19 December 2014.

Basic software: The basic software can be divided into four areas:

1. The *system services* (shown in blue in Fig. 2.10) include the operation system and different types of background services such as network services, memory management and communication services. Other system services include diagnostic protocols, for example.
2. The *abstraction of the control units* (shown in green in Fig. 2.10) offers standardised access to all functionalities of a control unit, such as communication, memory or inputs and outputs. The interfaces are independent of the control unit hardware in the vehicle.
3. Under *Complex Drivers* (shown in green in Fig. 2.10), non-standardised drivers for specific properties and fast, direct access to microcontrollers or control units are made available. As such, they are not specified in AUTOSAR. This applies, for example, to injection controls or existing software.
4. The *abstraction of the microcontrollers* (shown in red in Fig. 2.10) is the interface to the periphery, and, via the drivers, allows no direct connection to the register addresses for access to the microcontroller.

The standardisation activities concentrate on areas which should not be competitively relevant to manufacturers.[11] Until now, however, only little has been done to structure the vehicle data as part of the vehicle architecture; similarly, the architecture has not yet been changed in such a way as to decrease the complexity of the in-vehicle software instead of increasing it. An example is speech recognition, which vehicle manufacturers should nowadays no longer implement completely by themselves.

Similarly to AUTOSAR, the JasPar[12] is a consortium run primarily by Japanese companies, which also has other focuses – and which decries the higher resource consumption levels of AUTOSAR's abstraction levels.

The product documentation of the software and its versions, which are installed onto programmable ECUs and are updated during servicing, can be seen as part of the bill of materials – even if it is often treated differently in practice. In the case of build to order in particular, each vehicle would need its very own individual bill of materials following final assembly and installation of software.

[11]For more detail on standardisation and modularisation via AUTOSAR and the system development based on this, we refer to the literature [17].

[12]Stands for Japan Automotive Software Platform and Architecture http://www.jaspar.jp. Accessed: 19 December 2014.

This is due to the high level of variation in the control units built into the vehicles, and the software versions installed in them. It is absolutely necessary that such product documentation be managed centrally throughout the vehicle's lifespan. Central availability of the software must simultaneously serve a high number of vehicles at the producing factories, as well as enquiries from tens of thousands of linked workshops worldwide. The possible variation in the data which is obtained via a vehicle diagnosis of the ECUs is shown in Fig. 2.11 by BMW [21]. The combination with optional control units and their embedded software versions is what, in particular, creates complexity and makes every vehicle individual.[13]

The Rule-Based Variant Bill of Materials

In Fig. 2.11, control units were shown as either built-in or optionally configurable for vehicles. It is this principle that the rule-based variant bill of materials is based on so that the bill of materials is not limited to fixed classifications of parts. There are the following three types of rules:

1. fixed classification,
2. optional or
3. selectable from a number of parts and components.

The materials index can only be created after this selection. Thanks to the rule-based variant bill of materials, a very high number of different vehicles can be presented using bill of materials. Daimler, for example, is able to make up to 10^{27} different vehicle configurations within a series [38]. Due to the high variance of possible combinations of parts, even the manufacturing steps in build to order (see Fig. 2.2) cannot always be decoupled from order-specific instructions.

In sales, it is possible to configure a vehicle individually to meet customer requirements. However, developers and potential buyers have different focuses in terms of product configuration. Developers pre-select permitted specifications, while taking into account feasibility regulations and the legal provisions of the target market. The potential customer must adapt his ideas and wishes to the configuration rationale which has been developed. Each decision taken reduces the number of permitted combinations. Earlier configurations provided by vehicle manufacturers on their websites simply prescribed a set order which was often shaped by the hierarchical structure of the bill of materials. Configurations like these hindered customers with a very precise idea of what they want – because not everyone wants to start by choosing their engine. Nowadays, the configuration tools are more flexible, so that certain options can be reached more quickly, and a quote can be given after each selection. Even today, however, no configuration tool is able to go through the entire rulebook in the variant bill of materials in order to check

[13] We refer to the literature [26] for a more in-depth insight into the software in the AUTOmobile.

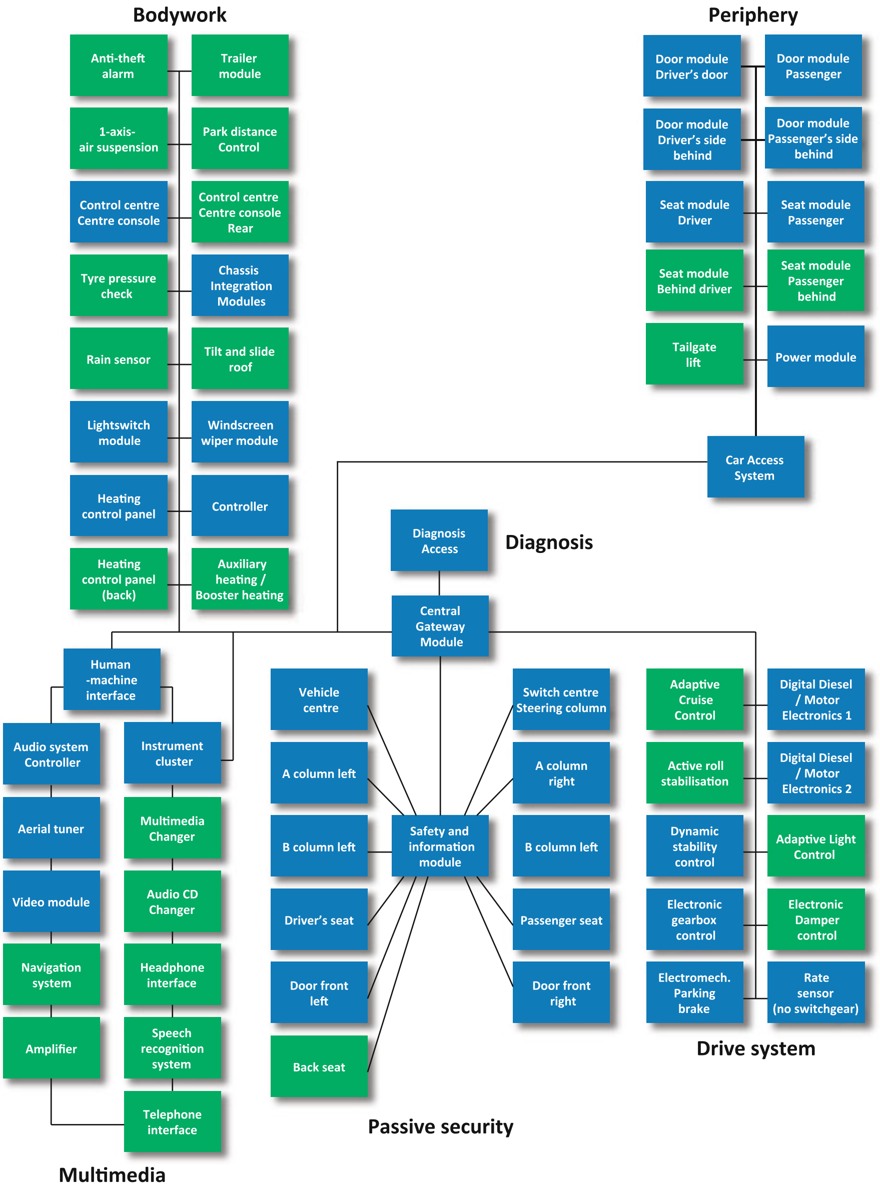

Fig. 2.11 The variation in possible ECUs in the standard equipment (*green*) and optional equipment (*blue*) in a BMW 7 series, construction year 2001 (E65) [21] (*Source*: BMW)

consistency and feasibility. A pragmatic approach is to offer package deals which are offered alongside the series equipment.

A rulebook is a structured form which is used to create a commission-specific bill of materials for the customer. The systems of the next generation need to portray the customer's wishes in a more individual way on bill of materials. New customers are often inexperienced with the terms used by manufacturers for different vehicle classes (see Table 1.1) and the terms used for equipment features. If a customer wants a 4-wheel-drive, for example, he needs to know that Mercedes-Benz calls it a "4MATIC", that BMW calls theirs an "xDrive" and that Audi calls theirs "quattro". Experienced customers, on the other hand, have their own profile – and attach varying levels of importance to comfort, safety, performance, green credentials, family, travelling and luxury. On the basis of the customer profile, a future system for personalising bill of materials must be able to understand the simple language used by the customer [36], such as:

- Must be able to drive off-road.
- Colour is not important.
- Needs to be good value for money.
- Shouldn't be too old.
- Safety is paramount.
- Needs to be a reliable vehicle.

Natural language is more about relationships and circumstances than about explicit rules about "What?" a vehicle should be made of.

Example of Bill of Materials by Daimler

We will finish this section on bills of materials with a specific example by Daimler. For Mercedes-Benz passenger vehicles, Daimler structures the bill of materials in a broadly standardised way on the upper level, according to main modules, modules and sub-modules (see Fig. 2.12) similarly to the schematic representation in Fig. 2.7. The further degree of detail in the structure is then transferred to the principle of the rule-based variant bill of materials. The bill of materials leads into items and their item variants, which represent the possible alternative variants of a vehicle function. Ultimately, the item variants refer to items along with their master data – either individual parts or components [38].

Table 2.4 shows a small selection of the optional extras available with the Mercedes-Benz C-Class W203, which can be combined in many different ways. However, not all combinations of equipment are compatible. Sinz [30] shows that "...the AMG styling (772) cannot be combined with the trailer coupling with detachable ball neck (550). The automated air conditioning (581) may only be used if a high-capacity battery (673) is also built in, except in the case of larger petrol engine variants with 2.6 and 3.2 litres cylinder capacity."

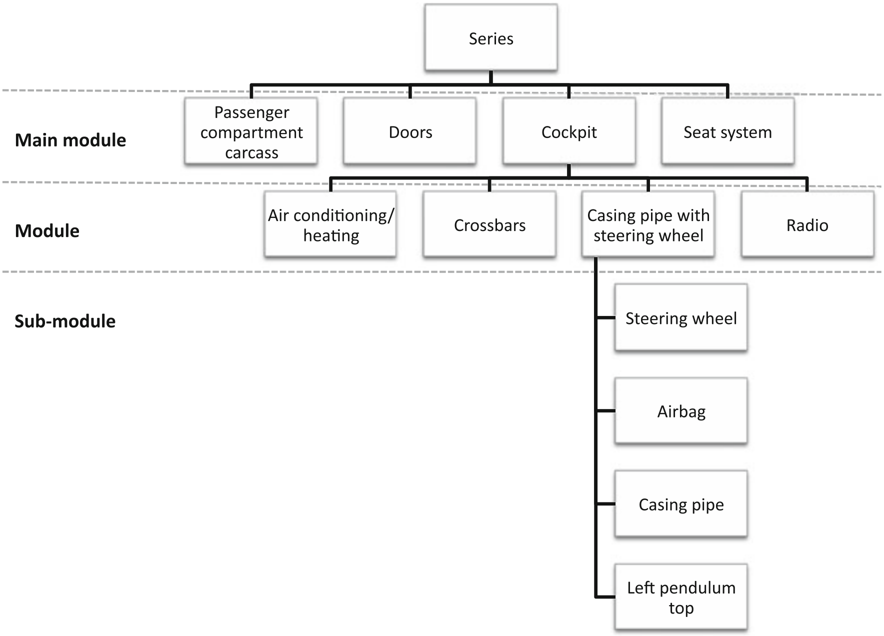

Fig. 2.12 Structure of the bill of materials of a Mercedes-Benz S210 according to modules [38]

Table 2.4 Excerpt of optional extras available with the Mercedes-Benz C-Class W203 [30]

Code	Naming
550	Trailer coupling with detachable ball neck
500	Exterior mirror left and right which can be folded electronically
673	High-capacity battery
614	Bi-xenon headlights with headlight cleaning system and dynamic headlight range adjustment
231	Garage door opener integrated into the inside mirror
551	Anti-theft alarm system with tow protection
581	THERMOTRONIC automated comfort air conditioning
280	Steering wheel in leather (two-tone) with chrome buckle
921	Engine powered by vegetable oil methyl ester (Biodiesel)
353	Audio 30 APS (GPS system with integrated radio and CD player)
293	Side airbags at the rear
671	4 alloy wheels, 7-spoke-design
228	Remote-controlled auxiliary heating
772	AMG styling

Four Main Phases of the Bill of Materials

The bill of materials is not a product structure which remains unchanged during the entire product development process (see Sect. 2.2). The three main phases of the bill of materials prior to the vehicle being dispatched are:

Engineering bill of materials	is created during concept development which is organized with regards to how the vehicle is designed.
Sales bill of materials	is created during development and describes what the vehicle should be constructed from, taking into account as they are ordered. the manufacturing requirements.
Manufacturing bill of materials	is created during production development and describes all the parts and assemblies required to build a complete and shippable vehicle by assigning the serial numbers to those which have actually been built.

The fourth phase of the bill of materials represents the stage of the vehicle's life which follows its dispatch.

Service bill of materials	is used during customer service in maintenance for the matching of replacement parts for the vehicle.

Additionally, in the case of this bill of materials, temporal and spatial validity must be taken into account. For example, over time, a part can be replaced by changing supplier. Spatial validity is determined by the location of the workshop and the possible replacement part logistics of the components.

But one bill of materials is still missing!

Daimler has created the basic requirement of the "Digital Service Booklet",[14] with which every service and every change made to the vehicle is recorded digitally. The only bill of materials still missing is that which represents the up-to-date, actual construction situation of the vehicle during the operational phase.

2.3.2 Network Architecture

All parts in the bill of materials come together to make up the vehicle. The fundamental question of "Where?" – where these parts are situated within the vehicle architecture – is more complex. At the beginning of this Sect. 2.3, we

[14]"Service and parts information – Digital Service Booklet" http://service-parts.mercedes-benz.com/dcagportal/DCAGPortal. Accessed: 19 December 2014.

introduced the basic problem by illustrating it with sensory perceptions. The introduction is via mechanics.

Technical drawing describes "Where?" the physical parts are situated within the overall vehicle. In particular, spatial limitations of the available construction space and information about shape and position tolerances of the parts are limiting factors overall. We cannot go into more detail about the many geometric challenges, construction details and determining factors here, which is why we would like to draw your attention to further literature [2].

Next, we would like to concentrate more on the network architecture [31] of the vehicle, which has come into being. The network architecture is more decisive for how we look at the enterprise architecture, because it had radical effects on the vehicle architecture and its development areas due to the introduction of electrics/electronics in combination with mechanics. An example of this is the Volkswagen Beetle (see Fig. 2.8) from the previous section. The corresponding circuit diagram shown in Fig. 2.13 fits on a single page due to its very low number of electrical parts, and is – notwithstanding the other vehicle parts – very clear by today's standards, even though the appearance of this technical documentation does not correspond to a norm in today's sense of the word.

Over the years, the number of electrical/electronic parts in the vehicle increased so quickly (see Fig. 2.5), that too many point-to-point cabling connections between the parts created huge wiring harnesses. The biggest problems posed by this cabling were its huge weight and the inefficient use of the limited space available in the vehicle. The system network has become an increasing problem, as has the wiring system – which was only developed as the result of shared experiences from vehicle projects, and therefore occurred in a non-standardised way. The wiring system, which consists of electrical power generation (Generator) and electricity storage (Battery) and energy consumers, is contained in the question "How?" of the network architecture, in the form of circuit diagrams.

Up until the end of the 1980s, the electronic systems in the vehicle consisted of individual, non-connected ECUs. Increasing demands on driving safety and the provisions on fuel consumption and exhaust systems, however, meant that an increased exchange of information was required between the ECUs. In order to make this possible, the Controller Area Network (CAN) bus system was created by Bosch in 1983 in order to interconnect ECUs.[15] With its introduction into the drive system at the beginning of the 1990s, a new technical infrastructure began in the vehicle. The technical specifications of the system [1] were internationally standardised in 1993 (ISO 11898) and are now used by all companies in the automotive industry. Since then, both the development of ECUs and the increase in performance of microprocessors have developed extremely rapidly, meaning that nowadays, nearly all vehicle functions are either monitored or controlled electronically.

[15] "CAN history". http://www.can-cia.de/index.php?id=161. Accessed: 19 December 2014.

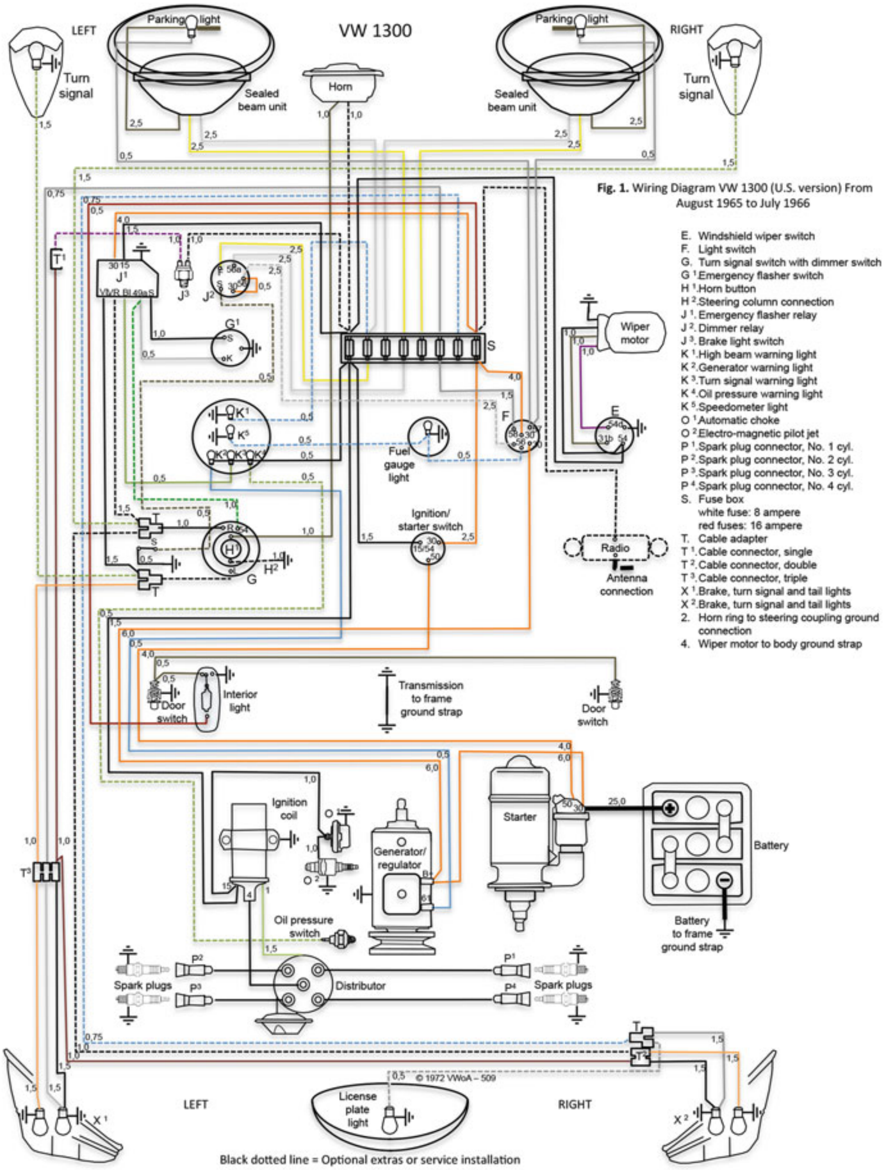

Fig. 2.13 In the mid-1960s, a Volkswagen Beetle contained only very few electrical parts (Photo: Volkswagen AG)

Table 2.5 Bus systems with different characteristics in today's vehicles

Bus system	Typical data rate	Characteristics
LIN	20 kBit/s	• Communication system for sensors and actuators • Low data rate and bandwidth • Good value • Typically integrated into CAN bus systems
CAN B	110 kBit/s	• Connecting ECUs • Fail-safe bus • Better value than CAN C • Error recognition and troubleshooting
CAN C	500 kBit/s	• Real-time connectedness of ECUs • Data transfer with extremely low latency • Fail-safe bus • Resistant to electromagnetic interference • Error recognition and troubleshooting
FlexRay	10 MBit/s	• Connecting safety-critical applications • Real-time, very fast bus • Deterministic time behaviour • Redundancy and error tolerance
MOST	25 MBit/s	• Communication system for multimedia data • High speed network • Optical bus with light wave conductors

Due to various requirements of the functional areas in the vehicle, different bus systems have developed over the past few years. While, for example, the use of ECUs in safety systems requires rapid transmission of data, heating does not have to react to changes in temperature in the passenger area in a matter of fractions of seconds. Passengers will not usually notice these kinds of delays, nor will they be willing to pay a higher price to have them reduced. In today's vehicles, up to five different bus systems such as CAN, LIN (Local Interconnect Network), MOST (Media Oriented Systems Transport) and FlexRay can be in use. Table 2.5 summarises the different bus systems along with some of their characteristics. It is important to note that the data rate is dependent on the length of the cabling. A CAN bus system, for example, would theoretically be capable of achieving 1 MBit/s, but in reality this would be reduced to 500 kBit/s. For a more detailed description of the bus systems, and of other bus systems and protocols, we would draw your attention to additional literature [39].

Similarly to the bill of materials, the requirements of the bus systems are also classified according to their functional areas within the vehicle. Table 2.6 lists typical controlling systems with examples of bus systems. The topology of any bus system can be different to that of others. CANs or LINs are executed in line topology, as part of which the different control units are connected with each other via stubs on a wire. The FlexRay bus system can also be executed as part of line

Table 2.6 Examples of bus systems according to their functional areas within the vehicle

Functional area	Controlling systems	Bus system	Topology
Interior	Heating, fan	LIN	Lines
Bodywork, door	Light controls	CAN B	Lines
Drive system, engine	Gearbox controls	CAN C	Lines
Active safety, chassis	Brake controls	FlexRay	Star
Infotainment	Navigation, multimedia	MOST	Ring

topology. Its standard topology is, however, star topology – as part of which all control units are connected to one star point. MOST on the other hand, is laid as a ring topology, as part of which the control units are connected to one another in the shape of a ring.

On the one hand, the different control units are spaced far apart from each other in the vehicle – on the other, they are closely connected to one another via several functional areas. The networking of the control units occurs via various bus systems with non-standardised protocols, such as different address areas and bit rates. Even CAN B and CAN C not only have different data rates – they are not compatible with one another either. The network architecture of the vehicle consists of the various bus systems for the integration of the control units, sensors and actuators, and the gateways, which serve to link and synchronise several networks with different protocols. Figure 2.14 shows a simplified network architecture in which the different ECUs are linked via a central gateway. An alternative to this is decentralisation via several gateways, which themselves are joined together via a bus system. The bus system is known as the "backbone" of the entire communication system of the vehicle. The presence of several gateways does not necessarily mean more hardware is needed – nowadays, this can also be achieved using software in existing ECUs.

As early as the beginning of the 2000s, there were 45 connected ECUs made by different manufacturers in the Volkswagen Phaeton.[16] Despite bus systems, the cabling in the Phaeton has a total wire length of 3860 m with a cable harness weighing 64 kg. The bill of materials of the electrics consist of 11,136 parts. Of these, most are situated in the wiring system, as shown in Fig. 2.15 [2]. As shown in Fig. 2.11, a BMW 7 series from 2005 contained around 65 ECUs, connected via five bus systems with an embedded software scope of around 115 megabytes.

This led to automobile electronics gaining great significance, and fundamentally shifted the focuses of the vehicle architecture as a whole. However, the resulting complexity of today's vehicles is the cause of many outages and malfunctions, and the data exchange via the different bus systems is not easy to control or check. For example, all ECUs are given the entire data exchange in the message-oriented CAN protocol. Even the gateways cannot prevent everything or always check access. There are numerous examples which involve several functional areas. In the case

[16]"Steer-by-wire: Innovation avalanche in automobile technology" http://www.heise.de/ct/artikel/Rad-am-Draht-288904.html. Accessed: 19 December 2014.

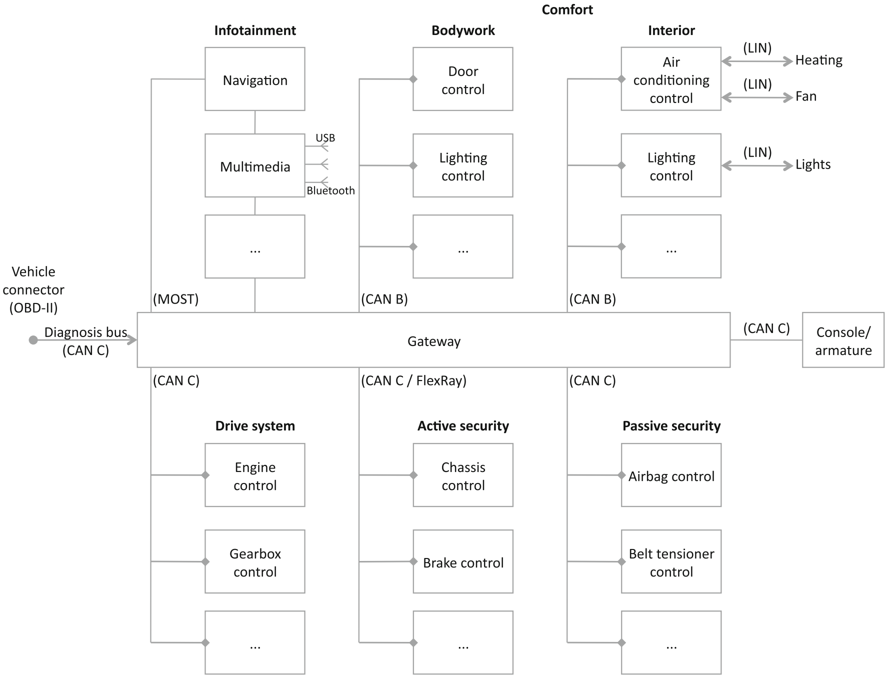

Fig. 2.14 Simplified network architecture with a schematic central gateway for the coupling of several bus systems

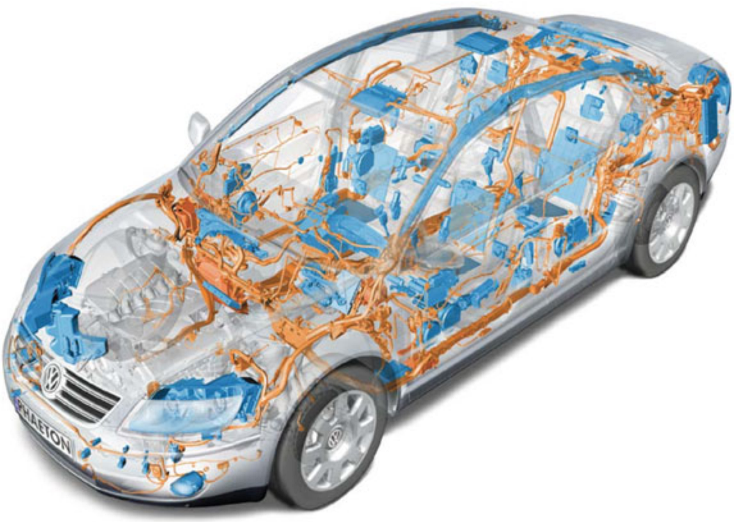

Fig. 2.15 Electronic components (*blue*) and wiring system (*brown*) [2] (Photo: Volkswagen)

of an accident, for example, the airbag control is communicated with in the passive safety system via the CAN C. Additionally, however, the door control must be activated via the CAN B bus system so that the door is unlocked via the LIN.

IT is gaining ever more influence over the network architecture. Over the coming years, some changes are still to be expected – within the vehicle architecture alone. A topic which is the subject of intense discussion in IT is the Ethernet [18].

In this section, we have looked only at the network architecture within the vehicle, in order to answer the fundamental question of “Where?” the parts are situated in the vehicle architecture. From Fig. 2.14 we can see that the multimedia module makes a network possible outside of the physical vehicle. We can also recognise the structure which has developed over time, because workshops access the gateway directly via the diagnostic connection to the OBD-II system. Thanks to connected vehicles, this part of the vehicle architecture is set to change.

2.3.3 Product Documentation

In the previous sections, we described how the vehicle structure is made up of many different parts, the distribution of which is very complex to design. Now that we have answered the two basic questions of “What?” and “Where?” in terms of the vehicle architecture, we come to the question of “How?” all the mechanical, electrical and software technology-related parts work together in the vehicle and make it possible to use functions.

Generally, a distinction is made between the following two function types for the vehicle as a product:

Usage function — ensures the technical and economically viable use of a product by fulfilling the desired function. Examples are commercial vehicles or construction machines.

Prestige function — is an external characteristic of a product which appeals to feelings and thoughts of prestige through the design and aesthetics. An example of this is a luxury vehicle.

Both types of function must be taken into account in the product development of a vehicle. In the case of investment items, the usage functions tend to dominate. In contrast, in the premium sector, the prestige functions also play an important role.

The goal-oriented usage function describes the task to be fulfilled by a vehicle in a solution-neutral way. The overall function is broken down into sub-functions so that we can gain a better overview of the task fields of the complex function range of a vehicle. Depending on the extent of the sub-functions, these can also be broken down in the same way that the bill of materials is. As part of the fulfilment of the overall function, the sub-functions are connected by relationships defined by logical, physical, chemical and biological effects – or a combination of these – depending on the type of part in question. The resulting entity is referred to as

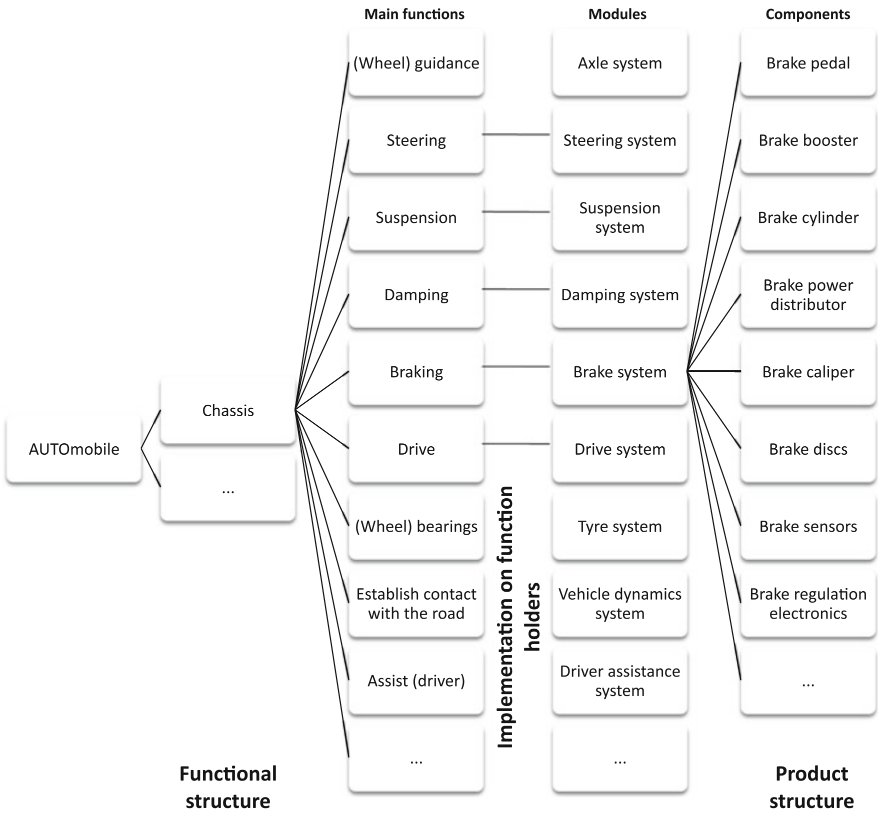

Fig. 2.16 Foundations of vehicle architecture: Implementation of the functional structure of illustrative main functions of the chassis [8] on potential modules as function holders of the product structure

the *functional structure*. During development and engineering, the functions in the vehicle are implemented by the parts as they work together.

The sub-functions in the functional structure are also broken down into main and secondary functions. Each main function directly serves to fulfil the overall function. In contrast, sub-functions only serve the overall function in an indirect way. For each sub-function, function holders are developed as solutions which can, for example, be realised using a mechanical or electrical part, or a software component. With the help of the partial solutions, it is possible to make a representation of how the parts of a system work together. Figure 2.16 shows a functional structure with examples of the main functions of the chassis [8], which can be implemented on potential modules as function holders. The bringing together of the functional structure and product structure fundamentally defines the *vehicle architecture*. Figure 2.16 reflects the definition of vehicle architecture as we introduced it at the beginning of Sect. 2.3. Only rarely, however, is it possible to implement the sub-functions of the function holder as simply as is shown in this figure, because the illustrative main function of "braking" must be broken down into sub-functions which, in practice, cannot be attributed directly to the components represented here.

Functions should not be confused with requirements. Requirements of a chassis would, for example, be categorised according to characteristics such as driving dynamics, comfort, safety etc., or chassis mass, costs, and reliability etc.

Technical Product Documentation

The description of the functional structure ("How?"), the bill of materials ("What?") with its product structure, and the technical drawing ("Where?") are the crucial parts of the product documentation. According to the guidelines of the Association of German Engineers (VDI) 4500 [33], the task of "technical product documentation" is to accompany a product through all the stages of its life, from development to disposal (see PLM). During the past decades, product documentation has been digitalised in almost all companies, which means that the readability and displayability of the digital documents – which have to be kept for 30 years or more – constantly need to be adapted to changing technologies.

In the guideline from the VDI, a distinction is made between internal and external technical product documentation:

- Internal information is very detailed and subject-specific. It covers the whole life of a product – from planning to development, creation, bringing to market, quality assurance and then discontinuation. Vehicle manufacturers can determine the scope of the internal documentation themselves, as long as the legal requirements and duties to the customer are fulfilled [33]. Product documentation usually remains with the manufacturer, who, among other things, archives them for legal reasons – to fulfil the burden of proof, for example. Product liability for the states of the European Union is based on Council Directive 85/374/EEC, in accordance with which it must be possible to trace back the construction status and related changes made to at least 10 years after the product was dispatched.
- Often, internal information is not only classified for internal use, but is also classified as confidential or top secret. Confidential, internal information in organisations often serves the purpose of differentiating competitors in the market. Descriptions classified as top secret, on the other hand, tend to come up in specialised vehicle research and development. The confidentiality classifications given to information can change over time. This can be the case, for example, after the publication of a financial report.
- The formulation of the external information is adapted to the users of the product. It is intended to ensure that the product is commissioned, used, maintained,

serviced and disposed of safely and in the proper way, and exists in the form of user handbooks, replacement part catalogues, operation and maintenance instructions etc.

Product Data Management

Alongside the product master data and product structure data, the Product Data Management (PDM) system forms the core of the internal, technical product documentation. As part of this, numerous different technical documents from different manufacturing systems – such as drawings, models and calculation results – are connected with the vehicle parts. Additionally, the increasing product complexity requires a higher degree of data networking due to the great diversity of models in the vehicle classes (see Sect. 1.3).

The rather technical PDM system can be given the primary focus of the virtual product and of supporting product development. In contrast, the material master sets and bills of materials – which serve the purposes of production planning and management – are updated into an economic ERP system. In this way, the main focus of the ERP systems can be seen as the basis for the order processing on the physical product after development. In Sect. 2.2 we showed that in product development, the transitions between product development, production development and product manufacture are fluid. This is why, in practice, there are overlaps in terms of both time and content in the use of PDM and ERP systems in product development (see Fig. 2.17). The large software companies make a fundamental contribution to this, as they constantly expand the range of functions and their focuses. The consequence of this is that integration between PDM and ERP systems is not only reduced to materials-oriented data. There are many functionalities which overlap, meaning that it is increasingly difficult to define where one system with its data and documents ends, and where the other begins.

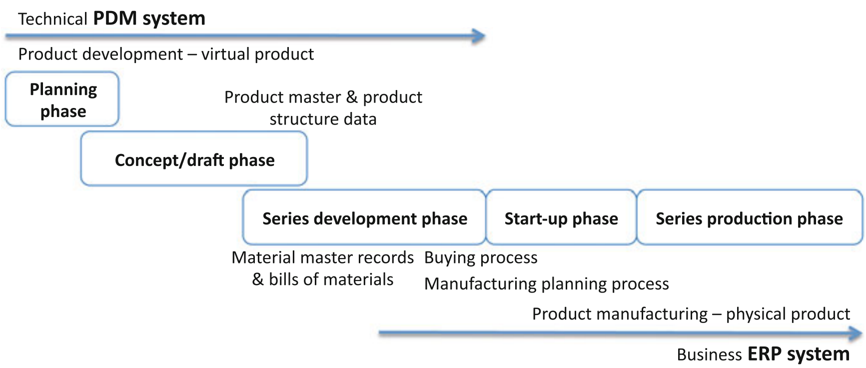

Fig. 2.17 Functional focuses in the use of PDM and ERP systems in product development

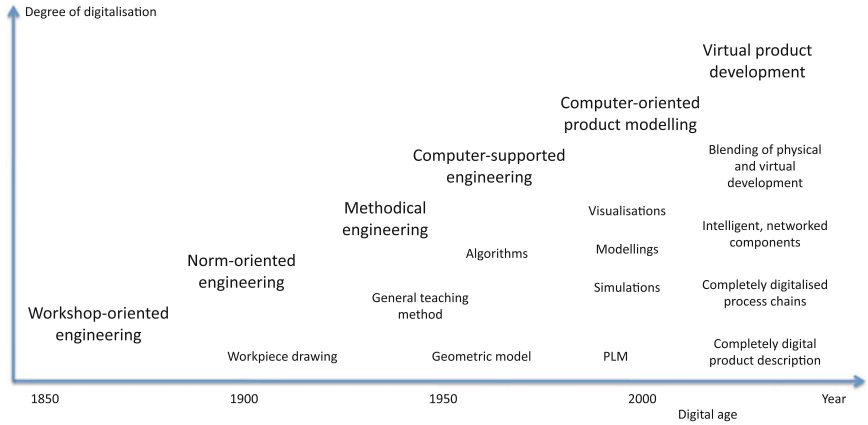

Fig. 2.18 Changes to working techniques in development and engineering, inspired by Feldhusen and Grote [9]

2.4 Digital Methods in Product Development

Digitalisation has not only permeated the vehicle architecture which is at the heart of the automotive industry. All core processes and supporting processes throughout product development in the whole company have been fundamentally changed thanks to digital options in terms of methods, and the rapid development of IT. This not only applies to the digitalised product documentation described in the previous Sect. 2.3.3. The processing power, data storage and data analysis which is possible today, along with the interconnections between them, have reached a level which makes it possible for engineers to use completely new working techniques. Figure 2.18, which draws on [9], shows the changes which have occurred in working techniques in development and engineering.

The first computer-based bills of materials were developed in hierarchical databases as early as the beginning of the 1960s. This was the beginning of the first early phase of digitalisation in vehicle development in the automotive industry with Computer-Aided Design (CAD), drafting and engineering, and Computer Numerical Control (CNC) of production facilities.[17]

By CAD, we mean the design and engineering – in particular the technical drawing – of vehicle parts or of the whole vehicle, using IT systems. CNC programmes, on the other hand, are used to manage production machines [35] in order to manufacture vehicle parts. For the process between designing and manufacturing, countless IT systems have been invented only for many of them to disappear again, because it was not possible to fulfil all expectations with the computer technology

[17] "50 Years of CAD" http://www.designworldonline.com/50-years-of-cad. Accessed: 19 December 2014.

of the time. Very early on, for example, Computer-Aided Manufacturing (CAM) was used to develop software which was independent of CNC machines, and then to expand this to include planning, management and administration tasks in the production process [27, 28]. The main problem encountered with CAM was finding a way to standardise the interfaces between the various production machines, and a standardised way of connecting the CAD systems. The abbreviation 'CAM' has become shorthand for IT systems in production, while CNC has remained a central CAM application. In the years to come, we will see how the fourth industrial revolution "Industry 4.0" will use the new possibilities offered by data processing and networking to change the production environment of logistics, engineering and manufacturing.[18]

Overall, computer-aided systems have developed over the years to become complex expert systems in the automotive industry. But it is not only geometric modelling using CAD systems which has made significant progress. Numerous physical tests and prototypes were replaced by the possibilities of simulating and visualising product properties with the help of computers – which led to significant time and cost reductions in product development.

For example, the following technologies for the calculation and simulation of product properties are nowadays used as standard as part of Computer-Aided Engineering (CAE) to test and validate developments, engineerings and product lifespans in the automotive industry:

- The *finite element method* for the simulation of physical properties of materials. These include, for example, the deformation of a vehicle during a crash, mechanical stress, and the vibration behaviour of parts and components.
- *Computational fluid dynamics* is an established method of fluid mechanics. Simulations of vehicle aerodynamics are common as an alternative to wind tunnel trials. Alongside conservation laws of physics for mass, impulse and energy, empirical approaches such as turbulence or heat transfer are also used. Fluid dynamics also makes it possible to observe flow processes in systems which are optically inaccessible – such as motoric combustion processes.
- *Multiple-body simulation* is used for the numerical calculation of the kinetics of systems which are made up of non-malleable components, the movement of which is limited by joints. The ability to move is described by categories such as position, speed and acceleration. These can also be used to define certain bearing forces in accelerations.
- Measurement of the overall noise level by simulating audible noises and noticeable vibrations, summarised using the terms *noise, vibration, harshness*. Sources of disturbance-causing noises and vibrations as well as their effects on passengers and environments are sought, for example by calculating the extent of

[18]"Industry 4.0 = CIM reloaded? We hope not!". http://www.august-wilhelm-scheer.com/2013/03/11/industrie-4-0-cim-reloaded-hoffentlich-nicht. Accessed: 19 December 2014.

the disturbance-causing noise component which is caused by the running motor or by the wind.

- A *Digital Mock-Up* (DMU) is used for simulating assembly and dismantling, in addition to testing for collisions and buildability. For this purpose, all geometry data of all vehicle parts is brought together in their planned installation positions in a digital model for tests. Specifically in the case of assembly and dismantling simulations, production suitability is tested, and critical distances are measured.

Process and function simulations have come about as part of production development as well. With the help of facilities for the simulation of movement processes in production, the system performance of production can be evaluated and optimised.

The numerous methods and applications concentrated their data in the PDM system. As a result of extensions to this, the concept of "Product Lifecycle Management" (PLM) came about, which is used in many contexts in the literature. We will concentrate PLM on the following concept:

> Product Lifecycle Management (PLM) is a concept for the administration and management of product data and processes for the stages of the product lifespan from its development up to its disposal.

PLM therefore cannot be classified as a system, an IT solution or just a process. The most important task areas for the implementation of the PLM concept are:

1. The basic CAD systems for mechanics, electrical technology, electronics and software for the creation of geometrical, technological and functional product data. Applications include, for example, modelling, technical drawing, development of the wiring system and conceptional engineering.
2. Data centralisation to guarantee the consistency of product data, structures and master data in the PDM system. Applications include, for example, the bill of materials – in addition to the vehicle configuration and structure.
3. Integration of CAE and CAM systems with a product data link to CAD systems. CAE applications include, for example, the finite element method, fluid dynamics simulations, multiple-body simulations and DMU.
4. Data integration of systems with no direct product data link to the CAD systems. Applications include, for example, quality analysis, project control and management, testing and change management, in addition to more general systems such as DMS and CMS for the administration and archiving of data.
5. Processes and interfaces to other application systems with a product link, such as ERP and Supply Chain Management (SCM) for the administration of the value creation and supply chain during the stages of a product's lifespan. This includes, for example, the integration of suppliers during product development.

We refer to the literature [7, 29] for a more detailed look at the concept of PLM. Due to numerous integrations of systems and data, the standardisation of product data is at the heart of PLM [24]. The framework of the standardisations is bound to be broadened as a result of the connected vehicle.

All of the concepts and systems described up until now had their peak phase in the 1990s. From the beginning of the twenty-first century onwards, we can talk of a *digital era*, which began when the amount of information available digitally started to be greater than the amount available in analogue form [13] – something which occurred not only in research and industry, but also in people's private lives. As a result, there were changes to possible work techniques in development, engineering and production.

Virtual product development aims to achieve the goal of process chains which are digitalised throughout, with completely digitalised product descriptions. The ideas and concepts for the merging of physical and virtual product development and validation are currently more developed than the practice.[19]

2.5 Development of New Vehicle Architectures

Not only have product development and manufacturing evolved during the past few years as a result of digital methods – so has vehicle architecture as the way of structuring the company's value creation. The miniaturisation of sensors and power electronics [22], the use of optimised (composite) materials [10] and the range of models which are possible nowadays have reached a level which allows for completely new vehicle techniques. However, the implementation of digital possibilities within working techniques (see previous Sect. 2.4) has established itself more quickly than it has become a part of vehicle architecture.[20]

Next, we will address two fundamental developments which have occurred in vehicle architecture.

1. Modularised vehicle architecture – which has the aim of reducing the complexity of the range of models brought about as a result of the individualisation of vehicles. In Germany, for example, the number of different vehicles on offer increased from 101 in 1990 to 453 in 2014 (see Sect. 1.3).
2. Virtual vehicle architecture – which has the aim of using the increasing information provided by the digital twin of the connected vehicle in a more targeted way. For example, researchers at Ford have begun to experiment with vehicles which

[19] In the next few chapters, we will address some concepts in more detail. For the moment, we will simply refer to the literature [16, 20].

[20] We will not go into the technical possibilities individually – instead, we draw your attention to the literature [10, 22].

create 350 gigabytes of data per hour[21] – something which is still technically impossible with the data rates of today's network architectures (see Sect. 2.3.2).

2.5.1 Modular Vehicle Architecture

In Fig. 2.16, we defined the basis for the vehicle architecture by bringing together the functional structure and product structure. There are two main types of vehicle architectures – integrated and modular. In reality, there are many links between sub-functions and between parts – especially in vehicle architectures which have developed throughout history. In an integrated vehicle architecture, there are many types of physical and functional interaction between the functional structure and product structure. In the modular vehicle architecture, on the other hand, an attempt is made to decouple the sub-functions and the modules/components of the product structure from one another in order to minimise interaction between the two structures. The aim of this is to prevent changes within modules having an effect on other modules. We present a comparison of both types in Fig. 2.19.

The early division of the vehicle into the three subsystems "drive system", "chassis" and "bodywork" (see Sect. 2.3.1) was a first attempt to modularise the vehicle architecture. The drivable frame consists of drive system and chassis – which are the main constituents of the vehicle's undercarriage – which is known as a *platform*. The platform provides the technical basis on which different models and vehicle classes from various brands of a company can build. The structures are referred to collectively as a *body*.

The modularisation goes even further than the platform in order to be able to develop individual modules as mutually independent units. For example, in a

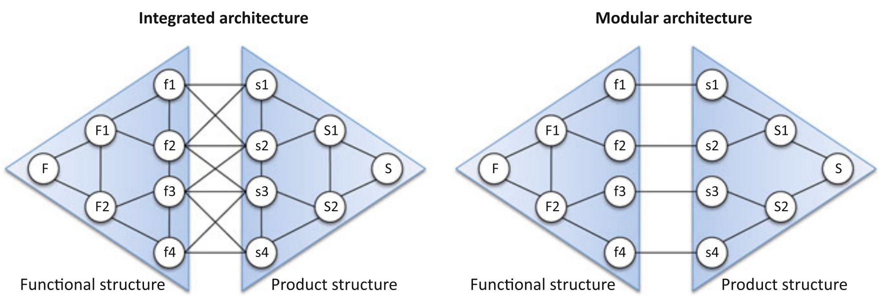

Fig. 2.19 Comparison of integrated and modular vehicle architecture types, inspired by Takeishi and Fujimoto [32]. F stands for the overall function of a product, and S for the product structure. The sub-functions are represented by F1, F2, f1–f4 and the modules/components by S1, S2, s1–s4

[21] "Ford embracing analytics and big data to inform eco-conscious decisions, stay green". http://media.ford.com/content/fordmedia/fna/us/en/news/2013/10/25/ford-embracing-analytics-and-big-data-to-inform-eco-conscious-de.html.

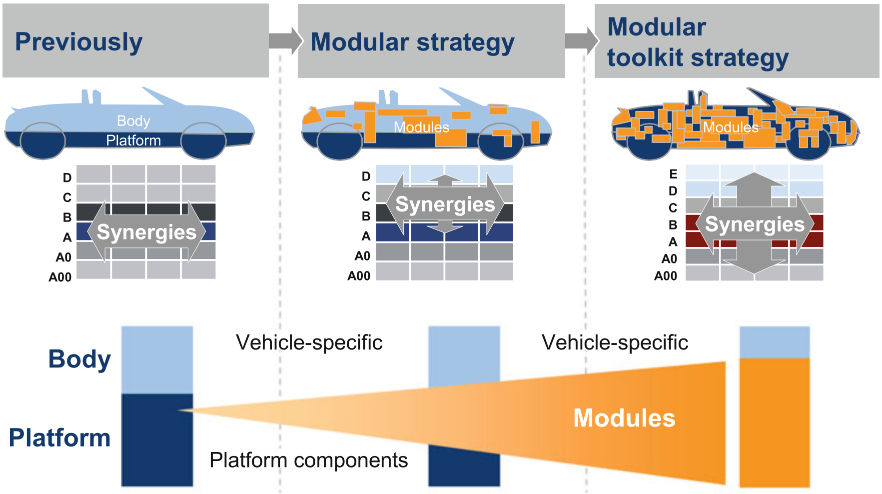

Fig. 2.20 Technical concept of Volkswagen's modular building block strategy [37]

modular vehicle architecture, it should be possible to use the electric motor of a window lifter for different vehicles. In the literature and in practice, however, there is no standardised definition, strategy or standardisation of the interfaces between the modules of the different vehicle manufacturers [32]. The resulting synergy effects are very different from one company to another. Volkswagen has a pioneering role with its modular building block strategy.[22] Figure 2.20 shows Volkswagen's step-by-step approach to modularisation. Volkswagen has introduced the module strategy between the platform and the modular building block in order to maintain the vehicle class-specific platform as far as possible, and just to start with some modules with the highest synergy potential. Volkswagen is pursuing the long-term objective of customer-specific mass production by using the concept of modularisation, where vehicles can be put together individually from diverse building blocks.

For a thorough presentation of modular product development, we refer to the literature [11].

2.5.2 Telematics is the Latest Addition to Vehicle Architecture

The term "telematics" was coined in the late 1970s as a result of the increasing interconnections between computers and telecommunications media as a combination of the words "*Tele*communication" and "Infor*matics*".

[22] http://www.volkswagenag.com/content/vwcorp/content/en/investor_relations/Warum_Volkswagen/MQB.html. Accessed: 19 December 2014.

The electronics described up until now are very dependent on traditional vehicle manufacturing. The development of telematics, on the other hand, is the result of consumer-oriented electronics such as computers, mobile phones and multimedia. In consumer-oriented electronics, product development has focuses other than those we presented in Sect. 2.4 for the long-life vehicle, as can be illustrated currently using the example of products by Google and Apple.

The first steps taken by telematics consisted of successively including telephones into the audio systems of the vehicle. By broadening the systems by using initial "Global Positioning System" (GPS – a global system for determining locations using satellites) navigation devices it was possible to make available targeted traffic information for logistics companies. Until the end of the 1990s, the first implementations of mobile offices or internet connections were only possible up to a point. The technologies and protocols available at that time, such as "Wireless Application Protocol" (WAP) had slow transfer rates[23] and long response times from the mobile network, which meant that they were not very convenient to use. Furthermore, at the time, that display and operation options of mobile phones were very limited. The Telematics Service Provider (TSP) OnStar was a pioneering company that connected emergency and information services with its service centre at the touch of a button from the vehicle, via a fully digitalised mobile network. For a more in-depth look at telematics, see the literature [34].

Telematics changed vehicle architecture because, due to the increase in telematics services, higher demands on battery performance became necessary, as did a higher-performance wiring system. What was even more crucial, however, was the fact that an architecture came about as a result of the networking of the vehicle with telematics services – including those outside of the traditional vehicle architecture. During the initial phases, different companies were often involved between the vehicle and the actual telematics service:

1. manufacturers of telematics units within the vehicle,
2. telecommunications network providers,
3. telematics service providers and
4. providers of information which is included in telematics services.

The responsibilities are concentrated in the market, as shown by the fact that telecommunications companies such as Ericsson or Verizon have expanded to also become telematics service providers.

BMW in particular has driven forward "Next Generation Telematics Patterns" (NGTP) in order to make more technology-neutral interfaces possible within the infrastructure, and to enable more flexible implementations of new telematics

[23] The maximum data transfer rate was 55 kBit/s, which, compared with today's 4G mobile networks with their 300 MBit/s, is very slow.

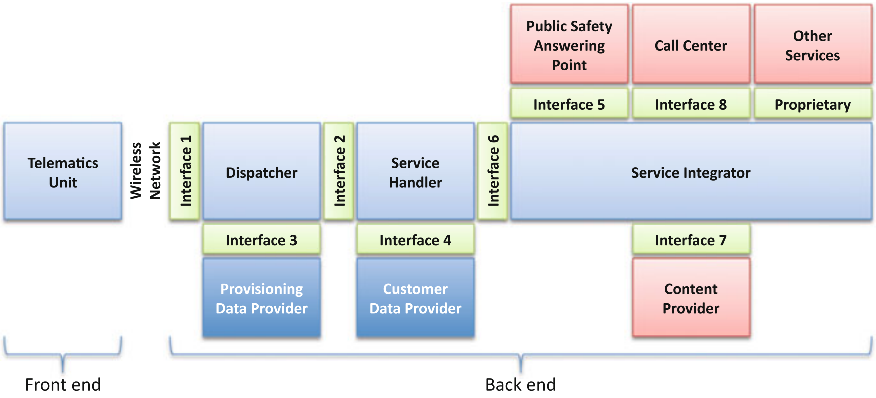

Fig. 2.21 Components (*light blue*), data (*dark blue*), interfaces (*green*) and telematics services (*red*) from the telematics architecture NGTP 2.0 [19]

services, more independently of the telematics service provider. The framework of NGTP is defined by the following four main components (see Fig. 2.21):

1. The telematics unit is built into the vehicle, and is often connected in the "Infotainment" area of the vehicle's network architecture (see Fig. 2.14). It collects data from the vehicle itself and receives information from outside, which it prepares for display. Via a wireless network, the telematics unit communicates bidirectionally with a "Dispatcher".
2. The role of the network layer is to pass messages across network borders, between the telematics unit at the "front end" and the downstream telematics system at the "back end". The "Dispatcher" is the entry and exit channel for both end systems, which are connected via local, regional and long-distance networks depending on the situation. Independently of the telematics unit, the region in which the vehicle is situated, the type of message and the decoupled regulation "Provisioning Data Provider", it finds the "Service Handler" for the message. Interface 1 serves to decouple the network layer from the telematics unit. As a result, the provider of the network layer can be exchanged, or expanded to new regions. The telematics unit can also vary depending on the vehicle, region and running time in question, and must be independent from the provider of the distributor.
3. Depending on the source of the telematics unit, the user and any given rights, the "Service Handler" can add vehicle and user information to the content of the message, or alter it. He makes it possible to interpret manufacturer-specific information in the messages, and to delete specific details from them which manufacturers do not wish to share with telematics service providers. Interfaces 2, 4 and 6 make it possible to decouple customer data "Customer Data Provider" from the telematics service provider.

4. The “Service Integrator” brings together telematics services. In the overall system, several integrators can be included at the same time – while acting independently of one another depending on their region. In particular, the “Public Safety Answering Point” is a regional emergency call service which is separated especially, using interface 5. The additional dedicated services “Call Center” and “Content Provider” for information or support can be made global or regional depending on the user profile, and are also decoupled from the integrator using interfaces 7 and 8. The telematics “Other Services” are not specified any more precisely, and can be manufacturer-specific own developments for the purpose of differentiation on the market.

For a more detailed description of the NGTP telematics architecture, see the literature [19].

In summary, telematics has expanded vehicle architecture, and constituted a particularly relevant step towards gaining a holistic view of architecture in order to be able to structure enterprise-wide telematics services in harmony with the vehicle architecture. Dealing with another type of interface which is common in distributed IT environments – but was and remains new in product development in the automotive industry – required new competences with an orientation towards enterprise architecture. The early implementations and limited infrastructures have left historical traces which are still visible in vehicle architecture today.

2.6 Changing Enterprise Architecture

In the previous sections, we described the way in which vehicle manufacturers focus on vehicle architecture. Only the introduction of telematics interlinked architecture to such an extent in a context with enterprise systems, that the architecture framework outside the vehicle was expanded. In Sect. 2.4, we described a fundamental part of the enterprise architecture via product development. The framework of enterprise architecture is larger, however (see Sect. 1.7).

It was only as a result of digitalisation which vehicle manufacturers gathered from outside the traditional value creation chain that holistic discussions began about enterprise architectures. While the 1980s saw office applications reach their peak phase, in the 1990s it was e-mails and the internet which began to take centre stage. During the initial phases, digital options were built up in isolation from one another. To begin with, for example, the internet was used solely as an information platform to display a business presence if new, separate business organisations had been established [12]. Very rapidly, however, consumer-oriented architecture gave it a new significance within the company. Even though application areas such as configuration tools in sales, searching for a workshop, product marketing and online sales of accessories were developed step-by-step, these tended to remain little more than websites, rather than integrated service provision ranges.

From the point of view of IT, office applications, e-mails, and business information systems such as ERP and the internet were primary drivers of innovation which revolutionised work processes within the company and brought about huge increases in efficiency. If this is compared to the significant change which has been undergone by vehicle architecture during the past 30 years, however, it is easy to understand why the automotive industry has seen little change in its focus or in its value creation chain. What is crucial, however, is the fact that as a result of digitalisation, a creeping change has taken place throughout the whole company. Nowadays, IT is found to different extents in all parts of the company, but even today, no other business-oriented architecture in the automotive industry is as well structured as vehicle architecture.

The long-held doubt in the automotive industry – that products which must be experienced physically, or which are particularly expensive, cannot be sold via the internet in the same way that books can – is no longer valid thanks to the coming of age of the generation of those who have "always been connected to the internet" (according to the US Bureau of Labor Statistics, those born from 1997 onwards).

The challenge is to identify and structure the technologies which have developed separately within the company – a challenge which will be illustrated by a model in the next Chap. 3.

References

1. Bosch (Hrsg.) (1991) CAN specification, version 2.0. Robert Bosch, Stuttgart. http://www.bosch-semiconductors.de/media/pdf_1/canliteratur/can2spec.pdf. Accessed 19 Dec 2014
2. Braess H-H, Seiffert U (Hrsg.) (2013) Vieweg Handbuch Kraftfahrzeugtechnik, 7. Aufl. Springer Vieweg, Wiesbaden
3. Bumes T, Schlinkheider J (2013) Funktionsintegration. In: Rudolph H-J (Hrsg.) Audi Q3: Entwicklung und Technik. Springer Vieweg, Wiesbaden
4. DIN Deutsches Institut für Normung e. V. (Hrsg.) (2008) Klein Einführung in die DIN-Normen, 14. Aufl. Teubner, Stuttgart
5. DIN Deutsches Institut für Normung e. V. (ed) (2012) DIN EN ISO 10209, November 2012. Technical product documentation – vocabulary – terms relating to technical drawings, product definition and related documentation. Beuth, Berlin
6. DIN Deutsches Institut für Normung e. V., VDE Verband der Elektrotechnik, Elektronik und Informationstechnik e. V. (Hrsg.) (2014) Technische Dokumentation: Normen für technische Produktdokumentation und Dokumentenmanagement. Beuth, Berlin
7. Eigner M, Stelzer R (2009) Product lifecycle management: Ein Leitfaden für Product Development und Life Cycle Management, 2. Aufl. Springer, Berlin
8. Ersoy M (2013) Struktur des Fahrwerks. In: Heißing B, Ersoy M, Gies S (Hrsg.) Fahrwerkhandbuch: Grundlagen, Fahrdynamik, Komponenten, Systeme, Mechatronik, Perspektiven, 4. Aufl. Springer Vieweg, Wiesbaden, pp 156–157
9. Feldhusen J, Grote K-H (Hrsg.) (2013) Pahl/Beitz Konstruktionslehre: Methoden und Anwendung erfolgreicher Produktentwicklung, 8. Aufl. Springer Vieweg, Berlin
10. Friedrich HE (Hrsg.) (2013) Leichtbau in der Fahrzeugtechnik. Springer Vieweg, Wiesbaden
11. Göpfert J (2009) Modulare Produktentwicklung: Zur gemeinsamen Gestaltung von Technik und Organisation. Books on Demand, Norderstedt
12. Green L (2010) The internet: an introduction to new media. Berg, Oxford

13. Hilbert M, López P (2011) The world's technological capacity to store, communicate, and compute information. Science. doi: 10.1126/science.1200970
14. Hoischen H, Fritz A (2014) Technisches Zeichnen: Grundlagen, Normen, Beispiele, Darstellende Geometrie, 34. Aufl. Cornelsen, Berlin
15. ITQ GmbH (2014) Kompetenz in Mechatronik. München https://www.itq.de/files/itq_unternehmensbrosch_re_online.pdf. Accessed 19 Dec 2014
16. Khan WA, Raouf A, Cheng K (2011) Virtual manufacturing. Springer, London
17. Kindel O, Friedrich M (2009) Softwareentwicklung mit AUTOSAR: Grundlagen, Engineering, Management in der Praxis. dpunkt.verlag, Heidelberg
18. Matheus K, Königseder T (2015) Automotive ethernet. Cambridge University Press, Cambridge
19. NGTP Group (Hrsg.) (2010) NGTP in a nutshell, Version 1.0 http://ngtp.org/wp-content/uploads/2013/12/NGTP20_nutshell.pdf. Accessed 19 Dec 2014
20. Ovtcharova J, Häfner P, Häfner V, Katicic J, Linke C (2015) Innovation braucht Resourceful Humans Aufbruch in eine neue Arbeitskultur durch Virtual Engineering. In: Botthof A, Hartmann EA (Hrsg.) Zukunft der Arbeit in Industrie 4.0. Springer Vieweg, Berlin, pp 111–124
21. Prenninger J, BMW Group (2013) Advanced diagnostics and predictive analytics of vehicle data. In: IECON 2013, 39th annual conference of the IEEE Industrial Electronics Society, Vienna. http://www.iecon2013.org/files/IECON2013_IF4_01_Prenninger.pdf. Accessed 19 Dec 2014
22. Reif K (Hrsg.) (2012) Sensoren im Kraftfahrzeug, 2. Aufl. Springer Vieweg, Wiesbaden
23. Reif K (2014) Automobilelektronik: Eine Einführung für Ingenieure, 5. Aufl. Springer Vieweg, Wiesbaden
24. Riefler B (2009) Standardisierung von Produktdaten in der Automobilbranche. Dissertation, Universität Stuttgart
25. Roschinski A, Hansis G, Penzkofer H-J, Kerner M, Mayer K (2009) Die Fahrzeugarchitektur: Eleganz, Dynamik und Komfort.In: BMW Group (Hrsg.) Der neue BMW 7er: Entwicklung und Technik. Vieweg+Teubner, Wiesbaden, pp 22–29
26. Schäuffele J, Zurawka T (2013) Automotive software engineering: Grundlagen, Prozesse, Methoden und Werkzeuge effizient einsetzen, 5. Aufl. Springer Vieweg, Wiesbaden
27. Scheer A-W (1990) CIM Computer integrated manufacturing: Der computergesteuerte Industriebetrieb, 4. Aufl. Springer, Berlin
28. Scheer A-W (1997) Wirtschaftsinformatik: Referenzmodelle für industrielle Geschäftsprozesse, 7. Aufl. Springer, Berlin
29. Schuh G (2005) Produktkomplexität managen: Strategien – Methoden – Tools, 2. Aufl. Carl Hanser, München
30. Sinz C (2003) Verifikation regelbasierter Konfigurationssysteme. Dissertation, Eberhard-Karls-Universität Tübingen
31. Streicher T, Traub M (2012) Elektrik/Elektronik-Architekturen im Kraftfahrzeug: Modellierung und Bewertung von Echtzeitsystemen. Springer Vieweg, Berlin
32. Takeishi A, Fujimoto T (2001) Modularization in the auto industry: interlinked multiple hierarchies of product, production and supplier systems. IIR Working Paper WP#01-02, Institute of Innovation Research Hitotsubashi University, Tokyo
33. VID Verein Deutscher Ingenieure (Hrsg.) (2006) VDI 4500 Blatt 1 Technische Dokumentation – Begriffsdefinitionen und rechtliche Grundlagen. Beuth, Berlin
34. Wallentowitz H, Reif K (Hrsg.) (2011) Handbuch Kraftfahrzeugelektronik: Grundlagen – Komponenten – Systeme – Anwendungen, 2. Aufl. Vieweg+Teubner, Wiesbaden
35. Wedeniwski HJ (2007) Technologie des rechnergeführten Schleifens. Tectum, Marburg
36. Wedeniwski S (2012) Object selection based on natural language queries. Patent US20120239682A1, US-amerikanisches Patentamt

37. Winterkorn M (2011) Part III: annual media conference & investor conference 2011. Volkswagen AG, Wolfsburg. http://www.volkswagenag.com/content/vwcorp/info_center/en/talks_and_presentations/2011/03/JPK_IK_2011_Part_III.bin.html/binarystorageitem/file/Part+III+-+Presentation+Prof.+Dr.+Winterkorn.pdf. Accessed 19 Dec 2014
38. Zagel M (2007) Übergreifendes Konzept zur Strukturierung variantenreicher Produkte und Vorgehensweise zur iterativen Produktstruktur-Optimierung. Schriftenreihe VPE, Bd 1, Technische Universität Kaiserslautern
39. Zimmermann W, Schmidgall R (2014) Bussysteme in der Fahrzeugtechnik: Protokolle, Standards und Softwarearchitektur, 5. Aufl. Springer Vieweg, Wiesbaden

3 Strategy, Business Model and Architecture in Today's Automotive Industry

The central theme in terms of the interplay between the three levels of strategy, business model and enterprise architecture are the business competences of a company. They allow enterprise-wide optimisation above and beyond the usual business processes – and it is only through them that a business concept can be created which enables independence from thousands of established processes, thus making it able to lead even the largest of companies in the automotive industry towards new business orientations.

On its own, the fact that a company has a strategy, a business model and an enterprise architecture does not give it any competitive advantages. The development of a business model is also a very extensive task which requires a lot of time and resources. This high level of effort is needed regardless of whether one wishes just to document the business orientation or to optimise and implement it too. It is not to be found in the overviews which are generally true for the entire automotive sector, and could be sketched quickly in a few graphics – instead, it is to be found in the focus on the decisive skills of the individual company, so that it is able to survive long-term in the modern world – with its new technologies, changes in legislation, and stiff competition. If we take a closer look at business competences, we may come to the frightening conclusion that the strategy – and perhaps even the business model – need to be adapted accordingly. This often leads to large, sometimes painful changes having to be made to organisations.

In order to gain a better understanding of where and for what reasons changes need to be made to parts of the business model, and where these parts can be targetedly changed for the purposes of creating a competitive advantage, a clear structuring of the business functions must be created. This chapter will describe the approach.

We will also detail the main business competences in relation to some business functions. To look at these business functions in too much detail, however – in particular with a focus on business processes and application landscapes along with their technologies – would be too company-specific, and it would not be possible

S. Wedeniwski, *The Mobility Revolution in the Automotive Industry*,
DOI 10.1007/978-3-662-47788-5_3

to draw more general conclusions from the examples. We will nonetheless use a few examples, as the modelling of business processes is similar to that of enterprise architectures [128]; a more thorough presentation would, however, be outside the scope of this book. Many software tools for businesses have established themselves on the market [106], which have the purpose of developing company-specific architectures in accordance with the company's criteria. The Alfabet Enterprise Architecture Management Platform, which our modelling approach is largely based on, has gained widespread popularity in the automotive industry in particular [4, 148].

Working from top to bottom – from the general to the specific – our starting point is strategy.

3.1 Strategy

Consciously or unconsciously, every company has a strategy as part of its mission – which is the reason for its existence. Strategies are either planned and developed consciously within the company, or they arise from the actions of different parts of the company. In simple terms, the strategy can be seen as a vision: Where is the company today, where does it want to be in the future, and how can it get there within the framework of constantly changing competition?

Even the best navigation system in the fastest vehicle there is cannot decide on a route if it does not know the destination. On their own, visions and company experiences do not constitute a strategy using which a company will successfully be able to set itself apart from the competition. Next, we will refer to work by Michael Porter [119], who sees strategy as being part of the context of competition.

A common definition of startegy is the following [81]:

> Strategy is the long-term orientation and framework of an organisation which helps it to achieve advantages in an ever-changing environment. The expectations of stakeholders are meant to be fulfilled through the use of resources and competences.

What is central to this definition is the focus on changes in the business environment. These tend to be very difficult to foresee, and are therefore hard to plan for. There are several business analysis models which have proved themselves in the automotive industry, which will be used in Chap. 4. We will look at strategies on different levels on the basis of the business competences of automotive companies. In larger companies, these tend to be the following three levels:

- The *corporate strategy* describes the overall aim and general business framework which the whole company sets for its organisation in order to fulfil the expecta-

tions of the owners, shareholders or stakeholders. It forms the basis for all further strategies and strategic decisions in the company.
- The *business domain strategy* concentrates on a strategic business unit of the company. It is common to classify according to brands or products – such as specific strategies for lorries, passenger vehicles, buses and automotive financial services.
- The *operative strategy implementation* is the action plan which is necessary in order to implement the corporate strategies or business domain strategies. In order to do this, the use of resources, processes and people needs to be planned effectively. Only very few companies, however, have a defined process for strategy implementation, which is why unregulated responsibilities can make them falter.

Before a strategy can be developed, a team is needed which has a broad spectrum of specialised qualifications. In addition to technological expertise, knowledge of finance and law is also indispensable – and, as the strategy has to be carried jointly and implemented by the employees of a company, social competences and creativity are also needed. Furthermore, it can be helpful to bring in opinions from outside the company – but overall it should be possible to cope without a great deal of external support. It is the company's own staff who shape the business – and only with them is it possible to formulate common goals which transcend the divisions between departments in order to create a strategy. The main focus should not, however, be reduced to the formalisms of strategic planning processes. It is important to remember that the whole point is to agree on certain answers rather than formulating certain questions in a disciplined way.

Michael Porter [118] has made it clear that it has already been the case for decades that strategies are no longer just about the positioning of companies – instead, they are also about a broad range of internal and external influencing factors whose reach extends far beyond the company. Due to digitalisation and connected vehicles, the automotive industry is gaining new dynamics in relation to the competition, which has changed substantially: Large internet companies such as Google and Apple have already got ahead in the connected vehicle market, where – with the help of the internet – they make numerous functions available to entertain, inform and assist the driver. The environment to be taken into account includes much more than just technological aspects, however – this is something which we will analyse in more detail later.

The summary of a strategy should at the very least include the following points:

- Long-term orientation
- Competitive advantages
- Distinction of action areas
- Resources and competences
- Values of the persons responsible for making decisions and acting
- Economic determining circumstances

For internal analysis, the question of policy between different business areas plays a role in addition to rationally logical and structured approaches to creating a strategy – when the assertive areas push themselves to the fore because their skills have a strong influence on a strategy in terms of the company's internal policy. Above all, these can include:

- *Dependence* – dependences always arise within large organisations, and they are often interwoven in multiple ways. Sometimes, this is clear and apparent: Following a company merger or takeover, a human resources department has a large influence over the employee structures and how talent is supported, because it takes strategic decisions for the organisation without being able to take an interest in different business cultures and terminologies. A very significant example dates back to 1998, when Daimler-Benz and Chrysler carried out the largest merger in industry history [98]. Areas of development can be so different that they do not logically go together – but a human resources department might put them together all the same.
- *Financial resources* – investments in the development of new ideas, products or services must be financed in order to allow for new business orientations or business models. Within larger organisations, different groups have different levels of financial freedom, thus giving them decisive strategic influence.
- *Position* – larger organisations can only be managed in a goal-oriented way via hierarchical management structures. Managers take on the role of catalysts within organisations, and are meant to support experts in key positions as they take action – but not to control them too much. In reality, however, they do not always limit themselves to having a positive influence in this way – they also shape the development of the organisation. Leading positions in hierarchies offer a wide-reaching overview, thus making it possible to take decisions based on data and facts. Often, however, they are also misused politically in order to gain advantages or to favour certain managers.
- *Uniqueness* – larger organisations have many historically determined old burdens – but also numerous redundancies in parts of the system which are consciously wanted. Identical information being available in several different areas of an organisation can have a positive effect, because it means that different views and potentials for development can be used on one piece of information. Despite this, certain key positions often remain unique – such as a particularly well-protected head designer in an automotive company, for example. The way in which he senses coming tastes in relation to the brand influences business strategy in a very targeted way.

In Chap. 4, we will present a few foundations for the development and evaluation of a strategy, using examples from the automotive industry. To a great extent, however, the framework is reduced to the context of digitalisation. A comprehensive look at the development of a strategy would be outside the scope of this book, which is why your attention is drawn to the wide range of literature on the subject. Further literature on the subject includes, for example, [81, 101, 114]. A global IT strategy, on the other hand, is derived from the corporate and business strategy. Robert Mack and Ned Frey [105] show a possible approach.

What is crucial is that any strategy which is developed be written down and communicated in the same way to everyone. This is for the following reasons:

- Decisions made by managing directors can be comprehended. This can create a feeling of belonging with a common focus within the company. Each part of the organisation can contribute to the company's success in a more targeted way.
- The strategy determines where new products, services or systems are needed for the future of the company.
- Control parameters which need to be used in order to fulfil crucial success criteria, are specified.
- A transparent framework is set for a pragmatic distribution of investments and other resources.
- The orientations are communicated outside the company, thus developing the expectations of parties interested in doing business.

Strategies are only of noticeable importance for the managing director of a company if they are clearly set out in their annual reports – in order to give shareholders and stakeholders the prospect of continuation and growth in the future. In terms of this last point, we will therefore look at three examples from externally communicated corporate strategies of BMW, Audi and Daimler – all three of which are world leading companies with renowned premium brands and corresponding customer loyalty, and whose strategic approach is to strive to differentiate themselves from their intense competition. In this context, long-term perspectives are more important than short-term successes.

3.1.1 BMW Corporate Strategy

Chairman of the Board of Directors Norbert Reithofer summarises his viewpoint as follows in the "Sustainable Value Report 2013" [12]: "*Our business model is based on premium vehicles and services for individual mobility. We look to the future and focus our actions over the long term. Our goal is to be pioneers, offering our customers solutions that pave the way to the future.*"

In 2007, BMW launched its corporate strategy "Number ONE", which will take it to the year 2020. By then, BMW would like to be the uncontested market leader in the premium sector for products and services in individual mobility. This also includes areas which affect the future of the automobile. The path to this goal will take us over the following four central action areas: Growth, shaping the future, profitability and access to new technologies and customers. In doing so, sustainability should be a basic conviction and therefore an integral part of every action area in the BMW strategy (see Fig. 3.1). Four action areas and basic convictions form the framework for the impact directions summarised in the following which are meant to contribute to these goals being reached. Detailed

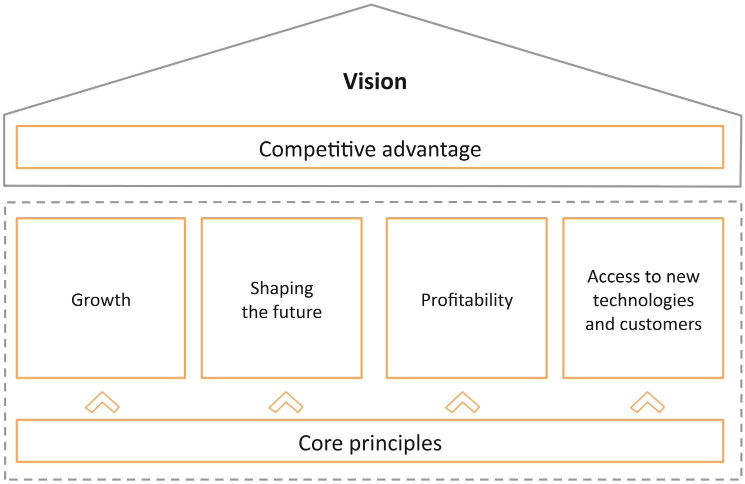

Fig. 3.1 BMW corporate strategy "Number ONE" (*Source*: "BMW Sustainable Value Report 2013" [12])

information on the measures and progress made in implementing them can be found in the numerous company reports published between 2007 and 2014 on BMW's websites.

Growth

BMW wishes to achieve growth using its existing brands BMW, Mini and Rolls-Royce, in addition to other brands if necessary; this has been contributed to by the segments BMW 3 series, BMW 5 series and the BMW X models. But the growth plan also includes new products. In 2013, for example, the new Coupé from the 3 series was introduced to the model range as the BMW 4 series. It is also planned to achieve growth with the very young brand BMW i, which concentrates on electric vehicles. The roots of this, however, are to be found even more strongly in the strategic action areas "shaping the future" and "access to new technologies and customers". For example, the BMW i appeals to new customer groups and requirements with green, emission-free, noiseless urban mobility in order to achieve long-term growth.

The growth should not be achieved through new products alone, however – but also by breaking into new markets. In the case of BMW, these include in particular the three main sales regions of Asia, America and Europe. Compared with the past, in the last few years BMW has achieved a much more balanced market position – which means it has a competitive advantages when fluctuations occur in the market. Another of BMW's growth targets is to increase capacities in emerging economies. The aim of selling over two million vehicles in 1 year may sound attractive in a decimal system, but at the end of the day it is only a number – which could be replaced by aims which make more sense.

Shaping the Future

Shaping the future actively throughout the whole value creation chain means making investments and taking conscious risks. BMW is pursuing three main impact directions here: Reduced emissions, electric mobility and integrated mobility services – with and without a car. In doing so, BMW is addressing numerous ecological and societal topics such as climate change, resource scarcity and urbanisation.

In terms of alternative drive technologies, BMW is concentrating on the electric drive and is a leader in terms of producing series with extremely light and durable materials such as carbon fibre reinforced plastics for the bodywork. The lightweight technology is around 50 % lighter than steel and about 30 % lighter than aluminium – but the material used is up to eight times more expensive than steel. Nonetheless, weight reduction is one of the most important measures which can be taken to reduce vehicle fuel use, and thus also to fulfil legal emissions requirements for exhaust gases and CO_2 efficiency [147].

BMW sees mobility as being part of an interdisciplinary overall context in the future, and wants to change urban mobility. Some of the new individual mobility concepts which are meant to bring users simply and comfortably to their destinations are car-sharing programmes such as DriveNow, parking solutions such as ParkNow, services such as ChargeNow and the networking of different mobility services – also for traffic management and technologies. But even today, BMW is more than just a vehicle manufacturer. Thanks to ConnectedDrive, which is set to be used by around five million BMW vehicles by 2017, the company is the market leader in terms of online-based in-car services. The services can also be individualised for second-hand BMW vehicles. BMW has a unique store in which services can be booked not only via the internet – but also on the move, via the vehicle's very own onboard system.

Profitability

Lowering costs in BMW's worldwide production network is one of the company's primary focuses. Numerous reductions have been made in energy and water use, and waste production has been reduced, as have emissions of volatile organic compounds.

Alongside the usual programmes for reducing costs and improving performance, BMW also pays particular attention to minimising risks in order to improve profitability. The two particular topics focused on are "avoiding financial risks" and "securing raw materials".

Due to the international nature of its business, BMW is confronted with financial risks in different currencies. BMW manages these by adjusting production in countries with different currencies such as Germany, USA, China and Brazil in accordance with sales demand, and the purchase volumes in the foreign currency areas. Comprehensively defined management processes are also used for the monitoring of available raw materials and their price risk. Depending on the risk evaluation, BMW covers its own back with financial derivatives and supplier contracts concluded for different periods with price maintenance for raw materials.

Access to New Technologies and Customers

In the action area of the continual exploitation of new technologies, which is linked to access to relevant customer segments, it is easily recognisable that the customer is at the centre of attention, and BMW is building up direct access to them. The classic dealer networks are given new roles or are even got around by BMW so that it can gain direct contact to the customer. We will examine three examples of this: the new role of "Product Genius" in dealer shops, direct sales, and mobile apps.

In 2013, around 700 Product Geniuses were used in around 450 dealer shops. This new role is carried out by experts – who do not receive a commission – who give the customer a better understanding of the product without putting any pressure on them to buy. In doing so, BMW wants to place more importance on the customer's product experience than on the classic sales. Additionally, BMW is building up a new customer interface for the BMW i brand – using a mobile sales team, the internet, and telephone-based information and customer services.

In addition to direct trade, BMW i Ventures customers are also given numerous mobility services via apps, so that they can stay in direct contact even after the purchase of the vehicle.

Sustainability

Statements from BMW such as those in its "Sustainable Value Report 2013" [12]: "We don't measure success by financial indicators alone but rather in terms of the solid integration of the company into society. Taking social and environmental responsibility for all we do is an integral part of our corporate image" play a significant role in ensuring that the company enjoys such a good reputation as an employer (see Table 2.1). The whole report contains many topics – from renewable energies and reduced resource use to employee health and diversity within the company. Thanks to its successful environmental protection and commitment to social matters, in September 2013 BMW was named Super Sector Leader in the "Dow Jones Sustainability Group Index" for the eighth time in a row. The index is the most significant worldwide for sustainable companies. The company's ethics and the positive effect it has can also be seen in many other commitments and memberships, such as UN Global Compact – which aims at ecological and social responsibility and the respect of internationally recognised human rights thanks to appropriate working conditions.

3.1.2 Audi Corporate Strategy

The core of the Audi brand identity "*Vorsprung durch Technik*" is intended to mean sportiness, progressiveness and high quality. Audi, with its three premium brands Audi, Lamborghini and Ducati, has given itself the mission of making it possible for customers to be inspired in diverse ways all over the world.

The 2020 strategy was presented for the first time in 2010. By then, Audi would like to be the worldwide market leader in the premium automotive sector. In the years following 2010, the strategy was continuously improved in order to keep up

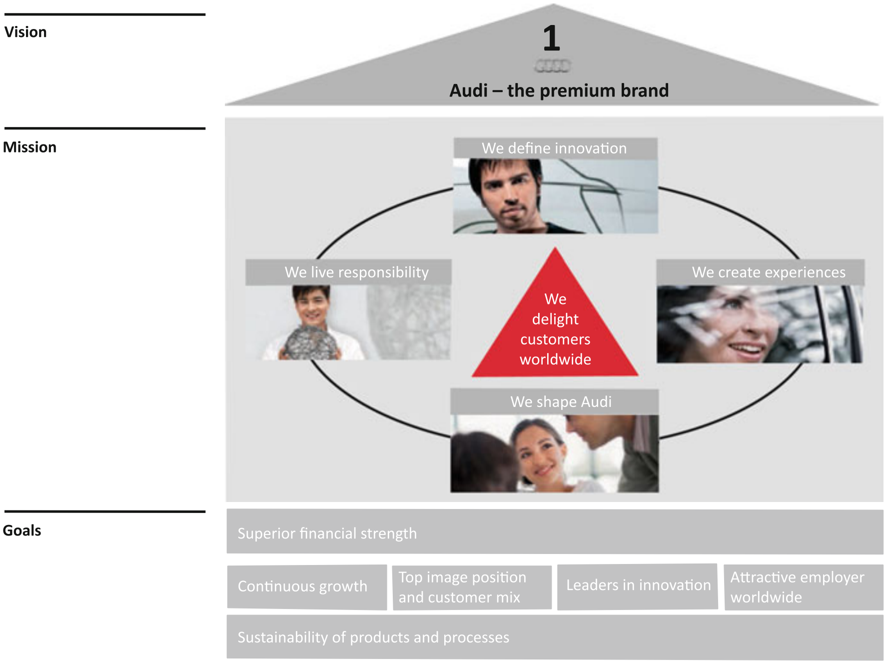

Fig. 3.2 Audi corporate strategy (*Source*: Audi annual report 2013)

with changing economic, ecological and social demands. In its 2013 annual report, Audi was still placing its mission to inspire customers all over the world at the heart of its 2020 strategy, and in order to achieve this it identified the following four areas for action: Defining innovation, creating experiences, living responsibility, and shaping Audi (see Fig. 3.2). The most important impact directions in the context of the four action areas and goals are summarised in the following; more detailed information on the measures and progress towards them can be found in the many company reports from between 2010 and 2014 on the Audi websites.[1]

Defining Innovation

In addition to offering its clients sporty, high-quality and innovative vehicles, Audi also wants to give them comprehensive mobility solutions. In order to achieve this, there is a focus on the three following key technologies: “alternative drives”, “lightweight construction” and “connectivity”.

In contrast to BMW, Audi has not yet made electro-mobility its main priority in terms of drive technology. In 2014, the alternative drives e-tron, with its plug-in

[1] http://www.audi.com/corporate/en/company/corporate-strategy.html. Accessed: 19 December 2014.

hybrid technology – and g-tron, with its bivalent power unit, which can be powered by fossil natural gas, are in the focus of attention.

Thanks to the use of aluminium, lightweight technology has had particular[2] significance for Audi since as early as 1981. At the beginning, however, lightweight technology was limited to just a few components – which therefore only had a minimal effect on reducing the weight of the vehicle, and the associated decrease in fuel consumption. In mid-1994, however, Audi presented the A8 – the world's first aluminium bodywork in a top range series vehicle. Audi, like BMW, can also see the potential of carbon fibre-reinforced plastics – which can be used to build much lighter cars than those which can be constructed from steel or aluminium. In its work on the development of carbon elements, Audi cooperates with its sports car subsidiary Lamborghini. The declared aim is to further reduce vehicle weight throughout the whole product range, by using an intelligent material mix as well as function and system integration into new types of vehicle architecture. Aluminium, steel and fibre-reinforced plastics are combined – each where it can be used most effectively. For Audi, the compromise made between weight reduction and economic viability is also crucial for large-scale production models.

All functions which connect the driver to the internet, the automobile and the environment are referred to collectively as "Audi connect". In Audi's 2013 annual report, this includes 23 different services from the areas of navigation and mobility, communication and infotainment, such as weather, news and traffic info, or music streaming. Some of them can also be personalised on myAudi. Furthermore, there are also technologies which, in the future, will make it possible for data to be transferred from one car to another, and will enable direct communication with infrastructure – for example with traffic lights.

Creating Experiences

In order to inspire their customers with experiences, it is important for Audi to have innovative sales formats. One example of this is Audi City,[3] an interactive show room which allows digital access to all Audi models – from any angle and in original size and high quality. By experience, we understand the configuration of a dream vehicle in all possible colour and equipment variations – which can also be ordered online straight away, just as you would at a dealership. As of 2014, Audi offers these modern dealerships in the metropolises of London, Beijing and Berlin.

Living Responsibility

Audi focuses all its sustainability activities on the following five thematic areas: "Operations", "Product", "Environment", "Employees" and "Society". The comprehensive Corporate Responsibility Report 2012, which was updated in 2013 and

[2]Firstly from 1981 onwards in racing, with Audi quattro rally, and then from 1983 onwards, in the series with Audi Sport quattro.

[3]http://www.audi.com/corporate/en/corporate-responsibility/we-live-responsibility/operations/customer-orientation-and-audi-city.html. Accessed: 19 December 2014.

published in May 2014, included transparent goals, measures, deadlines and degrees of fulfilment. The goals listed are derived both from company-internal requirements and from the expectations of different external stakeholders, depending on their relevance. We will look at a few examples from each thematic area.

The stakeholders consider guaranteeing Audi's economic stability as being particularly relevant. Two goals are avoiding corruption and sensitising employees to the issues surrounding anti-trust laws.

In 2013, product-related topics were evaluated as particularly relevant for sustainability – both within the company and by external stakeholders. One particular goal is to add the alternative drive concepts of natural gas and electro-mobility to the range on offer, in addition to reducing fuel use and CO_2 emissions, which is also an environmental goal. A further environmental goal consists of minimising consumption of natural resources during production.

Thematic focuses for employees including training and continuous education thanks to the introduction of new vocational professions and programmes for future technologies, and finding a balance between career and family/private life.

In February 2012, Audi became an active member of UN Global Compact – as part of which it identifies with its ten principles in terms of environmental protection, human rights, working conditions and fighting corruption. Audi published the 2013 progress report as a public-spirited contribution in May 2014.

Shaping Audi
Shaping Audi is about continually developing and adapting the organisation's processes and structures, in particular mastering challenges which come about as a result of volume growth, constant expansion of the product range, increasing internationalisation and the development of new technologies and business areas.

3.1.3 Daimler Corporate Strategy

It is an indisputable fact that Daimler, as the inventor of the automobile, (see Sect. 2.1) played a decisive role in shaping spatial mobility with innovations which pointed in new directions. Furthermore, Daimler can also claim to be a pioneer in terms of developing mobility for the future.

The 2014 Daimler annual report describes the following four strategic goals:

- *Technology leadership and innovation.* Daimler wants its products to be market leaders in terms of safety, autonomous driving and green technologies.
- *Delighted customers.* Thanks to interfaces in the sales and use processes, Daimler wants to be able to be in contact with customers at any time.
- *Best teams.* For Daimler, the foundations of its action are the four company values of passion, respect, integrity and discipline. Integrity particularly refers to action in terms of diversity of employees, the company, business partners and customers.

Fig. 3.3 Daimler strategy (*Source*: Daimler annual report 2014)

- *Profitable growth.* By 2020, Daimler wants its growth strategy "Mercedes-Benz 2020" to have made it the market leader in the premium passenger vehicle market. Particularly with its 'smart' brand, Daimler wants to expand its pioneering role in urban mobility. In contrast to BMW and Audi, Daimler also has growth goals in terms of commercial vehicles – which we will not go into here. The growth goals in the area of mobility services are mentioned in Daimler Financial Services.

From this, the company defines four strategic areas of growth which it wants to concentrate on (see Fig. 3.3). We will go into more detail about some aspects of the four strategic growth areas, and for further details we will refer to the 2014 annual report. These four growth areas are similar to those set out by BMW and Audi, but there are differences in the detail – especially in terms of mobility services in the fourth area.

Strengthening Core Business

The focus of strengthening core business is on:

- The comprehensive renewal and expansion of the model range in all sectors, and the further expansion of the international production network.
- Improving cost structures in order to encourage sustainable, profitable growth. One programme for this is the implementation of the module strategy, in order to cope with the increasing complexity which comes about as a result of additional model variants. Besides the module strategy, the restructuring of sales in Germany is also meant to contribute to improving cost structures.
- Making the organisation more customer-oriented in order to ensure continuous customer support throughout the products' whole life cycle.

Growing in New Markets

Daimler is aware that in the next years, worldwide demand for automobiles will mainly grow in markets outside Europe, North America and Japan, and wants to concentrate on growth in emerging economies such as Brazil, Russia, India, China and others. In order to achieve this, Daimler wants to expand its presence in these countries and – where it makes sense – build up cooperation with local partners.

Leading in Green Technologies and Safety

Daimler's portfolio of drive technologies ranges from optimising combustion engines to hybridisation to locally emission-free driving. The broad portfolio is to be developed even further in order to make it possible to ensure that different mobility requirements are met in a sustainable way. For this reason, Daimler is not as bound to technology as BMW or Audi.

The Daimler Sustainability Report [32] will go into more detail than the annual report does about long-term economic success in harmony with the environment and society. In addition to technological topics, Daimler also talks about health management and occupational safety.

Especially with its extensions to the assistance systems and the implementation of autonomous driving, Daimler is trying to expand its pioneering role in the areas of active and passive safety, in terms of both passenger vehicles and commercial vehicles.

Driving Ahead with Connectivity and Mobility Concepts

Daimler is continuing to expand its range of mobility services for private, business and public use. These include, for example, car2go, CharterWay, Bus Rapid Transit or the mobility platform "moovel". Daimler's mobility service moovel gives customers the chance to combine different private and public mobility offers optimally, and to be charged for them via a payment system.

On the basis of increasing digitalisation and connectivity, Daimler is testing and expanding its customer-oriented service range on the internet, as part of "Mercedes me". Another new service is "Mercedes connect me", which offers accident, maintenance and breakdown management as well as distance diagnosis. Furthermore, mobility services, vehicle networks and customer-orientation are integrated into the "Mercedes move me" service.

3.1.4 Comparison with Japanese Companies

As is demonstrated in the examples, the great strength of the German automotive industry is the fact that it includes the premium sector in its classification of executive and luxury vehicles (see Sect. 1.3). Japanese vehicle manufacturers, meanwhile, focus on comprehensive cost leadership in the mass production sector. Their corporate strategies are therefore different to those of premium manufacturers, who expand on more capital-intensive business models. During the 5 years up to 2012, the Japanese invested[4] 30 % less of their revenues than did European vehicle

[4] "Building cars with less capital". http://www.mckinsey.com/Insights/Manufacturing/Building_cars_with_less_capital. Accessed: 19 December 2014.

manufacturers (even in the mass production sector). Due to lower investments in vehicle manufacturing itself, advantages and room for manoeuvre are created in research and development in the field of vehicle and drive concepts. Toyota, for example, is producing the first vehicle powered by hydrogen, called "Mirai" (Japanese for "future") in mass production. From the point of view of engineers, such successes are revolutionary. From the point of view of business models moving towards creating a mobility industry, these are only incremental improvements.

The company culture, thinking and philosophy in Japan are very pragmatic and goal-oriented. According to one of their principles [104], problems in production cannot be solved from behind a desk – they can only be analysed and dealt with at the source. At the centre of the Japanese culture of further development "Kaizen" is continuous, systematic and gradual improvement with the involvement of employees. In 1986, Masaaki Imai produced a detailed summary of the concept of Kaizen [72]. Inspired by this, the German-speaking world established the "Kontinuierlicher Verbesserungsprozess", and the English-speaking world the "Continuous Improvement Process". The size of the change should not play a primary role – instead, what is important is that all employees are conscious of it and are constantly on the lookout for ways to improve. Toyota's particular focus is on quality, delivery times and cost.

Kaizen concentrates on permanent improvements in small steps – mostly on the operative level, with an orientation towards short-term results. In doing so, it is differentiating itself from bigger innovation and long-term plans for transformation to instead go along new, unknown paths – as required by a mobility industry. Furthermore, the joy of constantly improving engineering and manufacturing is the driving force and motivation. As a result, innovations are limited to the flow of materials, and neglect the flow of money from the market.

3.2 Business Model

In simple terms, a company's desired goal can be read from its strategy. In the same way, a business model shows – often as a snapshot of business – how the company's different business sectors fit together at a particular time.

The business model is crucial to the company's holistic orientation, and shapes its history. Really successful companies distinguish themselves not only in terms of how they find business models, but also in terms of how they implement them in their strategy. Even today, there is still no generally accepted definition of a business model – which is also due to the non-standardised way in which the term "strategy" is used. In practice, many different ways can be found to model a business's value creation. However, every company has a business model in the sense of describing the business which communicates successes or failures within a certain context.

We use the following definition of the business model [113]:

The business model represents an easy-to-understand aggregation of all relevant aspects of a business at a high level of abstraction. It shows how a company works in terms of its overall concept, how it creates values and makes them available, and makes a profit from these. The business model is looked at a certain point in time.

Our focus in the task of describing a business model in a simple way in order to derive an enterprise architecture from it, is a static point of view: The business model is a snapshot of a framework plan of how a company is functioning and making a profit at a certain point in time. This approach helps us to communicate business activities in terms of value creation in an easy-to-understand way. It does not, however, contain a strategic perspective on the transformation of business models. Strategy adds the dimension of time to the business model which has been adopted at the time. The transformation of the business model over a set period can be formulated, and the changes of the business from its current state to a specified goal at the end of said time period can be presented.

Our model is based on the simple requirement that it be possible for value to be created by investing services in a business on the market. On this basis, we can divide the business model into the following four questions (see Fig. 3.4):

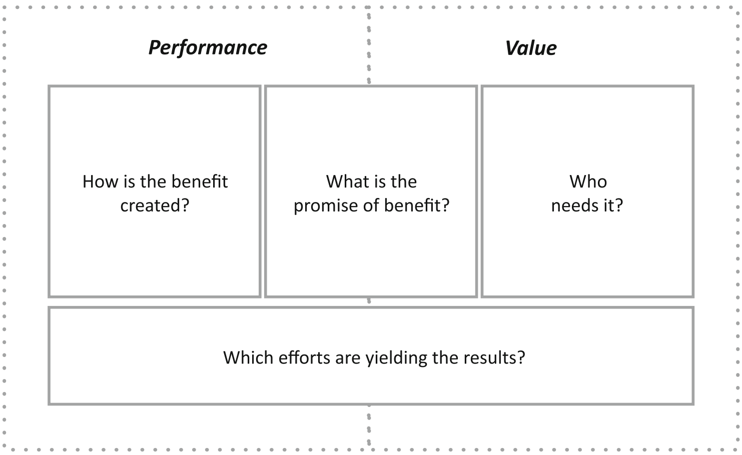

Fig. 3.4 A simplified business model for the structuring of the use of services in a business, through which value can be created in the market. The structuring is based on the four fundamental questions of "How?", "What?", "Who?" and "Which?"

Who is the target group that a company wants to appeal to with its orientation and services?

In terms of this question, the customers are the focus. They are often divided up into different target groups in order to make it possible to address needs or circumstances in a more targeted way. It is particularly important to define which customer relationships are to be built up and how they are to be kept. As part of the relationship, the channels and media are defined which the company will use to contact the customer.

What does a company promise to do in order to satisfy the needs of customers from one target group?

Values and the associated competitive advantages are created for the company in the market, and these are perceived by the customer. At the end of the day, it is the individual criteria and options of the customers which define whether the value proposition satisfies the needs, or even whether a longer-term relationship is possible. The offer of value also implies which needs the company does not promise to satisfy, and which are therefore not the focus of the company goals.

How is the value proposition achieved for the customer, with the help of resources and partners?

Often, a value proposition can only be fulfilled in cooperation with suppliers or general partners. However, the partners must also be able to see a benefit and value in the value creation in order for them to want to take part in the business model.

Which profits can result from the successful realization of the value proposition made to the customer?

The company profits are generated from various income sources and the cost structures which are necessary for these. They determine the value of the business model, and therefore also whether the success is sustainable. A very broad range of models can be sources of income – for example, a one-off payment for an AUTOmobile, a use-oriented payment for a car-sharing vehicle or continuous fees for insurance.

Of course, no company can be described using these four questions alone. We will not go into the higher motivations and the purpose of the company here. Concentrating on these four questions has the advantage of summarising the main factors which influence the business architecture in order to create business – in a simple model.

In the automotive industry, business is defined consistently via the vehicle product, via the services which are provided to customers in the vehicle context, and via the markets which are served. Figure 3.5 shows an example of an established business model in the automotive industry. We nonetheless took the very conscious decision to describe the business model only in terms of the value brought by the company to its customers. The product and the market are part of the value creation which groups itself around the customer in order to fulfil a value proposition for customers with mobility needs.

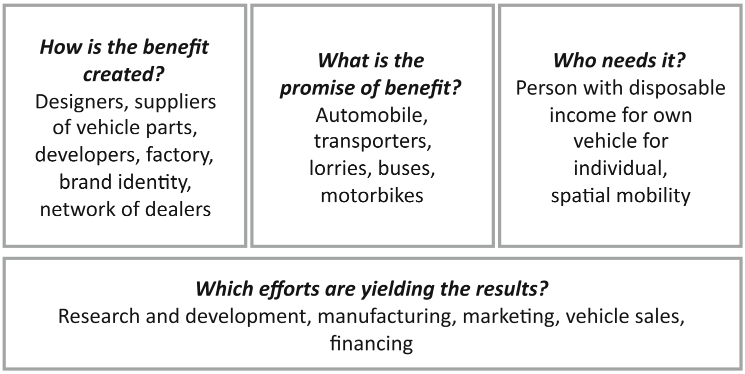

Fig. 3.5 Example of an established business model in the automotive industry

If we take a closer look, however, we see that nowadays, there is hardly any relationship left between the automotive company and the end user as the person using the vehicle. As the actual interface with the customers, the sales department mainly deals with relationships to dealers, and the sales of the vehicles as value propositions. The true relationship to the customer can be found in detail in the unambiguous lifelong vehicle documentation – no matter where the vehicle is or who it belongs to. This means that it is the dealer's garage which have the most intensive relationship to the end user. Most dealers are independent of the vehicle manufacturer and primarily represent their own interests rather than the brand identity of the manufacturer. At the end of the day, we should also ask ourselves: Does anybody really like spending time in a dealer's garage? The reason for a visit to a garage is always a problem with the vehicle, and there may be additional costs which usually do not lead to an improvement, but just restore the vehicle to how it was meant to be before. This is not motivation in terms of value creation – but it is an initial way of approaching bringing about targeted change of the business model for the digital age, in which a whole range of new and altered business models makes it possible to satisfy customers' mobility needs – and not only by selling them a vehicle. We will discuss the changes to the business model and the associated strategies in Chap. 4.

In view of our focus on enterprise architecture, we have merely touched on the topic of the "business model" as a basis for its implementation, and for a more in-depth discussion of sub-models for business modelling, we would bring your attention to the following literature: [2, 113, 175].

3.3 Business Domains

The primary goal of business domains is to consolidate critical aspects of business into individual focus areas. Their model is purely functional, and is designed independently of processes, organisations and applications. We define a business domain as follows:

> A business domain is a functional summary of the competences in the company which are needed in order to implement the business model. Every domain fulfils a specific business goal and there is a logical reason behind its existence in the company. Similar to the business model, a model of business domains is only created for a certain moment in time – and not for a period of time.

Companies are structured into several business domains which, together, form a model comprising different levels and which can become very complex and elaborate. In order to stay within the scope of this book and not get caught up in too much detail, we will therefore often present the specialist situations and problems faced by the automotive industry in a simplified way – as though we wanted to construct a new automotive company without any burdens from the past. Nonetheless, we will try to identify potential areas of conflict in the business domains on the level of competences, especially when unique competences are changed as a result of digitalisation.[5]

We categorise the business domains into the following groups: leadership, core business, administration and support (see Fig. 3.6). As regards the categories, including all business domains, we are looking at them from a purely functional point of view. There is no hierarchy in terms of an organisation. Neither do domains take into account any kind of geographical distribution.

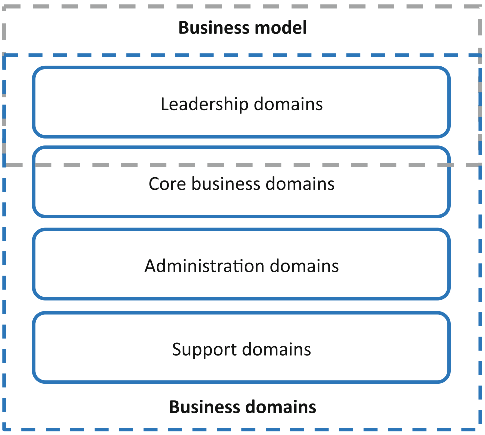

Fig. 3.6 The business model is implemented on the one hand via the business domains of the leadership level, and on the other hand via the sub-areas of the planning functions of the business domains, which are classified as part of the company's core business. The core business level includes the most important business domains of the company, and is industry-specific

[5]For a closer look at the identification and bundling of business domains, please refer to the literature [1].

Leadership Domains

Alongside the "corporate leadership", the leadership domain forms the framework for the transition involved in the implementation in the business model of the question of how what profit can be made by undergoing which risks, and how the cost necessary for this can be controlled. In terms of an objective measurement of the costs incurred and values achieved, control of risks and finances has a very high status in any company which is to remain financially viable (see Fig. 3.4).

Core Business Domains

The core business domains include all primary business competences which are necessary for the value proposition. They summarise the most significant business domains of the company, which can vary depending on the type of vehicle manufacturer. The main domains establish themselves throughout the product lifespan, because the product is the value proposition of the business model of our first consideration. These domains contribute to the company's value creation.

The vehicle's life span starts with the domain of "research and development". In the introductory Sect. 1.3, we explained how high the value creation share of the supplier is in terms of the product and its bill of materials (see Sect. 2.3). This is why the domain of "procurement and inbound logistics" is a fundamental activity so that all parts can find their way from purchase to the end product – which finally ends up with the dealer via outbound logistics. In order to create the value proposition, the central focus of the company is on the manufacturing and assembly of the product, as summarised in the domain of "production". "Marketing and communication", as a preparatory phase for the business domain "sales and outbound logistics", will be divided into two separate domains. It nonetheless makes sense when both of these cooperate very closely. Sales, acceptance of the vehicle by the customer and the phase following the sale are supported by financing options from the "financial service" domain. The final core business domain of the product life span is "after-sales support".

Administration Domains

Administration domains include all operative business competences which only serve actual value creation in an indirect way. They guarantee the design and supervision of the seamless processes which are needed to fulfil the value proposition.

All organisations have the "human resources" business domain, which concentrates on providing goal-oriented human resources. The second domain in the administrative category is "quality". It is meant to ensure products which are as fault-free as possible, and make sure that the customer has a perception of quality throughout the relatively long lifespan of the vehicles. Some of the competences in the quality domain could also be classified as core business of vehicle manufacturing, because safety standards are so high for the vehicle as a consumer good that even the approval for a sale is subject to strict regulation. All financial administrative tasks are summarised within the business domain of "finance and accounting"; some competences could also be classified as part of the leadership domain.

Support Domains

The support domains incur costs and often create no directly tangible benefit for the business model – but they provide the foundations for the implementation, which consists of two business domains. The domain of "infrastructure" combines all operating resources necessary for the implementation of the business via locations, machines, equipments etc. The second domain is broader, and structures business competences for "corporate support service" in the company. We distribute the competences of classic IT over both domains on this level.

Figure 3.7 summarises the four categories described, along with their business domains. The diagram also shows the transition of the business model to the business domains – in particular via the leadership domains. Not all of a company's competences can easily be demonstrated using the business domains described. In this section, we have also implicitly assumed that there is only one business model for the whole of the company. In practice, automotive companies contain many subsidiary companies, joint ventures, collaborations, capital

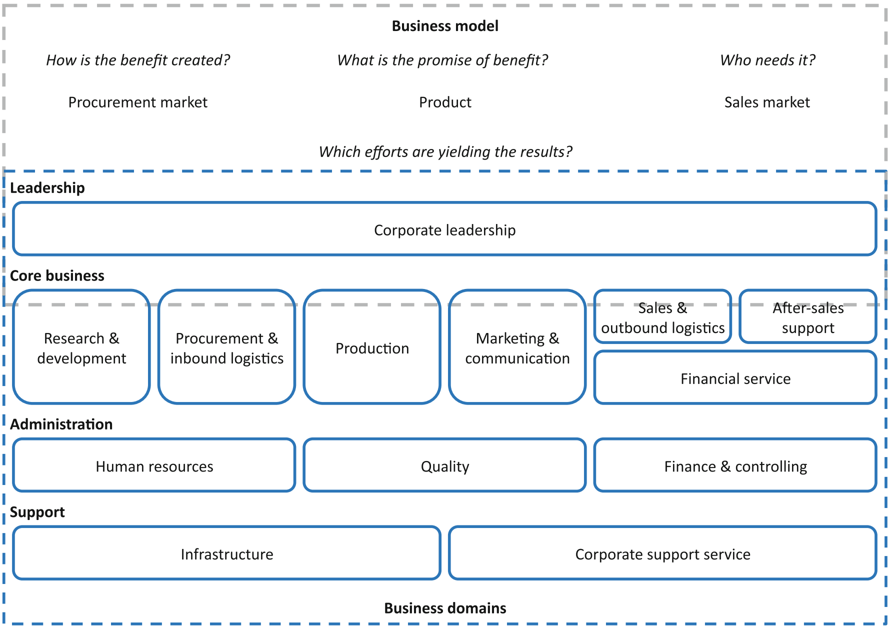

Fig. 3.7 Transition of the business model into the business domains of the automotive industry

participations etc., in which different business models are consciously managed. For example, the mobility company moovel pursues a different business model to that of the parent company Daimler. We will go into more detail about this in Chap. 4.

The tendency to create even more business domains is found especially when existing organisation structures are used during the creation of the model, and an attempt is made to model a snapshot of the company which is as precise as possible, even though not all domains can be technically distinguished from one another in complex companies. Within the framework of the automotive industry, we will limit ourselves to a minimum of domains, and will leave expansions to the individual companies themselves. What is important is not that domains should cope in their own system, but that they should be in harmony with the business orientation.

In summary, the model of the domains provides an essential tool with which to develop an overall picture before we go into more depth about the progression of digitalisation in the automotive industry, and evaluate it. With the help of the business competences, the individual domains will be presented in detail in the following sections.

3.4 Business Competences and Components

Business domains are the decisive level on which to orient and optimise companies. The company's simple and easy-to-understand structure, in which only very broadly defined focuses of the business are consolidated, is described in more detail by the business competences – a model which enables a more in-depth analysis of the company, and creates an overview of those company competences which are needed for value creation. As specialisations make it easy to differentiate in the market, the business competences have central significance for the successful implementation of the business model. In the case of further development, there is a close, mutual relationship when it comes to transformations at company level.

In the specialist literature, terms such as "business competency, business capability, business component" are used. In both the literature and in software tools, however, these are used in a very non-standardised way. People do not always think about what they mean. In our context, a business competence is made up of a combination of the knowledge, skills, capabilities, material resources and attitudes of an organisation, which allow a company to achieve unique market performances.

We define business competences and components in the following way:

> A business competence is a stable professional ability of a company, which allows it to continuously provide market services for business purposes in a

(continued)

particular area with several business components. One business component contains cross-references to groupings of business processes which carry out the actual value creation; additionally, business services which are based on applications and data can be parts of a business component. In the business competence model, all competences listed are unambiguous, and are dependent on one another. They form a functional summary of the separate competences in the company which are needed in order to implement the business model. While the competences of a company only represent one snapshot in time, they form the central element for the further development of the company orientation and value creation.

Building on the previous definition, we structure business competences, inspired by the "Component Business Model" from IBM [116], according to the following questions (see Fig. 3.8):

- *Business purpose:* What are the abilities, skills and specialist knowledge needed for?
- *Activity areas:* Which activities that belong together are carried out regularly?
- *Resources:* Which human and material resources are needed?

  These include technologies, materials, tools, machines, IT, methods or financial resources. Sustainable competitive advantages are found in interplay with person-related skills, capabilities, knowledge and experiences – which can be used again and again.

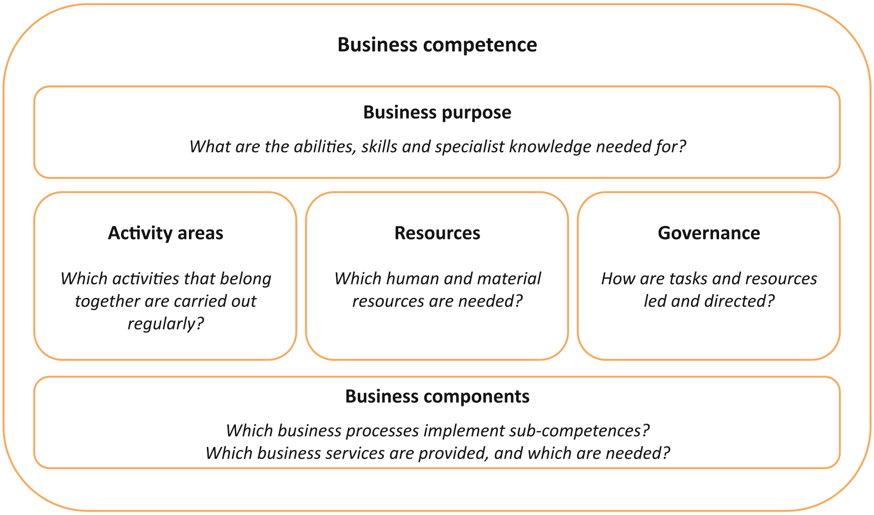

Fig. 3.8 Structure of a business competence, inspired by the "Component Business Model"

- *Governance:* How are tasks and resources led and directed?
- *Business components:* Which business processes implement sub-competences? Which business services are provided, and which are needed?

When identifying and structuring business competences, it is important to understand that different characteristics are decisive depending on whether we are working from the inside out or from the outside in. On the one hand, competences should develop separately from the inside out within the company in order to enable a high level of flexibility and responsiveness. On the other hand, the business components within each competence should form a coherent block in order to implement a high level of efficiency and quality.

Some of the company's business competences give direct added value and benefit for external customers, while others only exist internally for the support of value creation. This is why we divide the competences for a model into primary and secondary business competences. The performance provided as a result of the primary business competences is decisive for the business's success and competitiveness. The primary business competences are also revenue contributors, because customers come into direct contact with them and are prepared to pay a price for this. Secondary business competences, on the other hand, are not recognisable for the customer and are therefore irrelevant to him. Nonetheless, they have a fundamental influence on the effectiveness and efficiency of the primary business competences. Most of the primary business competences of any economically oriented company can usually be found in the core business domains. Depending on which business model we are dealing with within the same sector, the characterisation of primary and secondary competences may vary.

An additional characterisation in the model of business competences specifies what a company can achieve on its own, and in which areas it has to integrate specialised support from other external companies when it cannot provide this by itself. It is also perfectly possible for external primary business competences to be present in core business domains. In Sect. 1.3, for example, we explained that in automobile manufacturing, suppliers have a very high share of value creation.

In addition to the definition of the business competences, the presentation of the model is also inspired by the "Component Business Model". This is where all fundamental business competences are listed in groups in the domains. Additionally, we categorise the competences of each domain into the following three responsibility levels for the business:

Direct — The competences of the direct responsibility represent the strategic mission statement of the guidelines which need to be kept to. They ensure the long-term continuation and intrinsic value of the business domains in the company context. They allow and encourage cooperation between different competences in the company – whether they are primary or secondary, internal or external.

Control — The competences of the middle layer serve the mutual control of direct and execute responsibilities. They monitor performance and implementation results, deal with exceptions, decide on consequences in the case of non-compliance, protect assets, and validate information. To do this, they provide the relevant indicator systems for process evaluations using measurement tools.

Execute The competences of the execution responsibility have their feet firmly planted on the ground in situations where specific understanding, capabilities, skills, experiences, knowledge, and professional and social ways of acting are required. Thanks to their operative business components, they create the value of the company for the end customer.

The interplay between all three levels is very important. The business competences lie idle if there is a lack of motivation in the leadership in directing. And vice versa, the motivation is wasted if the execution competences are not as developed as they should be. Execution competences and directing motivations can only be understood and improved as part of a controlled value system. At the same time, it is not necessary for every domain to contain all three levels of the competence responsibilities. The business competences are meant to put companies in a position where they can flexibly and quickly re-orient themselves to future changes – for example due to the advance of digitalisation and the way it is changing business.

The two-dimensional classification of the business competences in the model produces a table view. In Fig. 3.9, we describe the model in a schematic way, with examples of primary (solid colour) and secondary (outlined), internal and external business competences. The business competences are designed in such a way that there are no overlaps in terms of competence areas.

The business competences model can be used to carry out different analyses in order to identify the strengths and weaknesses of a company's business as compared to that of the competition – for example to identify the competences which deserve the most attention in terms of revenue growth, cost reduction, profit maximisation, or outsourcing (externally or internally).

The main focus of our analysis is in identifying and specialising in those competences which become relevant in terms of developing a business model with a new orientation when a company from the automotive industry wants to develop into the mobility industry. In order to do this, however, we must first develop the business competence model for today's automotive industry.

At the same time, the business competences themselves do not need to be developed from scratch again. A good start are the established reference models for business processes, such as the sector-neutral Process Classification Framework (PCF) from the American Productivity & Quality Center (APQC).[6] In the next section, we will go into more detail about this before we harmonise the processes with the business components in order to develop a specialist focus on possible business competences. It is not necessarily advisable to take on the business competences model without also taking on business-specific adaptations. Each

[6] http://www.apqc.org/process-classification-framework-pcf. Accessed: 23 December 2014.

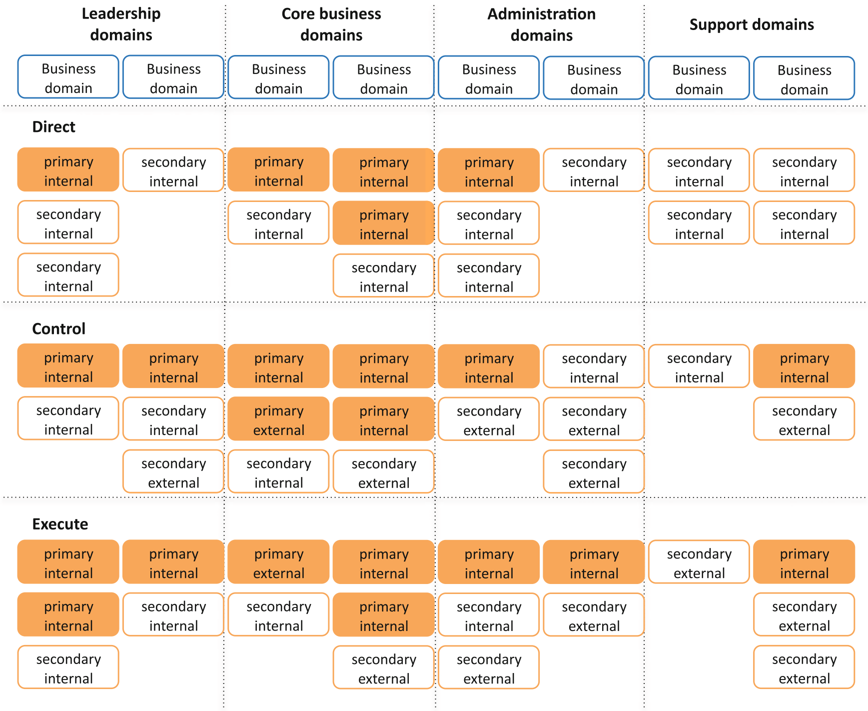

Fig. 3.9 Table view of the business competence model in the context of the domains, inspired by the "Component Business Model"

company should think about which core business competences it would like to develop in order to stand out from the competition. Competitive advantages are all about specialising in certain competences. Otherwise, it would be easy for competitors to imitate generally applicable descriptions on the basis of derived process standardisations, and it would not be possible to make distinctions in the competitive market.

In terms of business competences, we concentrate on specialist properties and do our best to avoid using the term 'management', which is used very often for numerous fields of work such as requirements management, change management, human resource management, quality management etc. Such terms include both administrative and organisational aspects as well as organisational measures for which terms such as change department, human resources department and quality department used to be used. Management is often misunderstood to be purely a control function, and is defined and experienced differently in every business culture. Differences in terms of the framework of the whole company being looked at arise, for example, because requirements management can also be referred to by the more comprehensive term of requirements engineering. At the end of the day, however, there are always requirements which need to be taken into account in the implementation of a product or a service. This is why we will simplify the terms used to refer to business competences and will also summarise a few, for example because requirements and changes are in a state of close interplay with each other in development.

The terms selected from the business domains and competences concentrate on the unique competences of the automotive sector, which may become relevant to a transformation of the enterprise architecture into one of a mobility industry. The supporting function of management only plays a subordinate role in the way we look at enterprise architecture, as the organisational structures should not be depicted through the competences.

3.5 Reference Models for Business Processes

Business processes carry out the actual value creation of a company, through the execution of a series of individual activities. Value creation is understood as an increase in economic value which represents an increase in value in the sense of increased utility for external or internal customers [7]. Many companies have already oriented themselves towards business processes, and have anchored them deeply in their enterprise structures. There is a great deal of literature on this subject, and to go into it would be outside the scope of this book. This is why we refer to [55, 133, 136], which should help you to gain a better understanding of business processes in practice. Furthermore, there are also numerous examples of further literature on business processes in industrial companies, particularly the reference work by August-Wilhelm Scheer [134].

Our focus is on the existing reference models for business processes in the automotive industry, which we can use for the identification and shaping of business competences. We have linked the business processes with business components and services (see Fig. 1.8). The latter are usually described using formal process modelling. The language developed by IBM, Business Process Modeling Notation (BPMN [145, 169]), is widespread. It can serve as a bridge between business and technical process models, and forms the essential element of Service Oriented Architecture (SOA, [48]). Since 2005, BPMN has been taken on and developed further by the Object Management Group (OMG).[7]

A helpful place to start is the Process Classification Framework (PCF) for Automobiles (OEM), which was developed as Version 6.1.0 as an open standard model[8] by IBM and APQC and was published in July 2014. The document includes around 1000 processes with corresponding activities and actions, which are only written about at a high level of abstraction without detailed descriptions. The broad

[7]OMG is an international consortium which deals with the development of vendor-independent, object-oriented programming http://www.omg.org. Accessed: 23 December 2014.

[8]http://www.apqc.org/knowledge-base/documents/apqc-process-classification-framework-pcf-automotive-oem-pdf-version-610. Accessed: 23 December 2014.

Execute								
Product Development			Supply Chain			Customer Relations		
Market	Research	Develop	Acquire	Build	Fulfil	Brand	Sell	Support
Analyze Market	Define Opportunity	Define Product Requirements	Qualify Supplier	Request Resource	Order Inquiry	Define Brand Requirements	Target Customer	Register Customer
Analyze Performance	Forecast Technology	Select Technology	Issue Request	Issue Material	Confirm Order	Differentiate Brand	Qualify Target	Manage Incident
Define Need	Acquire Technology	Design Product	Evaluate Proposal	Build Product	Plan Load	Select Market Channels	Position Solution	Resolve Problem
Architect Solution	Define New Technology	Design Process	Negotiate Contract	Verify Product	Receive Warehouse	Architect Brand	Develop Relationship	Process Return
Develop Case	Validate Technology	Validate Product	Place Order	Package Product	Fill Order	Validate Brand	Assess Need	Educate Customer
Validate Opportunity	Protect Technology	Align Supply Chain	Receive Order	Stage Product	Ship Order	Protect Brand	Develop Proposal	Deliver Service
Product Roadmap	Transfer Technology	Define Product Lifecycle	Verify Order	Release Product	Deliver Order	Assess Supply Network	Present Proposal	Monitor Experience
	Introduce Technology	Launch Product	Transfer Inventory		Verify Receipt	Create Marketing Roadmap	Finalize Contract	
			Process Invoice		Install & Test	Launch Brand	Review Win/Lost	
					Invoice			

Fig. 3.10 Excerpt from the overview of the execution processes of the manufacturing industry variant of the Value Reference Model from the Value Chain Group

portfolio of processes is divided into primary performance/execution processes and secondary administrative/support processes. PCF is linked to Open Standards Benchmarking (OSB), which provides very comprehensive performance metrics[9] for the processes of the Process Classification Framework.

A further economic process model is the Value Reference Model,[10] which is being developed by the Value Chain Group. This includes a broad range of processes which also exist in variants for different industries. Figure 3.10 shows some of the execution processes from the manufacturing industry, which are divided into the three process groups “Product Development”, “Supply Chain” and “Customer Relations”. In the background, standard process descriptions are available as far back as the level of activities. Also, as is similar to the case with PCF, comprehensive performance metrics are also provided.

Other types of reference process models are provided by software vendors [90]. While they do usually contain general structures of business processes and data, they only ever relate to self-developed software systems. For example, the company SAP offers business software including process models for the automotive sector, among others.[11] When using software systems such as these, it is recommended to take on the implemented reference processes and minimise costs associated with adaptation – which limit their general usability. SAP works on different model types in close collaboration with customers, partners and experts from industries, and integrates

[9] http://www.apqc.org/sites/default/files/files/osb_CompleteBPMeasureList.pdf. Accessed: 23 December 2014.

[10] http://www.value-chain.org/bptf/buildingblocks/vrm/. Accessed: 23 December 2014.

[11] https://solutionexplorer.sap.com/solexp/ui/vlm/i_autom/vlm/i_autom-ind-i_autom. Accessed: 12 January 2015.

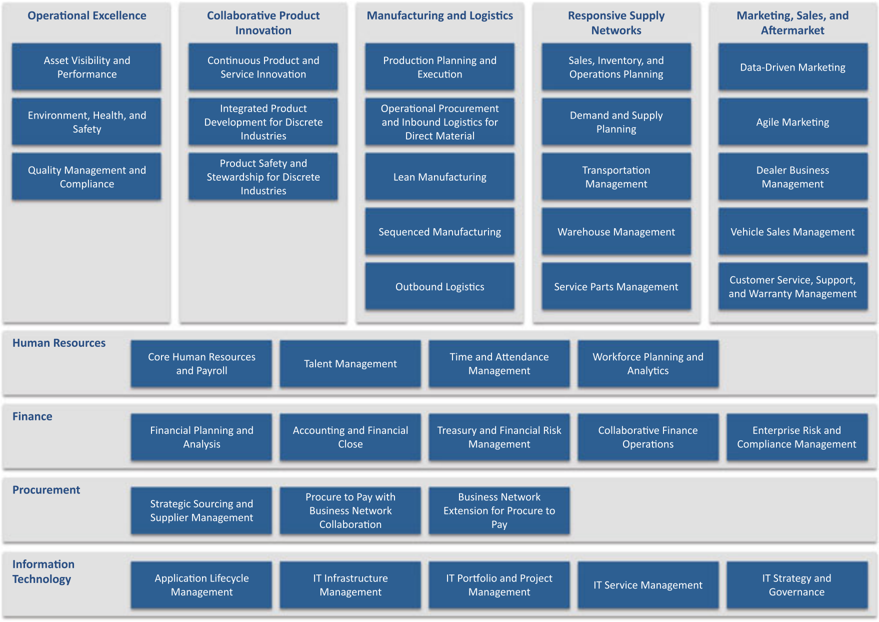

Fig. 3.11 Overview of the SAP Value Map on the highest level for the automotive industry (as of 2014)

these into their software systems. Many administrative or supporting functions such as accounting, financing, purchasing, warehousing or human resource management rarely have high strategic significance in the company. It is advantageous to orient business processes towards standardised software systems – especially while an automotive company is in the process of becoming globalised. Figure 3.11 provides an overview of the SAP Value Map on the highest level for the automotive industry.

3.6 Business Competences in the Automotive Industry

On the basis of the models presented in the previous sections, in this section we will bring together business competences in the automotive industry which can be used in order to structure and understand a reference model. Their descriptions do not claim to be exhaustive, and only cover a part of the business components and business purposes. For some vehicle manufacturers, some competences will be part of their plans for the future rather than part of the current reality. Other manufacturers still need to recognise the significance of this question at all in order to identify an overview of their global competences. The allocation of components to competences can be interpreted in different ways and may vary from one company to another. There may also be some vehicle manufacturers for whom such a reference model was worked out years ago, and who are now in a transformation phase; we will go into more detail about this in Chap. 4.

The key to a reference model in enterprise architecture is the business architecture, which we will approach holistically using the business competences. It is not easy to select a level of depth which is suited to all readers, which is why in general it has an introductory character and is focused on the automotive industry – although, of course, all the main core and framework processes are taken into account.

The number of possible business competences for the automotive industry is increasing rapidly, thus making it impossible to have an overview of all of them. This is why, even when we were merely drafting, we limited the business domains for the automotive industry (see Fig. 3.7) to a minimum of those domains whose main business competences are now in our focus, in order to be able to represent the business in question. In our first step, we must concentrate on a certain type of vehicle manufacturer (see Sect. 1.3). We will take a fictional automotive company which produces passenger vehicles as our example in order to create a business competences model which is as closely related to practice as possible. We will also refer to specific examples in the case of certain competences and components.

3.6.1 Corporate Leadership

Managerial responsibility in the complex network of companies which makes up an automotive industry is very diverse; all of the following must be taken into account: the globalisation of the world economy, a shift taking place in sales markets and many new driving forces from the automotive sector's external environment, as presented in more detail in Chap. 4.

The business domain "corporate leadership" brings together the competences for the strategic, integrated and overall leadership of all other business domains of the company. It provides the framework, company values and direction for this. It balances all business domains throughout operative daily business, right up to potential, future business models in harmony with existing unique competences and core processes.[12]

In addition to classic core competences which are shaped by engineering, financial management tasks are also increasingly playing an important role. During recent years in particular, the role of Chief Financial Officer (CFO) has become that of a critical decision-maker alongside that of the Chief Executive Officer (CEO) [42]. Although the automotive industry has gone through several global financial crises over the past decades, the financial crisis which began in 2007 had particular significance for the CFO [149]. This was also in the context of the fact that, due to the General Motors case in June 2009, the automotive industry was seriously affected by the largest-scale insolvency proceedings in the history of the United

[12]For a more detailed discussion of corporate leadership, there are further concepts – for which we refer to the literature [89].

States. Many suppliers who had specialised solely in the automotive sector also slid into a recession in the shadow of the large companies.

This is why investors and the capital market demand solid financial competences from corporate leadership – along with transparent reporting. Financial management has established itself as fundamental to competitiveness in the continuity and development of a company, and CFOs have increasingly taken on more management-based and strategic tasks within the automotive industry. This means: Ventures driven by enthusiasm are consigned to the past, while profit-oriented matters come to the fore.

In Fig. 3.12, we have summarised the business domains of the automotive industry (see Fig. 3.7) to just a few simplified challenges faced by corporate leadership. Yet, analysis of company-specific management should take place in more detail at the level of the business competences. For leadership, it is important to see which of the four quadrants a domain or competence is placed in. From the perspective of the future business models in particular, there is often uncertainty and a lack of clarity. In this case, identifying competences which are lacking is more important that placing them in the precisely correct position.

Now, the focus is on the question as to which competences shape the leadership of the corporation in such a way as to best support corporate leadership in the market environment, with all the changes it is currently undergoing. Larger-scale companies are not organisations which can be steered in a goal-oriented way on the basis of planning competences in a strict top-to-bottom hierarchy. The managing directors must operationalise abstract competences for the corporate leadership in such a way that their implementation can contribute to the success of the company – although this is easier said than done. Corporate strategy is a leadership business competence which we introduced in Sect. 3.1. A conscious decision was made to choose Audi as an example of a company. The products of its three premium brands Audi,

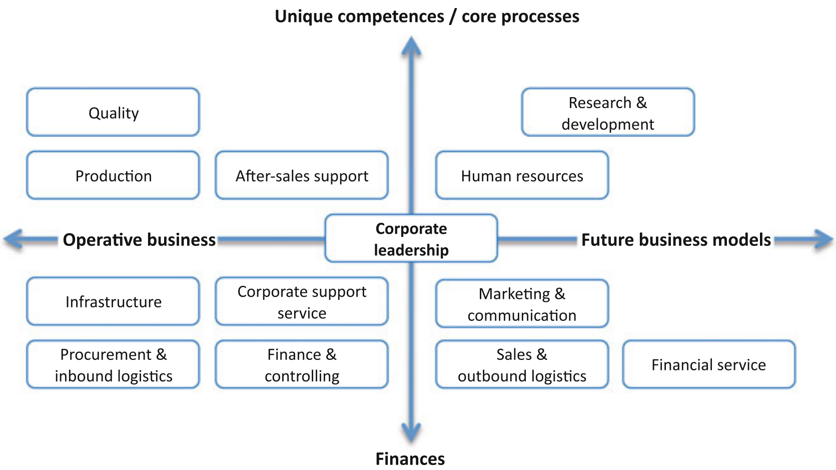

Fig. 3.12 Simplified representation of the business domains in terms of four challenges faced by corporate leadership

Lamborghini and Ducati can still be summarised in one strategy – even though their product manufacturing processes are all very different. But what about the strategy of the parent company? Volkswagen has a range of models which includes 12 different brands.[13] In December 2010, the German publication "Manager Magazin" asked the question: "Can a range including twelve brands still be managed?".[14]

So, overall, the business competences within the domain of "corporate leadership" are not sufficient on their own in order to actually manage the company – in all its complexity. This was presented in Fig. 3.7 by classifying parts of the business competences to the core business domains of the corporate leadership.

The domain "corporate leadership" includes the following eight business competences (see Fig. 3.13):

Direct:
- Goals, values, principles
- Corporate strategy

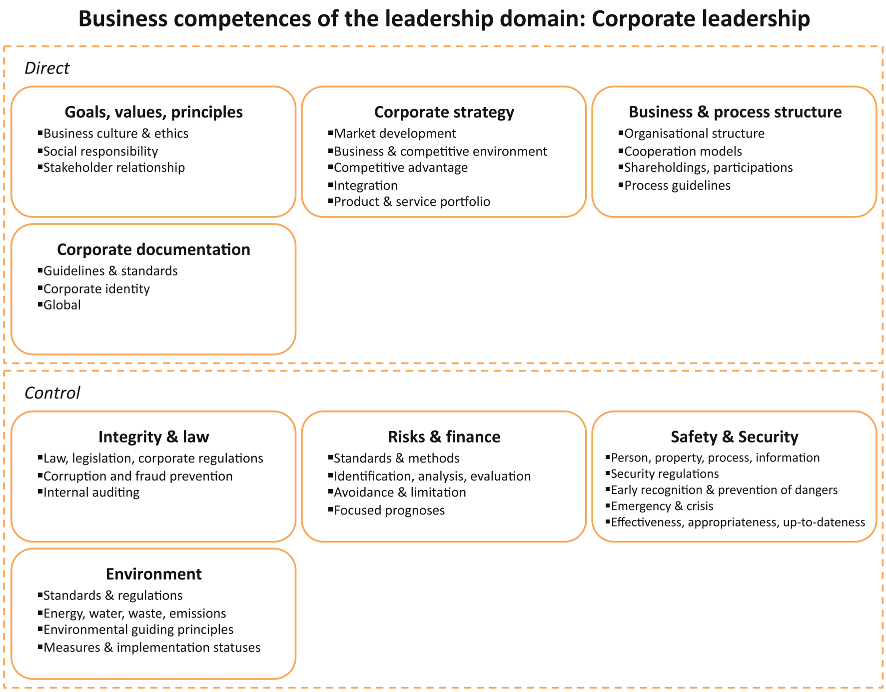

Fig. 3.13 The business competences of the domain "corporate leadership"

[13] http://www.volkswagenag.com/content/vwcorp/content/en/brands_and_products.html. Accessed: 23 December 2014.

[14] http://www.manager-magazin.de/unternehmen/autoindustrie/a-733019.html. Accessed: 23 December 2014.

- Business and process structure
- Corporate documentation

Control:
- Integrity and law
- Risks and finance
- Security
- Environment

Direct Business Competences

Sustainable business success is crucially dependent on motivation in the leadership team. The following three driving forces in particular serve the business purpose:

1. Sustainability for long-term continuity of the company, with values and principles
2. Long-term trust of internal and external stakeholders in the corporate leadership
3. Continual improvement of the efficiency and productivity of the business processes in the globalised world economy.

Goals, Values, Principles

Every company needs clear statements and instructions about values as a yardstick for decisions and ways of acting, which employees and executives can orient themselves towards [170]. In the three strategic examples from the automotive industry which are listed (see Sect. 3.1), it can be recognised that *business culture and ethics* are just as crucial for achieving goals as are professional qualifications. BMW talks of its basic convictions alongside the action areas, Audi about its German slogan “Wir leben Verantwortung (We live responsibility)” and Daimler about the fact that its employees orient themselves towards the company values of passion, respect, integrity and discipline. All three together show that violations of the business and corporate ethics put the success and reputation of the company at risk.

But even just the three industrial nations of the USA, Japan and Germany, in which the automotive industry is one of the most significant sectors of industry and every manufacturer is represented, there are very different cultures. And typical satirical American humour can easily lead to misunderstandings in other cultures. Similarly, the German way of expressing criticism in a very direct way can be hurtful to people from other cultures, because in many Asian countries criticism is given more sparingly and carefully.

How can the use of social media be harmonised with the corporate strategy? This is not about the controlled and regulated use as part of the company's marketing and official communications, but about the problem that social media are bringing about a communications transformation throughout the company's entire workforce. This is why companies which use social media in their official communications should also maintain and encourage an open communication culture among employees if they want to be successful. This does, however, lead to a loss of control over which content is published and is relevant to the business competence of security – as there is the risk, for example, that sensitive business data will be disclosed – whether consciously or unconsciously.

Not only must managing directors set out values – they must also be seen to live by them, so that they can develop within the whole company. In this way, the company's corporate culture is a product of the personal behaviour of the executive staff. What is important, what is appropriate? What are the main focuses on? In order to answer questions like these, principles are needed – as is unambiguous internal communication. For example, in 2006, chairman of the board of directors Dieter Zetsche instructed "We want the Board of Directors to be where the action is",[15] that the Board of Directors should return to the company roots at the Daimler main factory in Stuttgart-Untertürkheim, where the cars are manufactured[16] and where you can smell the oil – even though this change in location meant more inconvenience for the members of the board, who travel a lot.

As global vehicle manufacturers, all three list the principle of corporate *social responsibility* in their regular reports on "Corporate Social Responsibilities". These include respect for and compliance with internationally recognised human rights standards such as the refusal to use forced labour or child labour, no discrimination of any kind, and guaranteeing equal pay for equal work. This responsibility results from the globalisation of the markets and the organisation of worldwide value creation chains by the automotive industry, which acts on a global scale. Respect and compliance is one side of the management level. But in the reality of the harsh competition which the companies are up against, which of these values can really be lived out? Can the implementation of upright values in practice be an obstacle to beating the competition?

The three automotive companies are merely examples. In Sect. 3.1.4, we mentioned the high significance of the company values of Toyota, and listed its principles [104].

Every company is always in a *stakeholder relationship*. These include shareholders, investors, employees, customers, suppliers, partners, state institutions and the public. Each of them has different, sometimes contradictory interests to those of the company, and expects certain co-determination rights. Through interactive communication via the integration of expectations and their effects on corporate leadership, trust can be won in the long term. Particularly in times of crisis, dialogue with investors is demanding. Corporate leadership creates the framework for the different relationships in external and internal communication, while actual communication takes place as part of other business competences. In this way, the business domain of "marketing and communication" takes on large proportions of the internal and external "corporate communication", but not the multitude of examples of specialised direct communication such as "financial market communication" from

---

15 http://www.automobilwoche.de/article/20080714/HEFTARCHIV/988029673/sternzeichen-daimler-chef-zetsche-zum-umzug-der-konzernzentrale. Accessed: 23 December 2014.

16 http://www.spiegel.de/wirtschaft/immobiliendeal-daimlerchrysler-verkauft-stuttgarter-konzernzentrale-a-445099.html. Accessed: 23 December 2014.

the business domain "finance and controlling" or communication with suppliers as part of the "supplier relationship" from the domain "procurement and inbound logistics".

Corporate Strategy

We introduced tools for corporate strategy in Sect. 3.1. In Chap. 4 we will go into more specific detail about strategy and *market development* in the *business and competitive environment* of the automotive industry in order to discuss long-term *competitive advantages*.

The corporate strategies of large company groups are not necessarily free from objections. Figure 3.12 is meant to show that the implementation of new business models in established daily business does not necessarily happen in a very harmonious way – instead, that it is only through objections from below that new business models can mature. What is important is the *integration* of all business area strategies into the operative strategy implementation and its approvals – even in the case of objections, especially when digitalisation thoroughly changes the way the company does business.

The *product and service portfolio* represents the company's value proposition, and establishes its offer in the market. The strategic design of the portfolio, in particular the range of models of the vehicles (see the different vehicle classes in Sect. 1.3), is at the heart of the business orientation of vehicle manufacturers. In doing so, customer requirements and trends must be recognised and implemented in a product and service portfolio whilst taking into account the goals, skills and potentials of the company. It is essential for a company to know where it stands in comparison to its competitors. To be more precise, it needs to know in which markets it can sell its products and services to generate what revenue, profit and market share, and increase its market share. This will show the strengths and weaknesses of the company – also in terms of individual products and services. A regular comparison is made in order to determine whether the company goals can be achieved using the available portfolio, or whether investments need to be made in new market sectors or groups of customers. In particular when changes are made to the range of vehicle models, both costs and risks need to be evaluated. These are easier to calculate in the case of successor models, because it is possible to draw on experiences made with the previous model, focus on existing customers, and utilise knowledge from sales. The details are worked on as part of the business competence "market analysis and success evaluation" from the domain "marketing and communication" before they are decided on and managed.

The portfolio must ensure that long-term goals of the product brands are fulfilled. Each brand has an identity which is shaped by parameters and is marketed as such. If, for example, a brand stands for sportiness or comfort, then these core messages should be found in every new product which is part of this brand.

In practice, the portfolios of products and services are often still dealt with and organised separately. For example, in the case of many vehicle manufacturers, the management of the product portfolio is part of the "research and development" business domain, where it is limited to vehicle development in a very one-sided way.

Service portfolios are often not even strategically managed, or are only found as part of the "financial service" business domain. In these cases, holistic qualifying and bundling of customer requirements to products with integrated customer-specific services is not possible.

Business and Process Structure

The corporate leadership sets out basic guidelines for the *organisational structure* of the company. It is not only about the reporting done by internal staff, but also about *cooperation models* in the global market. There are many types of connections to other companies – such as joint ventures, *shareholdings, participations* or strategic alliances. There are low-level and high-level cooperation models for low or high levels of competition [29]. For example, despite a high level of competition, the independent companies Renault and Nissan Motor have made close cooperation possible through an alliance. Besides, in China it is usual to found, supervise and deal with joint ventures in order to be able to construct and sell cars at all. Different types of outsourcing of business processes are no longer carried out just to lower costs, but also in order to improve quality and dissemination of the company range. Everything is carefully prepared and carried out in order to manage long-term competence advantages and disadvantages in the correct way. As part of this, newly oriented *process guidelines* bring about long-term effects.

Corporate Documentation

What must/should be documented by a company? This question is so fundamental that it must also take into account corporate leadership. This business competence is not about enterprise-wide creation of content; instead, each individual business competence has its own documentation which must be created, approved, published, maintained and stored in accordance with enterprise-wide *guidelines and standards*. All corporate documents which are used both internally via various communication channels and made publically accessible, should represent a thoroughly standardised part of the *corporate identity* of global companies, which is free from contradictions. Furthermore, documents must not only be *globally* accessible – they must also be understood all over the world, also in terms of adapting the corporate language to suit the cultures of each country. In American organisations, for example, the German precision in documenting meetings is perceived as excessively formal.

In 1998, the largest merger in industrial history happened when Daimler-Benz and Chrysler came together [98]. The English skills of most of the German-speaking employees proved insufficient for an effective working relationship, however. Furthermore, things were made more difficult by the fact that almost all technical documents were written in German, and hardly any of the English-speaking employees had any German skills. It was therefore impossible for either side to understand all of the corporate documentation. Meanwhile, in more and more companies, it has now become usual for corporate documentation to be created primarily in English. Only Japanese vehicle manufacturers are a long way away from achieving this.

Control Business Competences

Which value feeling is correct? The direct competences showed the framework, but not the consequences of violations.

The following five driving forces serve the business purpose:

1. Increasing the transparency of business risks thanks to a comprehensive insight into occurrence probabilities, effects and possible, region-dependent reactions
2. Better evaluation of financial, economic, security and environmental risks and violations of legal and legislative provisions; management of counter-measures
3. Fraud avoidance in the context of financial losses thanks to early recognition which allows quick action
4. Reduction of security, health and environmental liability thanks to systematic identification, analysis and management of risks
5. Reduction in fines which have to be paid by improving consumption, emissions and other environmental provisions in order to fulfil regulations and legislation

Integrity and Law

The huge number of *law, legislation and corporate regulations* which have an effect on a company and its employees, are difficult for individual employees to have an overview of. Nonetheless, proper and law-abiding activity in terms of all business activities must be guaranteed. The employees can only be sensitised to this through targeted awareness-raising and the creation of transparency. For example, Daimler has published a guideline for how to act with integrity [31]. There should be clear rules for behaviour in addition to instructions with consequences in terms of complying with laws, legislation and corporate values, but there should also be support and advice for questions about possible violations. *Corruption and fraud prevention* is particularly important in order to ensure that the trust of internal and external stakeholders is not lost.

In addition to reporting requirements and appropriate reactions from employees, *Internal Auditing* is an auditing and advisory activity which is independent of daily business, and which supports the corporate leadership to control directions [49]. The Internal Audit must be independent of the working process being checked, and may not bear any responsibility for the results. In addition to monitoring organisational structures and business processes which are susceptible to corruption, it also acts in a preventive way by identifying new dangers of corruption in new regions/markets or business models. Particular attention should be given to the internal auditing environments and systems when auditing financial transactions and accounting and financial processes. Additionally, in specific situations, external bodies such as investigative authorities or auditors are involved in investigations. Above all, the Internal Audit checks the business competence of the "internal control system" of the "finance and controlling" domain.

Risks and Finance

The risks being looked at are insecurities in the business environment which we try to understand by evaluating occurrence probabilities and possible effects through qualitative and quantitative evaluations. Risks can mean damage or losses for a company, and therefore present the possibility of negative future developments of the company's financial situations, with potential effects on asset values. In addition to economic damage, unwanted events can also stand in the way of meeting other goals. German legislation [27] enshrines risk management in stock corporation law, which includes an obligation to provide reporting as part of the annual report.[17] Not all companies in the automotive industry are stock companies, however. One of the best known automotive suppliers is Bosch, which has been around for over 125 years before going on the stock market. But Chrysler also disappeared from the stock market for a few years, only to turn up on the list of America's largest non-listed companies when Daimler sold Chrysler to the financial investor Cerberus. Nonetheless, these are only very rare cases of large companies which implement their risk management in accordance with other duties of care and regulations – even without provisions related to stock corporation law. This is why risk management has gained influential significance on the level of the managing directors – where corporate leadership enables a comprehensive overview thanks to transparent, understandable *standards and methods*.

A distinction is made between several different types of risks. The focus is primarily on the legal, economic, financial and political risks – but also on advances in technology as a product risk, which means that the products manufactured by the company are more quickly outdated by new technologies and digitalisation. As part of a continual process, the risks are *identified, analysed and evaluated* in accordance with defined criteria in order to safeguard business [174], and this also creates a buffer for unknown risks so that they can be dealt with early.

The financial risks usually include the following four areas, in which the management of approaches to avoid, minimise, transfer and accept risk is crucial.

Market risks	such as interest, currency and commodity risks due to international business. For example, we mentioned that BMW (see Sect. 3.1.1) manages currency risks by comparing production in countries with different currencies, such as Germany, USA, China and Brazil, with demand for sales and purchases in foreign currency areas. Thanks to interest rate hedges, the influence on the earnings, finance and asset situations can be minimised.
Contractual risks	have a particular connection to large jobs, for example in the case of manufacturers of commercial vehicles, construction

[17] See for example Schaeffler annual report 2013 "Report on opportunities and risks" http://www.schaeffler.com/remotemedien/media/_shared_media/09_investor_relations/dokumente/publikationen/2013_6/20140320_Schaeffler_AG_GB_EN.pdf. Accessed: 23 December 2014.

machines and construction equipments. In general, the *avoidance and limitation* of suppliers becoming insolvent in the worldwide value creation chain of the automotive industry has become part of daily business – which always has an effect on liquidity risks.

Liquidity risks: occur when companies are unable to fulfil their payment obligations when they become due. A distinction is made between short, medium and long-term risks. Customer payments which are not paid on time may lead to increased risk if the classic sale of a vehicle becomes a business model for the payment of use.

Pension obligations: are risks which occur as a result of obligations for employees as a result of occupational pension schemes. These risks are not just something from the past – as was demonstrated by the insolvency proceedings of the car city of Detroit in July 2013, where the three big American automotive manufacturers General Motors, Ford and Chrysler had downsized and the state had to clear up after them. Due to the transformation currently taking place in the mobility industry, traditional vehicle manufacturers will also have to go through far-reaching reforms in terms of pension obligations. In order to be competitive, service and software companies such as SAP act in accordance with different obligations when it comes to pension commitments in the market – similar to what will be the case in the mobility industry. Twenty-five years ago, for example, IBM was – much like vehicle manufacturers – more focused on the production of hardware and technologies, and in 2010 had to adapt its obligations in terms of pension commitments to the market (to the dissatisfaction of its workforce) by transforming itself into a service and software company [64].

For a more detailed look at the evaluation of financial risks, please refer to the literature [17]. Their derived measures are closely linked to the business competence of "treasury" from the domain "finance and controlling".

In planning and management, the different perspectives of risks and finances create a great deal of reporting content which is caused by changes in management or new regulations. There are situations such as those in IT landscapes, which are typically unaudited – where new applications are added, but existing ones are not replaced or turned off. In this way, it is not rare for the data being asked for to already by part of other reports – or the actual utility is not regularly checked critically over time.

Focused prognoses can avoid waste, as listed in the literature [122], for example:

- High number of useless prognoses and planning talks
- Calculating and putting together the same figures several times
- Countless reports end up in the recycle bin or archive without actually being read
- Endless consolidations and checking of reports
- Endless discussions between the sales and finance departments about which control parameters are correct and important.

Basic thought principles such as Kaizen (see Sect. 3.1.4) from the Toyota production system [104, 112] could also be applied to this.

Security

Security (from the Latin securus, "without worries") and safety (from the Latin salvus, "uninjured, healthy") are different. In the vehicle or in the factory, the primary concern is operational safety for the protection of people from sources of danger – in the sense of physical distance from that danger. Above all, security comprises the protection of IT systems which are in focus, in the sense of immunity. The difference between security from attack on the one hand and operational safety on the other becomes blurred as digitalisation helps us develop towards the idea of the connected vehicle and connected factory, as digitalisation and connectedness overcome physical distances. This is why we can summarise everything under security – even if the solutions are very different. In cases when security is no longer effective, reliability describes how the system functions in case of a malfunction. This means that the potential for danger is dependent both on the security and on the reliability of a system – for example, that of an anti-lock braking system. Customers are prepared to pay a higher price for increased safety (for example child seatbelts, driver assistance systems) and reliability in a vehicle – but this is not yet the case for security from attack. In short, it is increasingly the case that security can only be guaranteed through close integration of security and safety.

The security and integrity of the four elements *person, property, process and information* are a fundamental principle of corporate leadership and the business guidelines. Enterprise-wide *security regulations* with overlapping planning and management of measures in order to reduce risks are crucial – even if different regional adaptations to local regulations are needed.

The following count as threats for a company which operates worldwide:

- Organisational deficiencies such as inadequately clarified responsibilities and competencies, a lack of company guidelines, training and awareness raising in addition to inadequate documentation.
- Intentional acts such as decisions made consciously to damage, misuse or steal
- Technical problems such as disruptions to the electricity supply, hardware or network disruptions or malfunctions in the software
- Negligent user behaviour as a result of a lack of safety awareness, defective use and maintenance or violations of security measures

- Force majeure, such as environmental catastrophes as a result of water damage, forces of nature such as storm damage, lightning strikes or earthquakes, but also measures taken by the authorities

In this way, companies can treat security in a similar way to what they do with other risks – by evaluating external and internal risks in terms of occurrence probabilities and possible effects and preventions. They should, however, also take into account the fact that security and risk are in a relationship of negative correlation – i.e. high security means a low level of risk, and vice versa. Depending on the company values or regions, different measures can be planned within the company premises in order to *recognise and prevent dangers early*, such as:

- Constructional and infrastructural operational safety in the form of entrance checks, burglary protection, redundant electricity supplies or fire and water proofing
- Personal and organisational safety and security as a result of company guidelines, training and awareness raising for staff, confidentiality obligations, checking the integrity of staff, or insurance protection
- Technical security against attack by securing data and networks, encryptions, access and login permits or security monitoring and logging

But measures outside the company premises are also relevant for security against attack and operational safety, such as:

- In terms of personal protection, one tends only to think of a select handful of particularly exposed personalities. This can, however, also be about the safety of employees when they are outside the company premises and its production sites – for example when they are staying in accommodation in unstable and unsafe regions as part of trips abroad.
- Protection of property applies not only to permanent locations with their facilities, infrastructures and communications facilities. In the introductory chapter, for example, we mentioned the new experimental vehicle from Google. Prototypes existed before Google – and even then, the vehicle manufacturers already had an interest in not giving away too much to the public too early. For this reason, experimental vehicles in public research institutions and universities are placed under particular protection. Particular challenges are associated with short-term and provisional activities. These include classic trade fair stands, or innovative sales channels such as temporary "pop-up stores"[18] in city centres.

[18]Car manufacturers find new ways forward: Daimler opens "Mercedes me" shop in Hamburg. http://www.stuttgarter-zeitung.de/inhalt.autobauer-geht-neue-wege-daimler-eroeffnet-mercedes-me-shop-in-hamburg.eaec43bf-c3c5-44b2-ab3e-d3f1750a43a6.html. Accessed: 23 December 2014.

- Nowadays, information (such as corporate data, customer data, contracts, databases) can no longer be kept within the company premises. A lack of data protection can lead to more damage being done than through the loss of company knowledge due to personal changes. Due to many technological possibilities such as removable media, work from home has changed so drastically during the past few years that companies now have practically no idea where their data is to be found – which is why they try to protect it using classifications of the information by the creator according to the source principle. For example, there are the classifications of "public", "for internal use only", "confidential" or "(top) secret" (see Sect. 2.3). A system like this, however, is only secure to the same degree that it can implement *security of business processes* for all information providers, transmitters and receivers in a legally binding way – which, in many cases, is either technically not possible, or cannot be enforced for operational reasons. Often, it is only possible to take additional personal and organisational measures – but these are not always legally possible outside of the company premises.

It is not possible to plan and prepare everything in advance. Increasingly, the global, complex structures and business processes of the automotive companies are active in spheres characterised by political and economic instability. An organisation which is networked enterprise-wide is needed for an *emergency and crisis*, which must also be able to cooperate with national and international security authorities in certain situations.

New ways of attacking technology are constantly evolving, and achieve ever greater effects due to the advance of digitalisation. This is why the *effectiveness, appropriateness and up-to-dateness* of the measures must be checked at regular intervals and, if necessary, adjusted.

In short, security plays an active role in the economic functionality of a company. This also means that it is part of value creation in corporate leadership.

Environment

During recent years, financial, economic and security risks have been joined by environmental risks, with a focus on operational environmental protection. Threats from natural and environmental catastrophes, for example, should not be examined from a safety perspective only. Violations of environmental protection laws can also occur as a result of pollution. Vehicle manufacturers in particular are increasingly confronted with specific expectations from external stakeholders in relation to their ecological behaviour. Additionally, the legal and regulatory requirements have become significantly stricter; the same applies for taking into account the common good. This is why environmental risks in corporate leadership have constantly increased in significance in terms of sustainability.

The *standards and regulations* which are recognised internationally include environmental management in accordance with norm ISO 14001 [57] and energy management in accordance with DIN EN ISO 50001 [58]. Both norms aim to achieve reduced environmental pollution, and continual improvements to environment-related services. For example, the Daimler factory in Sindelfingen introduced an environmental management system in accordance with ISO 14001 in 1995, and added to it in 2012 with an energy management system in accordance with ISO 50001 [33].

Today, both norms confront all vehicle manufacturers with sustainable measures for environmental protection in areas such as *energy, water, waste and emissions*, which are recurring themes throughout the whole of the value creation chain. In the development, engineering, production and operation of facilities, and recycling etc., the corporate leadership sets out and checks *environmental guiding principles* in order to protect resources and minimise environmental pollution. Vehicle manufacturers regularly publish environmental declarations from their branches in order to enable continuous improvement and evaluation of business activity in terms of sustainability. These contain all important site-related environmental data and goals, as well as current *measures and implementation statuses*, such as BMW,[19] Audi[20] and Daimler.[21]

3.6.2 Research and Development

The business domain of "research and development" includes the whole history of product development, as we introduced in Chap. 2. Some business competences such as electrics or software have entered the domain and grown over time. It represents the origin of the vehicle manufacturers' competences. The product development process is very blurred when it comes to this business domain and that of "production", which follows it.[22] In the transition, there are many overlapping business competences which are classified differently depending on the company in question. In Sect. 2.2 it was shown that it is not possible to make a clear distinction between development, engineering and production. Product development also tends to vary somewhat from one company to another – but it is fundamentally structured in a similar way. Over the past decades, digitalisation in particular has played a role

[19] Environmental declaration 2013/2014. BMW Munich site. Factory 01.10, factory 01.30. http://www.bmw-werk-muenchen.de/lowband/com/de/verantwortung/1_Q_2013-2014_Muenchen.pdf. Accessed: 23 December 2014.

[20] Audi Ingolstadt: Environmental declaration 2013. http://www.audi.com/content/dam/com/DE/corporate-responsibility/enviroment/audi_umwelterklaerung_2014_ingolstadt.pdf. Accessed: 23 December 2014.

[21] Daimler environmental declarations from the factories. http://www.daimler.com/dccom/0-5-84972-49-1665525-1-0-0-0-0-0-0-0-0-0-0-0-0-0-0.html. Accessed: 23 December 2014.

[22] We will leave the business domain of "procurement and inbound logistics" for now, which we positioned between "research and development" and "production" in the model. It is divided into similar phases – and ensures the product development process, because product manufacturing is not possible without it. It only plays a subordinate role in the product development process inspired by the VDI 2221 guideline, however.

in this – because digital models including manufacture and assembly simulations have come about in parallel to actual development (see Sect. 2.4).

Figure 3.14 is a schematic reference model for the framework of this business domain, which Fig. 2.4 details from the point of view of product development. The process presented is inspired by the guideline from the Association of German Engineers (VDI) 2221 [159] and the supplementary guideline VDI 2222 [160], but is not to be understood as the presentation of a timetable or of the time-related relations of the individual phases of a development period. Depending on the type of engineering or on the development culture of a company, for example, developing a series may take longer than developing a concept. This leads to significant differences in time scales between further development of a model through adaptation or variant construction, and the development of a completely new vehicle from scratch. Both VDI guidelines are to be viewed as generally applicable framework concepts which are also repeated in steps between batch and mass production. In practice, many new concepts have been added, for example through the development of modules (see Sect. 2.5.1). We cannot go into more detail about the many determining factors of development and engineering here, which is why we would like to draw your attention to further literature [22, 61, 154]. A descriptive example of vehicle development demonstrated with the Mercedes-Benz SL is shown in the literature [50].

The framework of this business domain – "research and development" – covers the tasks in the product development process right up to the individual product and approvals for the series launch. A similar framework for this domain was set out in [88] – in contrast, we are simply shifting the integration of suppliers into the business domain "procurement and inbound logistics".

We shape the domain of "research and development" using the seven following business competences (see Fig. 3.15):

Direct:
- Planning, requirement, change
- Research and preliminary development
- Standard, method, process

Control:
- Testing and validation

Execute:
- Concept, design, construction space
- Development and engineering
- Product data and documentation

Direct Business Competences

Product development is so complex that planning, monitoring and controlling need to take place in a way which overlaps. Many vehicle manufacturers implement their desire to develop with the help of international teams. Votes and approvals are regulated by processes. However, many transnational steps – which also take place with the help of external development partners – cannot be managed in a linear way. It is very usual for an interactive and interdisciplinary approach to be used, as part of which improvised measures constantly need to be supported.

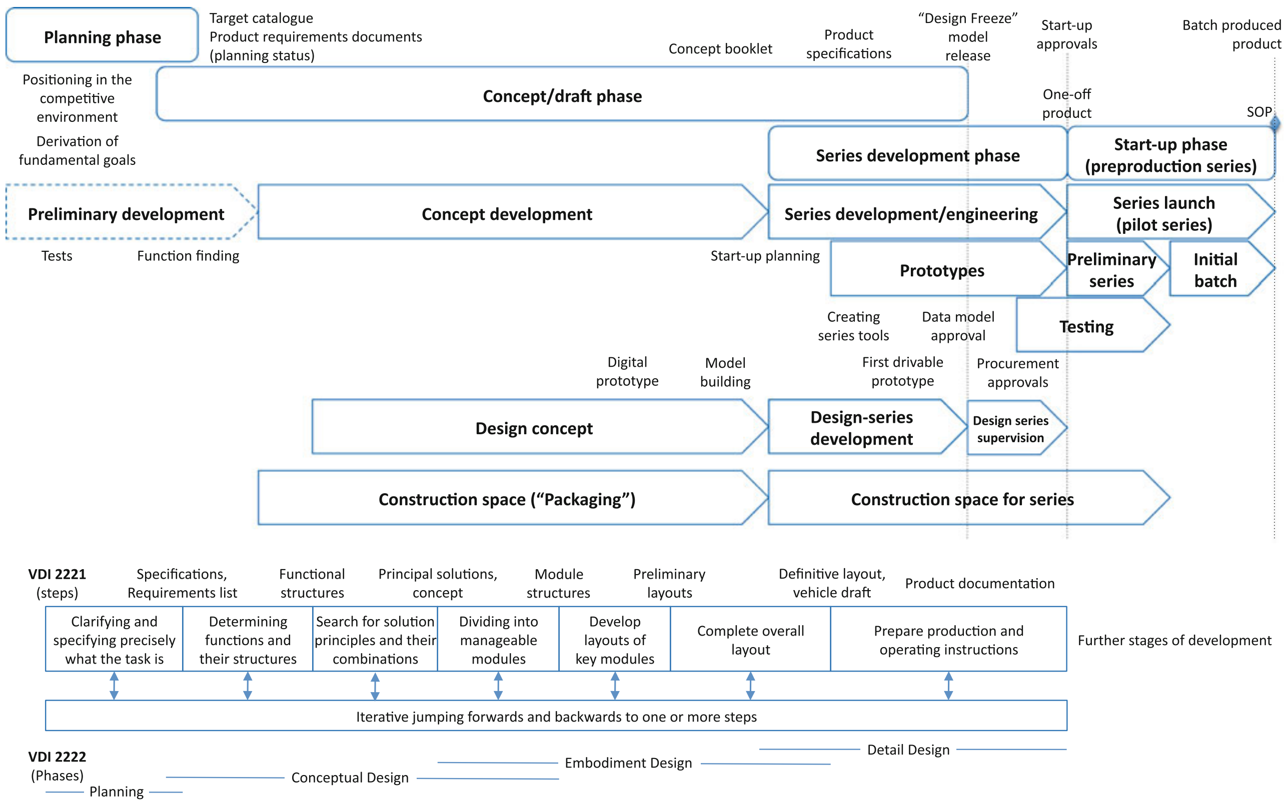

Fig. 3.14 A schematic reference model for the product development process, inspired by the seven working steps of the VDI 2221 [159] guideline as a framework concept. The diagram does not show any kind of timetable or time-related relations of the individual phases of a development period

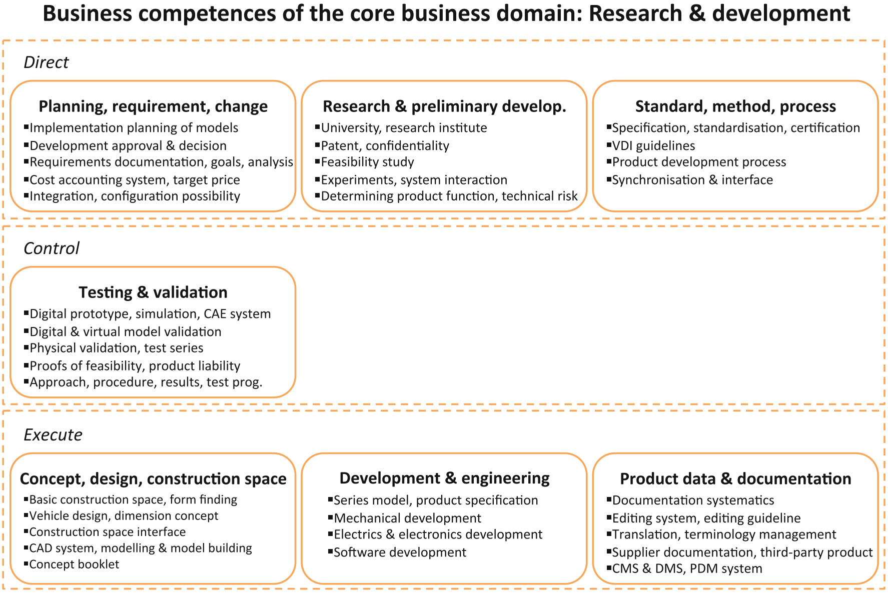

Fig. 3.15 The business competences of the domain "research and development"

The following three driving forces serve the business purpose:

1. Development of new products in order to achieve company goals and increased revenue
2. Product developments within the timeframe and cost limit chosen
3. Transparency of financial and capacity demands in terms of research and development

Planning, Requirement, Change

In contrast to the strategic planning of the product portfolio in the "corporate strategy" of the business domain "corporate leadership", this business competence also concentrates on the operative *implementation planning of models*. This is about a complete overview of which vehicle classes are offered and marketed with which equipment on which markets. From this complete overview, plans, *approvals and decisions* are prepared for development. Some approvals, such as the passage of the model from the design and drafting phase, occur through "corporate leadership". The necessary approvals of data models or bills of materials for the preparation of the procurements which are needed for the manufacturing of vehicles, are governed in committees of this business competence.

In the case of new and existing products alike, the product management must ensure sustainability of the brand. This is about the implementation of the brand identity in the products. If the brand represents sportiness, for example, then customers should be given the experience of a sporty car. Indicators such as these must be broken down to the levels of the individual parts, and be defined in the functional *requirements documentation*. In these, technical target values and ranges are defined and prioritised accordingly, before being continually checked during the development phases. For a sports vehicle, for example, engineers would be given correspondingly targets for the development of the chassis. Further *goals* include, for example, the fulfilment of functions, guarantee of safety, taking into account of ergonomics, simplification of manufacturing, simplification of assembly, ensuring accuracy and documentation, compliance with standards and interfaces, minimisation of used resources, making it possible to transport the vehicle, improving consumption, supporting maintenance, striving to recycle as much as possible, and constantly reducing costs.

More and more frequently, there are more product ideas and suggestions than it is possible to implement. Future needs of customers, which need to be planned more than 5 years ahead, are often difficult to estimate and evaluate. Even more important are clearly defined selection criteria for qualified and prioritised requirements, the result of which can be felt in sales – even years later. It is a constant challenge to foresee the *integration* of the requirements and the effect they will have on the development phases. During development, changes cannot be avoided – because many things only become apparent in connection with a varied range of specialist aspects. As far as possible, the planning phase is used to *analyse* and document the effects of measures for the implementation of planned amendments on dependencies and side effects; but not all effects which are made possible by vehicle physics can be planned in advance. The versioning of all changes is an elementary, basic requirement in the product development process. For example, a new Mercedes-Benz Actros (second generation, construction year 2011) may be made up of more than 300,000 individual parts, the development of which generates several thousand amendments to requirements over their lifetime.[23]

The planning phase aims to create a list of requirements which are included in product specifications which contain the main goals and conditions of the task to be completed. During the development phases, the product specifications bring together functional requirements and technical product properties in addition to financial figures, deadlines to aim for, and quality and performance requirements. When the model is approved at the end of the concept phase, the product specifications set out the conditions for series development. The product specifications are also for advertising – in order to involve suppliers and their suggested solutions.

During the product planning phase, the task to be completed is specified using the requirements lists, external influences from the market environment, and internal influences within the company. Alongside the technical requirements made of the product and its applications, especially in terms of priorities, *cost accounting systems* are used to set a cost ceiling, and various market-specific influencing variables are used to set the *target prices* of vehicles with market-specific basic

[23]Daimler EDM CAE Forum 2013. http://www.daimler.com/edm-cae-forum/0-1140-1615763-1-1615772-1-0-0-0-0-1-0-1615763-0-0-0-0-0-0-0.html. Accessed: 23 December 2014.

equipment, before development is started [47] – in order to eliminate solutions which are not economically viable as early as possible [54].

In comparison to a build to stock production, plans for a build to order production demand even more rules and constraints in terms of the *configuration possibilities* of vehicle characteristics, power modules and equipment. In Sect. 2.3.1, we described configuration logic using the rule-based variant bill of materials. In build to stock as well, however, *product variants* are planned which must have configurations that it is possible to build. Many feasibility rules only come about step-by-step in the development phases, when changes are constantly made.

In practice, however, it is very rare to find companies which have a standardised approach to product planning throughout the whole company – especially in terms of general target-setting such as broadening the usability of the products. Particularly in large companies such as Volkswagen, where many brands[24] have been added as a result of acquisitions, overlaps occur in terms of functions and products.

In Fig. 3.14 we have positioned and described the planning phase at the beginning of the product development process only. By doing this, we are covering the main task areas – but not all which are listed in the VDI 2220 [157] guideline. Some of the steps, such as brainstorming as part of the business competence of "knowledge and ideas" from the domain "corporate support service", were consolidated in other business domains.[25]

In practice, planning and developing a complex vehicle is not a precise process. Instead, it is an interactive process during which errors occur, and it is possible to make optimisations. Changes will inevitably have to be made at every stage of development, and must be managed holistically. The later a change is needed in development or production, the higher the associated costs will be. Late changes which come about as a result of knowledge gleaned during vehicle testing, for example, may occur despite numerous early validations, and are thoroughly screened and evaluated before decisions are made about them.

Research and Preliminary Development

Research, and to a certain extent preliminary development too, take place continuously within the company and are not limited to the product development process alone. As shown in our presentation in Fig. 3.14, the preliminary development can accompany the planning phase and the beginning of the concept phase, in order to pre-empt technical risks before the planned development. Both research and preliminary development set out the technical framework for product planning and development, which means they have a level of influence equal to that of the corporate strategy as a governing business competence.

---

[24]Twelve brands from seven European countries Volkswagen. http://www.volkswagenag.com/content/vwcorp/content/en/brands_and_products.html. Accessed: 23 December 2014.

[25]For a more detailed discussion of different approaches and product planning concepts, please refer to the literature [144].

Research and preliminary development in the automotive industry have the following things in common:

- the stakeholders are unknown,
- the benefit for the customer cannot always be shown,
- the scope of the requirement is unclear, and
- it is not possible to predict whether it will be technically possible to implement.

In research, a distinction is made between:

- Pure basic research which serves the purpose of gaining new scientific insights and experiences. This means experimental or theoretical academic works. Through materials research, for example, the general knowledge base is broadened. As the conclusions often cannot be protected, companies usually cooperate with *universities or research institutes* – for example, the institutes of the Max Planck Society.
- Focused basic research which concentrates on a certain type of basic or background knowledge which could contribute to solving a current or future problem. Accident research, for example, works in the area of prevention, constant improvement of vehicles, and the development of new safety systems by identifying, reconstructing and analysing common causes of accidents.
- Applied research, which serves to acquire and develop knowledge, skills and scientific insights with a practical use in the real world. For example, the conclusions aid the product manufacturing process directly, or the development of certain methods and processes. The knowledge gleaned is often protected by *patents or confidentiality*. This includes, for example, vehicle studies which show new ideas in the form of a complete vehicle as a *feasibility study*, but which are not roadworthy. They create a seamless transition to preliminary developments.

Preliminary development can serve the specific preparation of the product or procedure development of a vehicle model range – but it can also check whether new technologies can be implemented – independently of the product development process. In *experiments*, new concepts with new *system interactions*[26] from research, are experimentally tested in order to determine whether they can, in principle, be used in the company's product portfolio. Feasibility studies represent a seamless transition from applied research and preliminary development. In the planning phase of a new development, there is a particular focus on *determining products function* if new, complicated parts are involved – in order to minimise *technical risks* and to go a long way towards ensuring that the product can be introduced onto the market.

[26]The interactions of a system are, according to Association of German Engineers guideline VDI 2242 [158], the type, form and intensity of the physical or chemical effect – effects such as vibrations, noise, radiation, temperature, materials.

In practice, it is usual for innovation management to be organised during preliminary development in order to systematically prove the feasibility of ideas which are related to products, applications, technologies and procedures. We have classified innovations as part of the business competence of "knowledge and ideas" from the domain "corporate support service", so that innovations can be derived and developed from corporate strategies in a more holistic way – even within the framework of the autoMOBILE (see Sect. 1.1). This should also be considered in light of the fact that nowadays, innovations largely come about as a result of work with suppliers – which means they can also be treated in a more standardised way throughout the company.

Standard, Method, Process

A standard is a standardisation – in the areas of technology and methodology, for example – which has asserted itself over other ways of doing something. In simpler terms, standardisation can be seen as the setting out of *specifications*. As part of a *standardisation*, it is not always necessary for all interested parties and the public to be involved. Worldwide, for example, the ISO (International Standard Organisation) creates internationally coordinated standards, which are published as ISO standards. Standardisation refers to the formulation, publishing and application of rules, guidelines or attributes by a recognised institution.

On an international level, the following standardisation organisations are relevant:

- General standards, ISO
  http://www.iso.org
- Standards in the field of electrical engineering and electronics IEC (International Electrotechnical Commission)
  http://www.iec.ch
- Standards in the field of telecommunications ITU (International Telecommunication Union)
  http://www.itu.int

On a European level:

- European Committee for Standardisation CEN (French: Comité Européen de Normalisation)
  http://www.cen.eu
- European Committee for electrotechnical standardisation, CENELEC (French: Comité Européen de Normalisation Électrotechnique)
  http://www.cenelec.eu
- European Telecommunications Standards Institute (ETSI)
  http://www.etsi.org

On a German level:

- General standardisation (German Institute for Standardisation – Deutsches Institut für Normung)
  http://www.din.de
- German Commission for Electrical, Electronic & Information Technologies of DKE of DIN and VDE for standards in electrical, electronic & information Technologies
  https://www.dke.de

In particular, the German Institute for Standardisation committee on automotive technologies,[27] which is affiliated to the German Automotive Industry Association (VDA), represents the national, regional and international standardisation interests of automotive institutions and companies of the automotive industry in the field of vehicle production.[28]

In the fields of software and IT, terms such as "standard" and "specification" are used differently. International standardisation organisations include:

- The Institute of Electrical and Electronics Engineers (IEEE), which, among other things, forms committees for the standardisation of technologies, hardware and software
  http://www.ieee.org
- World Wide Web Consortium W3C, the consortium for open web standards
  http://www.w3.org
- OSGi Alliance (formerly Open Services Gateway Initiative – Standardisation of an open infotainment platform in the vehicle) specifies a hardware-independent software platform
  http://www.osgi.org

The standards developed in vehicle technology are able to keep up with the rapid increase in the significance of software in the vehicle, as well as the IT of the connected vehicle. Even more changes will take place in this regard, with the result that this business competence will have to be addressed more broadly within the company than just in the business domain "research and development", just for the vehicle.

When planning the distribution markets of the vehicles to be developed, the approval criteria which are valid in each individual country must be taken into account, as must the legislation and standards in terms of development. By obtaining *certifications* which are applicable to more than one market or country, it can be proven that laws are being complied with. In terms of the legislation, a distinction is

[27] http://www.naautomobil.din.de. Accessed: 23 December 2014.

[28] For a more detailed look at the standardisation, please see the literature [8].

made between product laws (such as exhaust gas standards or lighting provisions) and requirements which are made of the production procedures.

In the research and development tasks, a very broad range of methods are used – which either have a physical or a digital focus. Many of them are recognised and standardised globally. Some examples from the field of Computer-Aided Engineering (CAE) were listed in Sect. 2.4.

In practice, while methods and processes may indeed comply with *VDI guidelines* 2221 [159] and 2222 [160] from the German Association of Engineers, each vehicle manufacturer has their own additions and modifications. For example, the phase-based vehicle development process from Daimler is known as the "Mercedes Development System" [50], which involves different milestones to those defined in the *product development process* in Fig. 3.14. In the case of the milestones, a clear presentation of sub-goals is relevant. In Sect. 3.5 we presented some process models such as PCF, which describe the development of a new vehicle at the level of task steps to be taken. The processes and methods for the development of vehicles, modules and parts change over time – often determined by the use of new tools, advancing digitalisation in development, and further optimisations. In terms of the shaping of processes, the synchronisation of development processes via defined interfaces is relevant, because many teams work in parallel. For example, concept development, the design concept and the packaging of chassis, drive system, equipment, sub/superstructure etc. require *synchronisations and interfaces*.

Control Business Competences

The high number of variations within vehicle classes, and the different variants within a construction series (see Sect. 1.3) make it necessary to run many developments in parallel. This is why, nowadays, module development overlaps more than one construction series (see Sect. 2.5.1). Nonetheless, the modularised overall system must be validated, which requires the targeted use of capacities of test benches, and simulation methods for every vehicle which is developed.

Testing and Validation

During concept development, a *digital prototype* is created, which is validated and optimised solely through computer-aided *simulations*. The demand on a model or prototype is that it should achieve a representation of the future product which is as realistic as possible. The digital and physical model building validate the design and construction space suggestions during the early stages of development. Of fundamental importance is geometric control – so that no collisions take place between the parts in the integration. There are, however, even more diverse investigations which have been made using prototypes – for example, in aerodynamics, air conditioning, thermodynamics and acoustics – taking into account vibrations, structural stiffness, energy management, driving performance, operational stability, wear and tear, or lifespan [8]. Using a range of investigation methods, goals are pursued – such as the suitability of function, durability, ergonomics, assembly or maintenance.

As part of CAE (see Sect. 2.4) there are numerous calculation and simulation technologies which can be used to prove and validate product properties and integrations of parts and groups into the vehicle. A distinction is made between *digital and virtual model validations*. Digital validation is based on the data of CAD and *CAE systems* that makes it possible to use virtualisation to create interactive models in the context of the whole vehicle. Such virtualisations can begin at a very early stage of development, for example with the exterior design as part of Computer-Aided Styling (CAS) – but also in detailed designs of exteriors and interiors [21]. The virtual models allow for additional simulation methods at later confirmation phases of development, during the overall design of the vehicle in different environmental models such as climate conditions.

Despite the technological possibilities and advances made in terms of digital models, *physical validations*, such as those provided through *test series*, remain necessary and indispensable. Even if this is only about confirmation readings, these are still necessary for *proofs of feasibility* and validating *product liability*.

In addition to the measures for minimising the consequences of accidents, to limit the harm which can be expected to come to passengers (passive safety elements such as the seatbelt, airbag or passenger space), it is increasingly frequently the case that measures for the prevention of accidents are gaining significance thanks to assistance systems (active safety systems such as the anti-lock braking system ABS, traction control system TCS or electronic stability programme ESP) [22].

Due to safety systems in particular, in practice, a combination is needed of digital computations and physical tests in order to validate the vehicle to be developed in a targeted way [96]. The *approach*, *process* and *results* of the computer-assisted and physical tests are often standardised, and are based on established *test programmes*. They get a picture of the whole vehicle with its functions, consisting of its mechanical engineering, electrics and electronics, as well as software components. In so doing, specific regulations, state laws or ordinances must be complied with – which are checked by external auditing organisations such as the German Technical Inspection Association "TÜV".

The final proof that all planned vehicle requirements have been met is given by the test process, which takes place during series preparation under a diverse range of conditions in the different target markets. This includes a test drive over several tens of thousands of kilometres, in normal and extreme climate conditions. These include, for example, journeys during winter and summer – in the rain or over extremely dusty land. This is because vehicles should not only be able to drive successfully at the North Pole, in the Sahara, the Alps, and through mudflats – but also to be able to cope with less severe conditions.

The vehicle's lifespan must be proven at temperatures between -25 and $+80\,°\mathrm{C}$, and that it can cope with a wind load at wind speeds of between 60 and 250 km/h – but also simply that it can cope with conditions all year round. Teams of developers and manufacturing technicians use the test vehicles in order to identify final problem areas, and to validate the production processes before the SOP of the series. Excerpts from test reports are also published regularly too.[29]

Execute Business Competences

In Sect. 2.3, it was shown how the relationships between mechanics, electr(on)ic components and software in the vehicle are constantly being shifted, which inevitably has an effect on the development and engineering process. Nonetheless, we will present the business competences in a simplified way alongside the mechanical aspects of a vehicle, because this continues to be what is done by most vehicle manufacturers.

Concept, Design, Construction Space

The unique competences for the holistic design of a new vehicle – from the creation of the vehicle concept to the design and packaging – are very different. These must all be constantly coordinated with one another until the managing directors approve the model ("design freeze" [45]). This is why, from the point of view of the company, we summarise the simultaneous task areas of concept, design and construction space into a single business competence. The framework of this business competence covers the tasks in the product development process right up to the individual product and the approvals for series launch.

During preliminary development, ideas and impulses are created for the basic vehicle concept as part of the corporate and brand identity. The definition of the concept begins in parallel with the product planning phase. The basic vehicle concept is the constructive draft of a product idea, which is used to check its basic feasibility. It brings together the main subsystems and modules (see Sect. 2.3.1) along with their properties. The foundation of the vehicle concept is the platform, or the building block (see Sect. 2.5.1). Further focuses of design in terms of concept definition can be found in the following specifications of the *basic construction space* [22]:

- construction characteristics, basic vehicle form, and future variants,
- number of seats, space needed for passengers,
- storage space and volumes (such as tank),
- main dimensions (such as the main exterior and interior dimensions), as well as
- motor and drive concept (for example, combustion or electric engine).

Using the concept definition as a starting point, the design gives the technology shape which goes further than just geometry, and specifically addresses user-related factors. In design, there is no single standardised process which can be used to structure the basic principles of design. These are steps towards achieving the basic

[29]For example, "testing under extreme conditions: New Unimog and new Econic in winter test drives and final tests". http://media.daimler.com/dcmedia/0-921-1130157-1-1585024-1-0-1-0-0-1-0-0-0-1-0-0-0-0-0.html. Accessed: 23 December 2014.

principles of *form finding* and technical feasibility, which are subject to constant change. While there are indeed structured processes and guidelines for the concept and construction space phase as part of product development (see the seven steps listed in VDI guideline 2221 in Fig. 3.14), they are, however – especially in early phases – still a step-by-step elaboration of the *vehicle design*, with the aim of achieving the best, constructive solution possible while taking into account a broad range of different influencing variables. For example, the interplay between the following factors must be checked constantly [21]:

Technical Factors:

- development/engineering (for example, measurements of the modules or the fulfilment of planned functions)
- production (for example, both internal and external assembly processes should be simple and clear)
- reuse/recycling (for example, materials used, reused, or recycled)

Economic factors (in close coordination with the business competence "planning and management system" of the business domain "finance and controlling"):

- manufacturing and distribution costs (for example, keeping to set cost limits, economically viable manufacturing, new market or customer segments, sales training for new functions or models)
- procurement and operation costs (such as fuel consumption, effort minimisation for the replacement of vehicle components, and for maintenance, inspection, servicing or repair costs)
- profit margin (for example, through the market analysis of potential buyers)

Administrative Factors:

- laws/regulations/recommendations (such as CO_2 emissions, manufacturability, passenger safety)
- processes/organisation (for example, involvement of suppliers, globalisations)

User-related factors:

- ergonomics (user comfort, for example)
- use/usefulness (i.e. purpose for use, life phases, daily demands, leisure activities, season/weather)
- aesthetics/design (i.e. equipment, overall impression, colouring)
- social and cultural influences (such as tradition, product recognition value, continuity, brand perception).

Many of these factors are not internationally standardised. These include, in particular, legal regulations such as field of vision or exterior mirrors, in addition to user needs which are dependent on region. Additionally, the favoured solutions from the points of view of the concept, design and construction space are often conflicting. In situations such as these, compromises must be found – especially if the design, with its emotional nature [103], plans forms which are in conflict with the measurable possibilities of the construction space. Compromises have to be found by all sides, however, because it is only the design which has an original "face which stands out in the crowd" of technically similar vehicles, and therefore has high significance.[30] After all, it is often the first impression of a vehicle which is crucial to a purchase decision – in situations where it is the exterior and interior design which shape the perception of the vehicle. The art of design, however, is not just about uniqueness, but also about the vehicle being recognisable as part of the manufacturer's model range.

The step-by-step specification of the construction space requirement and the ever more specific *dimension concept* lead to the definition of *construction space interfaces* as an initial geometric definition of the vehicle. Further specifications of the engineerings take into account these interfaces. The elaboration phase always results in more precise digital and physical models, using which all materials to be used are determined as well. Even in the era of virtual development, physical models continue to have high significance in terms of making it possible for people to check the feeling of space and the vehicle interior – because people have very different physiques and subjective opinions. Nonetheless, physical models are no longer shaped and manufactured by hand alone. *CAD systems* and individual manufacturing machines support *modelling and model building*.

Checks and validations for completeness, accuracy and standard conformity of the models take place before the data for preliminary examinations can be given to the engineering team. The result is a *concept booklet* which describes the details of the vehicle to be developed, and on the basis of which the series development phase can begin.

Development and Engineering

The concept decision, establishment of a design and approval of a model mark the beginning of one of the busiest development phases in terms of complex decisions which need to be made to ensure that the model can be worked on whilst avoiding development loops and delays to achieve a *series model* for the series launch. The packaging is continued – but with series development, it is also given the goal of bringing together all components into a geometrically and physically compatible order. Essentially, the design is completed when the model is approved. Nonetheless, series supervision of the design remains necessary until a customer-friendly individual product can be made, so that the parts from the suppliers – which differ in their details – can work together in harmony. For example, the different colour, material and surface concepts must be coordinated with the suppliers.

[30] Over 80 % of parts are developed by suppliers who often serve several OEMs at the same time. See Sect. 1.3.

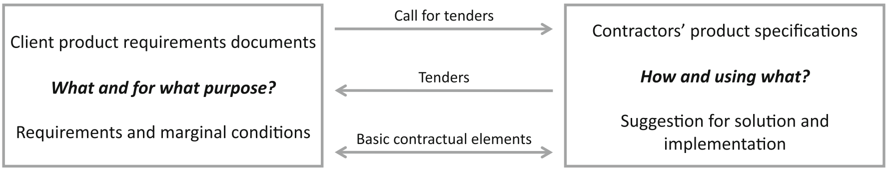

Fig. 3.16 Product requirements documents and product specifications for establishing cooperation between vehicle manufacturers and suppliers

A fundamental difference to series development and concept development is represented by the cooperation models with many external organisations. This includes trans-company and transnational cooperation with subsidiary companies, suppliers, joint ventures and collaboration with other OEMs. Complex organisational structures come about as a result of the large number of parts which use very different technologies – in combination with complex production processes. For the cooperation models, it is often the product requirements documents which are used as templates for calls for tender, which describe "what?" should be produced or developed, and "for what purpose?" it should be done. It is during the call for tender phases that the *product specifications* from the potential contractors are created, which describe specifically "how?" and "using what?" the requirements can be fulfilled (see Fig. 3.16). Building on the product specification which has been accepted and selected, the contract for cooperation with the contractor is concluded. Hundreds of development and parts suppliers, who are rated and integrated differently by the "procurement and inbound logistics" business domain, are often involved in the creation of a series vehicle. A number of specialist suppliers with special properties are already included in early concept phases or even preliminary developments – which, on the one hand, gives them a strategic competitive advantage, but on the other hand results in investments and risks – because OEMs demand certain preliminary work of such suppliers.

In the detailed development, which is broken down into sub-levels, the following three very different development types must be integrated in close collaboration with the suppliers:

1. The *mechanical development* of construction structures and materials engineering, and the use of numerous physical and chemical methods and procedures in the fields of statics, kinematics, kinetics, vibrations, flows etc. takes place on the levels of the physical parts, the modules and the overall vehicle. The development takes place in different teams specialised in the fields of drive systems, chassis, platform and body, equipment and functions which span several vehicles. The focus is on functionality, ease of integration, and possible manufacturing procedures. As well as the vehicle itself, the operating equipment and special tools are also constructed for its manufacturing and assembly. There are many options for optimisation, such as the use of identical parts or modules which span more than one construction series.

2. *Electrics and electronics development* concentrates both on the individual systems such as electricity supply, communication, entertainment, comfort electronics, safety electronics, wiring system and bus systems, sensors and control units, cable and wire sets etc., and on their integration into the overall vehicle while respecting the electrical conditions such as energy distribution, mains fluctuations, electric heating, shielding, safety etc.
3. In practice, *software development* is often still seen as a part of electronics development, which makes sense in the context of embedded software – especially when it is integrated into control units. With the advent of the connected vehicle, more fields come about within the framework of the virtual vehicle – as part of which software development, including tests and versioning, is separated from the life cycle of the vehicle and its electronics. These fields include, for example, newly programmable control units, remote diagnostics systems, and amendable digital control concepts within the vehicle. Software, which has no direct access or link to vehicle functions, however, belongs to the business competence "IT development and documentation" from the domain "corporate support service". On the other hand, access via interfaces on vehicle functions for software could be allowed on mobile end devices – for example, virtual keys – with all their advantages and disadvantages.[31] Software development like this is also part of this business competence.

Nowadays, the traditional separation between development and the subsequent manufacturing-related construction is increasingly losing significance in many companies. The two activities are often merged as a single unit as part of series development. Once the series developments are completed, the procurement approvals are completed for the series tools and components.

Product Data and Documentation

Nowadays, product documentation is only still organised historically as part of the business domain "research and development", and by the vehicle manufacturers. The central task of this business competence is to document a vehicle in a standardised way throughout its lifespan, and includes all information necessary for development, production, testing, maintenance and disposal. If vehicle sales remains the primary business model of the company, there are many reasons why it is advantageous for the documentation to be administrated at the source of product development. Due to a connection which goes beyond the vehicle itself, and business models in combination with services for an autoMOBILE, the business competence "product data and documentation" must be centralised in its own business domain for products and services. The question arises as to whether, in practice, the documentation can be completely centralised.

[31] "Connected Drive: ADAC finds security breaches in 2.2 million BMW". http://www.automobilwoche.de/article/20150130/NACHRICHTEN/150139999/1276/connected-drive-adac-deckt-it-sicherheitslucke-bei-22-millionen-bmw-auf. Accessed: 7 February 2015.

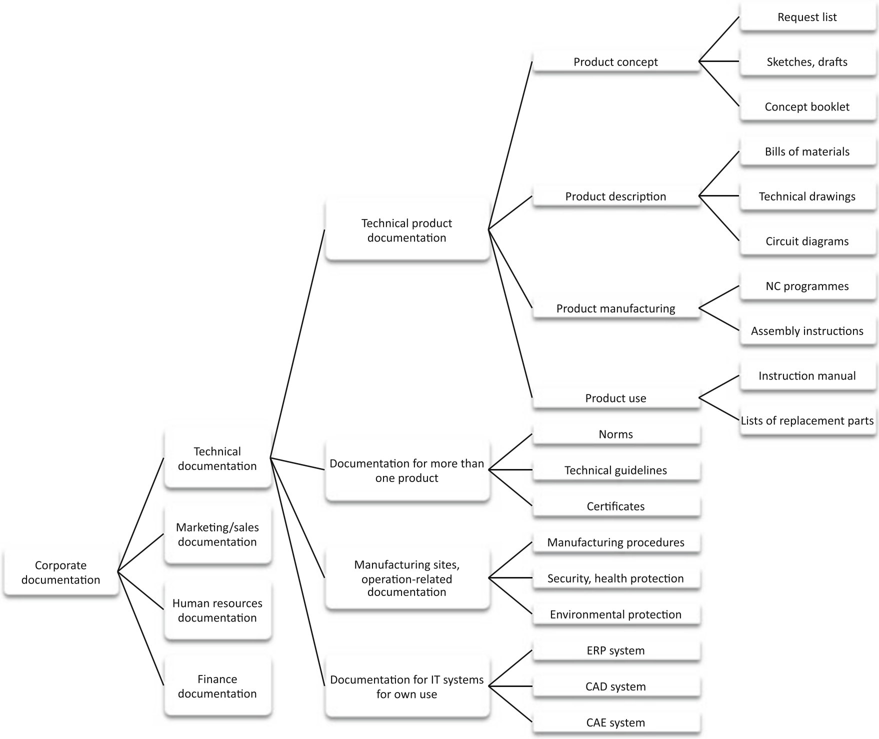

Fig. 3.17 Corporate documentation systematics inspired by DIN 6789

The product documentation is a very extensive part of the manufactured product, and must be delivered at a consistent level of quality. In Sect. 2.3.3, the different types of primary information were described in general. There are standards such as DIN 6789, guidelines, such as the VDI guideline 4500, and various publications [95] which structure the technical documentation and place it in a specialised context. A somewhat older *documentation systematics* is defined in DIN 6789, for example, which we present in Fig. 3.17.

We apply this system to the business domains and competences, and list just a few examples in Table 3.1 which come about during the life cycle of a vehicle.

In addition to the *PDM system*, the data and documents must also be validated, administrated in a structured way and made available in downstream phases in the document management system (DMS) and content management system (CMS). The external technical product documentation is usually created electronically using an *editing system*, and managed using a DMS. The *editing guideline* takes into account both instructions from the business competence "corporate documentation" as well as regional, national and international laws and guidelines, such as the German Product Liability Act, or translation obligations for product documents which are enshrined in law. Technical product documentation must be as exact and precise

Table 3.1 Examples of the product documentations which are created in the different business domains during the life cycle of a vehicle

Business domain	Business competence	Documents
Research and development	Planning, requirement, change	Market study, target catalogue
		Requirements list
		Target prices
	Research and preliminary development	Research results
		Patents
	Standard, method, process	Guidelines
		Certificates
		Process descriptions
	Testing and validation	Test and measurement data
		Test/audit reports
	Concept, design, construction space	Sketches, drafts
		CAD data
		Concept booklet
	Development and engineering	Product and requirements specifications
		Bills of materials
		Circuit diagrams
Procurement and inbound logistics		Calls for tender
		Orders
		Contracts
Production		NC programmes
		Assembly instructions
Marketing and communication		Brochures, photo material
		Campaigns
Sales and outbound logistics		List prices
		Sales catalogue
Finance services		Financing contract
		Account statement
After-sales support		Repair orders
		Operation instructions
		Maintenance intervals
		Repair shop equipment
		Complaints
		Disposal order
Quality		Quality test data
		Warranty and goodwill calculation

in the languages of the target markets as it is in the manufacturer's language. For support, many different systems are used for *translation* or *terminology management*, which are managed via the business competence "assistance" from the domain "corporate support service". The *supplier documentation* must be integrated as well such that it cannot be distinguished between the original and the *third-party product*.

The transition between the more finely structured *CMS and DMS* is fluid. The primary goal of the CMS is to link and bring together content from separate sources such as websites, master data sets, document content, and other forms of media. This generates a new document, which can then be filed in a DMS.

3.6.3 Procurement and Inbound Logistics

The aim of procurement is to

- make the required type of raw and other materials available
- in the required quality
- in sufficient quantities
- at the right time
- in the place where they are needed, and
- at the lowest prices possible,

thus ensuring the economic supply chain.

As a result of the falling value creation depth of vehicle manufacturers,[32] the significance of procurement and purchasing from external suppliers increases in terms of the company's competitiveness. In particular, at 68.4 % , the material cost share is very high compared to other types of costs, such as labour costs – at 14.7 % of gross production value in the automotive industry.[33] As a result, procurement has a fundamental influence on the profit of a company, because reductions in costs as a result of low value creation depth and high purchase costs have a stronger effect on company profit than an increase in turnover does [77].[34]

However, globalisation, supply fluctuations, the increasing number of vehicle variants and the associated material diversity of a broad range of drive systems all lead to increasing demands on the domain of "procurement and inbound logistics",

[32] As described in Sect. 1.3, the value creation share of OEMs fell to 29 % in comparison to that of suppliers.

[33] German Federal Statistical Office "Manufacturing industry company figures 2012" under "Manufacture of vehicles and vehicle parts". https://www.destatis.de/DE/ZahlenFakten/Wirtschaftsbereiche/IndustrieVerarbeitendesGewerbe/Tabellen/KennzahlenVerarbeitendesGewerbe.html. Accessed: 23 December 2014.

[34] "In the automotive industry, there is a rule of thumb according to which saving just one percent from materials and materials overheads cost will bring about the same increase in earnings as could be achieved by an increased revenue of at least 10%" [165].

which has long since stopped orienting itself towards purchase costs alone. Strategic partnerships and global alliances created new value orientations in new growth markets and themes such as the connected vehicle. Through this, procurement acquires an additional strategic level in addition to the operative one, with purchases as one of its sub-competences.

Procurement is already included in the phase of product development in order to plan series development with the different suppliers of subsystems/modules, components and parts, before the procurement approvals take place for the series launch (see Fig. 3.14). As a rule of thumb, it can be said that the profitability of a new vehicle series is no longer possible in series production if it has not yet been achieved through procurement in the pilot series. In the German automotive industry, purchases are set up globally so that the high purchase volume can be managed centrally for all factories.

In the industry, there is overwhelming consensus that a standardised, centralised purchase system is advantageous – even though there are often fewer than one hundred components, modules or parts which are significant for profitability. The Japanese automotive industry now also follows these advantages, even though opinion is divided on the extent to which purchases in the supplier market still serve a differentiating function, and how many business processes can be standardised by using economic ERP systems – in particular those from materials management [67], or systems for supplier relationship management (SRM) [20].

The term "logistics chain" applies to the whole value creation chain. In the literature [5, 62] and in practical implementations, sub-areas of the chain such as procurement logistics, production logistics and distribution logistics are defined differently. In this domain, inbound logistics – which occurs through purchases and delivery by the supplier – is part of procurement logistics [134]. It includes the acceptance of the supplier's goods, their temporary storage, and their transport to the production site. Additionally, it is also used to determine the production logistics for preliminary products (see Fig. 3.18). As such, in inbound logistics,

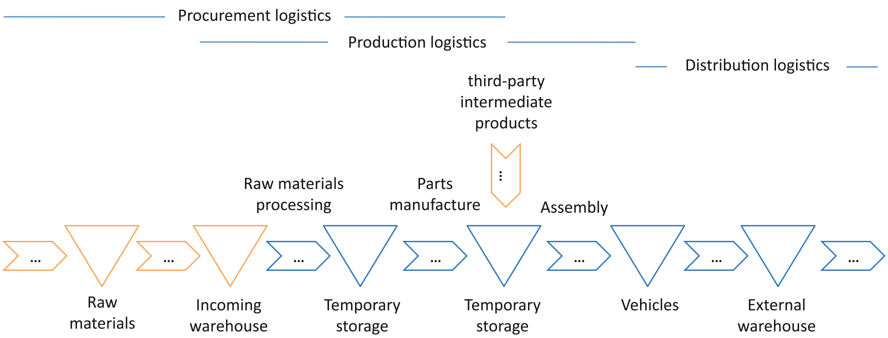

Fig. 3.18 Example chain of procurement, production and distribution logistics, with inbound logistics shown separately (*orange*)

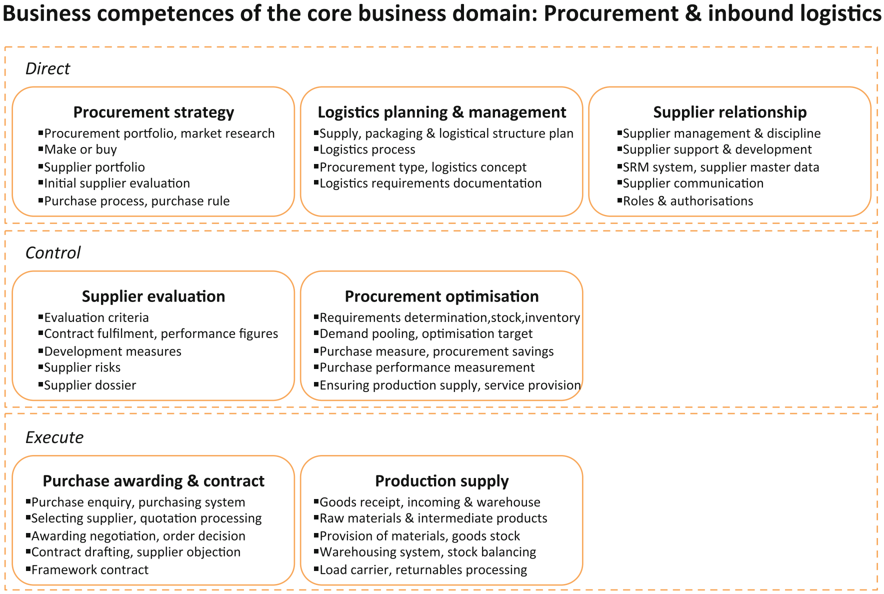

Fig. 3.19 The business competences of the domain "procurement and inbound logistics"

both in-house produced and externally procured materials are covered for use in production. We only link the resulting production logistics to the in-house logistics of the production-related storage, transport and disposal processes of production residues – something which is part of the domain "production".

Procurement is also about goods and services which are not relevant to production, but which the company needs for supporting processes. For a further look at procurement and inbound logistics, please refer to the literature [97, 165].

The domain of "procurement and inbound logistics" includes the following seven business competences (see Fig. 3.19):

Direct:
- Procurement strategy
- Logistics planning and management
- Supplier relationship

Control:
- Supplier evaluation
- Procurement optimisation

Execute:
- Purchase awarding and contract
- Production supply

Direct Business Competences

The procurement of goods for the manufacturing of vehicles, and the relationship with suppliers, have a strategically central role throughout the whole company. The logistics necessary for this must be planned in the long-term – commercially and professionally – for long after the vehicle has been created [141].

Procurement Strategy

Strategic procurement focuses on the procurement market with a *procurement portfolio*, a strategic supplier portfolio, and easy-to-understand procurement processes. It must integrate the production and marketing strategies of the company. The procurement portfolio consists of external materials (raw materials, aids and working materials), commodities and purchased products which have not been produced by the company itself.

In order to establish a purchase strategy, *procurement market research* is carried out. This involves different criteria and models which help to decide between *make or buy* (in-house production or external procurement) and intermediate coordination forms such as division of labour in value creation by using contractors [109]. In many situations, OEMs must nearly always opt for external procurement, for example in terms of making available the constantly increasing number of electronics components in the vehicle (see Fig. 2.5).

This is why the strategic *supplier portfolio* is defined independently from the procurement market in many materials and goods groups. This includes, for example, potential suppliers and regular suppliers for electronic parts, working materials, standard parts or mass-produced goods. Non-critical goods groups are characterised by a low supply risk which has low-level complexity, volume or costs. Strategic goods groups, on the other hand, have a high supply risk. These include, for example, special ECU technologies, which can only be manufactured by a very small number of suppliers. In this context, special cooperation models are often needed, as is cooperation with suppliers. Procurement paths also have an influence on the strategic orientation of the supplier structure. In particular in the case of changes in the procurement market, risks must be evaluated in the context of current circumstances.

The registered suppliers in the materials and goods groups are often classified into three loose categories:

1. preferred supplier,
2. supplier to be developed, and
3. banned supplier.

The classification is a result of the approval and the *initial supplier evaluation*. Daimler, for example, uses the methods "On-site Assessment" in the case of factory visits, and "Internal Cross-functional Assessment" for products and services before SOP for the planning and implementation of the initial supplier evaluation [34].

In the procurement strategy, *purchase processes* are defined and documented in order to ensure the ease of understanding of operative purchasing. We have presented an example of a procurement process in Fig. 3.20, inspired by SAP ERP. The processes vary depending on the complexity of the call for tender, and the availability of suppliers on the market. In particular for preferred suppliers,

Fig. 3.20 Schematic procurement process inspired by SAP ERP in materials management

framework agreements are often concluded independently of calls for tender, in order to simplify the creation of contracts in the case of calls for tender, and in order to manage them better centrally.

In addition to the processes, some managing *purchase rules* are defined and administrated. These include, for example, representative regulations, signature regulations and value limits for approvals.

Logistics Planning and Management

Inspired by Klug [93], logistics planning has many different action areas during the *supply, packaging and logistical structure plans* throughout the product development process (see Fig. 3.21).[35] The central content of the different types of planning is:

- Planning of the *logistics processes* (see Fig. 3.22) and of the goods flow,
- prognoses of logistics costs, incurred by transport, containers, goods handling, storage, stock and shortages, and
- material and financial investment planning.

The strategic establishment of the type of planned manufacture (see Fig. 2.2) and the *procurement types* are primarily determined by logistics management [151]. Fundamentally, in controlling the *logistics concept*, a distinction is made between the three following procurement types:

Individual procurement	takes place when specific demand occurs. Only then is the material which is needed ordered.
Stock procurement	takes place independently of specific demand. Large quantities of materials are bought and stored.
Demand-appropriate procurement	takes place in close coordination with product manufacturing. Examples of warehouse-free direct delivery include "Just-In-Time" or "Just-In-Sequence" with central material flow management, and Kanban with decentralised consumption management.

[35]For a more detailed description of the plans, please see the literature [93].

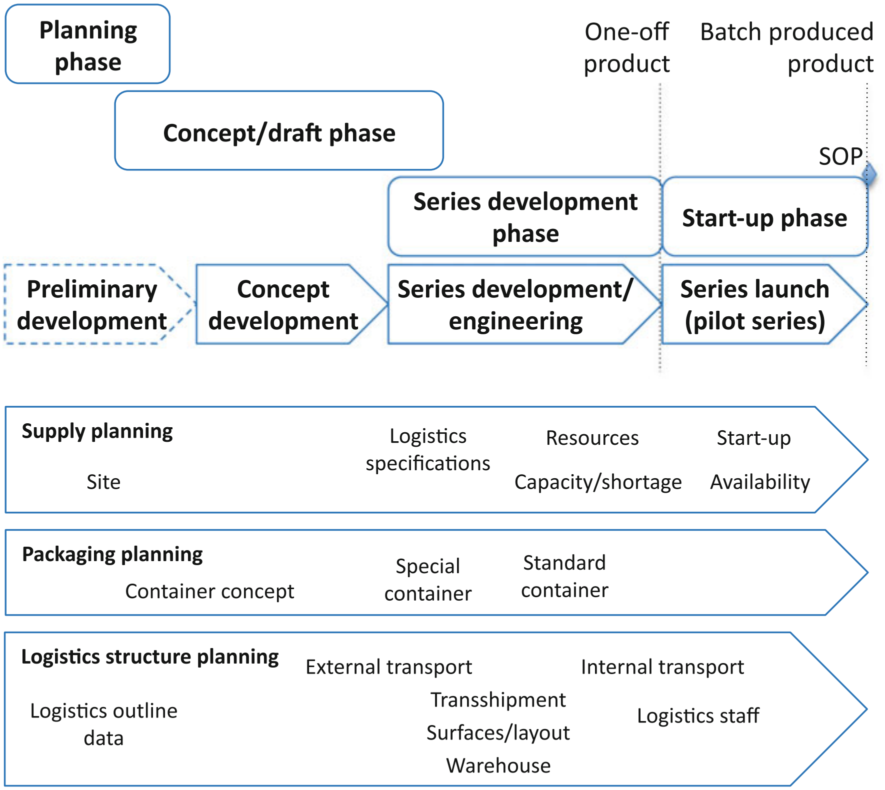

Fig. 3.21 Planning areas of logistics planning in the product development process Fig. 2.4 inspired by Klug [93]

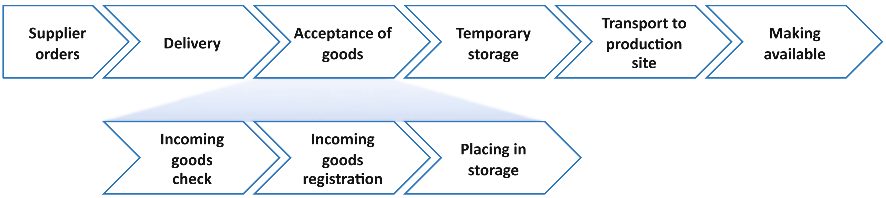

Fig. 3.22 Schematic process of inbound logistics

As early as the 1950s, Toyota developed the Kanban system for the planning and management of material flows in production [104].

Logistics planning is classified into that which occurs before and after SOP, and is divided into strategic, tactical and operative levels. Please consult further literature [138].

The *logistics requirements documentation* specifies all logistical requirements of the OEM in the context of the call for tender and awarding processes of planned scopes of delivery (parts, components, modules, subsystems). The instructions and degree of detail vary depending on the procurement type – as is explained in more detail in the literature [93].

Supplier Relationship

Nowadays, even early phases of development processes take place largely in cooperation with suppliers – something which is due in particular to the large numbers of parts which use a wide range of very different technologies. While many automotive companies produced their own cable sets well into the 1970s, nowadays the development is partially outsourced to system suppliers, and manufacturing is completely outsourced to them. Detailed engineering of a wiring system is often only carried out by suppliers. Suppliers who are involved early gain a competitive advantage, which makes it more difficult to negotiate prices and delivery conditions for procurement. Yet, more and more often, vehicle manufacturers look for potential suppliers who want to enter into long-term strategic partnerships.

By building up strategic partnerships with suppliers early and maintaining sustainable relationships with them, it can be possible to make joint efforts to reduce costs in the broad field of in-vehicle technology.

The following four methods have established themselves for the management of the supplier relationship [6]:

Supplier management	in order to turn an existing relationship into a partnership.
Supplier discipline	consists of measures which involve recognising the services provided by suppliers – but also sanctions when the services do not fulfil requirements. Types of recognition include, for example, awards, premiums or an increased delivery ratio. Sanctions, on the other hand, can include warnings, increased checks, decreased delivery ratios, or selective or total blocking or removal from the list of suppliers.
Supplier support	increases the performance level of an existing supplier.
Supplier development	helps a new supplier to gain a foothold in a new market.

For the strategic planning and central management of the relationships between a company and its suppliers, the *SRM system* was developed in order to support sustainable links and support purchasing in the procurement process. In the SRM system, the supplier portfolio is maintained and developed along with the initial and current evaluation, in addition to the *supplier master data*. The system also enables integrated and consistent *supplier communication* throughout the procurement process. Furthermore, the *roles and authorisations* of the suppliers are managed – for example, access or login details to resources, buildings or IT systems.

There is, however, still plenty of movement in the development of systems for supplier relationships. For example, the web-supported supplier management system "Lima on Web" [135] no longer exists. It was developed just a few years ago by Daimler, with a focus on the pilot series.

A core problem exists in terms of how to manage supplier master data which continue to be saved traditionally by vehicle manufacturers in their own systems. As vehicle manufacturers often have many thousands of contacts all over the world, contact information soon becomes out-of-date or wrong – or takes you to another supplier altogether. The same situation also occurs when a supplier manages the master data of his clients himself. This leads not only to redundant information, but also to having to mainly deal with data from other companies. The principle of "Linked Open Data", which is well-known from the internet, now also applies to companies [60], meaning that they can maintain their contact information and addresses themselves, and make them available to partners via online services. In terms of contracts, there are some framework conditions as part of the responsibilities, with which implementation is not possible so simply. However, such uses of current technologies are the right way to modernise relationships between companies.

Control Business Competences

There is a constant need for improvement in procurement and supplier checks in terms of lowering prices, improving quality, minimising risks, and reducing throughput times etc. in purchasing [28].

Supplier Evaluation

Alongside the initial supplier evaluation in the "procurement strategy" business competence, a running evaluation takes place in accordance with defined criteria. The *evaluation criteria* of the suppliers, and their weightings, are always different from one company to another. What is the same in all companies, however, is the *contract fulfilment*, as part of which the supplier's fulfilment of contractual duties is evaluated. More precise evaluations are often more related to costs, delivery and services. For example, the following standard evaluation criteria are commonly used to determine the ability of suppliers to provide services:

- price,
- delivery date,
- delivery quantity, and
- returns policy.

Especially for preferred suppliers, there are numerous other additional evaluation criteria, such as:

- technical competence and ability to innovate,
- reliability in terms of complying with quantities ordered and delivery dates,
- quality of the parts delivered, and
- financial stability.

Performance figures can be calculated from the evaluation criteria in order to classify the suppliers, and evaluate their ability to provide services in terms of quantitative and qualitative requirements of the vehicle manufacturer. Due to the high number of possible supplier performance indicators, we will merely refer to the literature here [28, 79].

Daimler, for example, uses its own in-house developed system "External Balanced Scorecard"[36] for a standardised definition of the current performance evaluation of suppliers [34]. A standardised evaluation in relation to the business volume takes place by way of a target/actual comparison of the established indicators, using the data from the different specialist areas, operative purchasing and the supplier. The results are documented and, in most cases, are communicated directly to the individual suppliers via the supplier portal.[37]

Dependent on the evaluation action areas identified, *development measures* are derived for the business competence "supplier relationship". The status of current and completed measures is regularly checked and documented. Particularly critical are the financial developments of suppliers – which can mean risks and supply shortages for vehicle manufacturers. Both the associated *supplier risks* as the result of a fault, as well as the evaluations of fundamental contracts, performance characteristics, performance scopes and the dependent revenue, are bundled in a *supplier dossier*.

Procurement Optimisation

The continuous procurement optimisations include comparisons of the planned *requirements determinations* and the actual *stocks* according to different threshold values in the storage, through the *inventory*. Measures are derived from these which, alongside reductions and increases, could also mean *demand pooling* of one-off and permanent needs. In particular, procurement optimisation focuses on the critical and cost-intensive parts on the bill of materials, as well as the new parts in the preliminary series (part of the series launch, see Fig. 3.21), where there are yet to be any experience values or solid prognoses for future demands from previous years [82]. In this context, a daily comparison can be made between the forecast demand figures and those actually achieved for new parts in the series launch.

In practice (but also in theory) there is no "optimal" way of demand planning. Alongside data quality, on the basis of which demand planning is to be optimised, the many-layered and contradictory conditions are difficult to optimise. For example, the costs of set-up time, machine utilisation and storage costs are dependent on each other during planning – and the complex conditions can only be estimated. Priorities which have been set also have a considerable influence – for example, when a vehicle manufacturer prefers to procure the material for production, trade or customer services. By contrast, spare parts have the highest priority for manufacturers of construction machines. We could name even more conditions in order to illustrate how complex demand planning is. The conditions

[36] "Supplier management: Mercedes creates more transparency" http://www.beschaffung-aktuell.de/home/-/article/16537505/26156641/Sehen. Accessed: 23 December 2014.

[37] "Daimler Supplier Portal" http://daimler.portal.covisint.com. Accessed: 23 December 2014.

also include different temporal observations – for example an operative plan for the next 14 days, or long-term orientation for the next month.

Forecasts of the developments in the procurement market, for example relating to possible materials shortages or broader ranges offered by suppliers, are defined as *optimisation targets* in the purchasing target agreements. The *purchase measures* implemented, and their effects, are checked and documented regularly. For example, the progress of purchase success can be planned and measured using a *procurement savings process* with the following levels [69]:

Level 1:	Goal formulated, estimated through roughly planned savings Example: 50,000 € through savings on materials of a shell
Level 2:	Plausibility of the measure recognised Example: Supplier workshop for the optimisation of materials
Level 3:	Measure elaborated through specifically defined and approved activities Example: Workshop carried out; material constructed
Level 4:	Measure implemented by order being given to supplier Example: New shell ordered
Level 5:	Measure effective in terms of results, identifiable through the profits and losses calculation of the implementation Example: The supplier is paid for the new shell

In this presentation form, current and completed cost savings and potentials in purchases can be shown and documented. During the course of defined time periods, the changes can be read immediately as *purchasing performance measurements*.

The monitoring of logistics is not only *ensuring production supply*, but also for the operative coordination of the *service provision*. This includes operative consolidations of logistics orders, individual and regular shipments, and vehicle services.

Execute Business Competences

The awarding of the purchase and the resulting contracts with suppliers are central, operative competences in procurement, and allow for the critical production supply of the vehicle manufacturer's value creation chain.

Purchase Awarding and Contract

The operative procurement of a material, good or service starts with a *purchase enquiry* being sent to a supplier. The following variants have established themselves for the management of supplier enquiries via *purchasing systems* – from collecting quotes, to comparing quotes and *selecting suppliers*:

Request for Information	(RFI) to potential suppliers, to ask whether they could in principle respond to a demand with a price list.
Request for Quotation	(RFQ) to suitable suppliers who in principle are in a position to respond to a detailed description of

	requirements (requirements documentation) with a service description and as precise a price as possible.
Request for Proposal	(RFP) to qualified suppliers who are able to provide binding quote in response to a detailed description of requirements (product specification), for a certain period of validity so that, if selected, a contract can be concluded.

Procurement processes (see Fig. 3.20) rely on standardised IT systems which document processes and communications in an easy-to-understand, audit-proof way. Especially during *quotation processing*, all quotations received must be checked for completeness and to ensure that they comply with formal instructions in terms of equal treatment. The purchase systems must guarantee an easy-to-understand awarding decision in accordance with guidelines and established criteria which are valid throughout the company.

In the case of larger-scale procurement, a supplier can be selected over several rounds, using all variants of the RFI, RFQ and RFP, including the respective *awarding negotiations*. They serve to get rid of weak points in individual ranges, and prepare the *order decision*. The expert reviews take place through the business units which have created the call for tender documents. By contrast, legal verifications on the contracts with the supplier are carried out through the domain "corporate support service" as support to the business competence "law and regulations". During *contract drafting*, legally binding contractual documents are created. These are subject to approvals in accordance with valid guidelines, and also following adjustments made after *objections from suppliers*. The purchase is completed when the supplier is commissioned and he confirms the order.

The procurement process can, however, be significantly simpler in the case of order requests for consumables which are not relevant to production, services on the basis of existing *framework contracts* or past supplies.

The whole process of all documents with changes and internal processing comments during the procurement process is filed in an audit-proof way in accordance with defined retention periods and access authorisations in a DMS.

Production Supply

Through the established concepts such as the "Kanban" [104] system in "logistics planning and management", the design of the production supply is defined in a significant way. Production supply includes *goods receipt*, running of the *incoming and temporary warehouses* for *raw materials and intermediate products*, in addition to *provision of materials* for production (see Fig. 3.18). Alongside the regular supply, specific demands, missing parts and materials which are needed urgently for production must be dealt with differently as soon as they arrive in incoming goods.

This is where numerous verifications and documentations take place of the physical handover of externally procured products and those manufactured in-house, before they are taken in as part of the stock. Goods verifications as part of incoming goods, which go further than damage to packaging and commercial aspects such as supply amount and delivery date, are carried out as part of the business competence “quality assurance” from the domain “quality” which makes claims in the case of damages. The commercial accounting of the accepted good takes place as part of the business competence “accounting, financial statement” from the domain “finance and controlling”.

Depending on demand, the material accepted is either forwarded directly to production, or to a corresponding warehouse. The entire administration of sorting of the *goods stock*, the storage place, the storage movements, the inventory and commissioning often takes place via standardised *warehousing systems* such as ERP systems [84]. If the warehousing systems are laid out centrally, then consolidations and *stock balancing* of surpluses and shortfalls between different warehouse locations are possible.

The design and administration of in-house delivery and transport processes between intermediate products warehouses, raw materials warehouses and production sites are now also standardised by IT systems [102], but are usually provided by external logistics service providers. By contrast, *load carriers* and, in particular, special containers, often belong to OEMs, which are responsible for operative *returnables processing* with the logistics service provider. Any customs clearances which may become necessary are dealt with as part of the business competence “law and regulations” from the domain “corporate support service”.

3.6.4 Production

The domain of “production” implements the series vehicle by planning and creating the necessary environments and manufacturing equipment. While different types of vehicle production do indeed exist (see Fig. 2.2), these only have an influence on the details of the business competences. In addition to the three main types of build to order, build to stock and engineer to order, there are also other more specialised types of production which follow the demands of the market, such as the case of export into markets which impose high import duties to make it difficult to import ready-manufactured vehicles. In this context, BMW pursues the strategy with “Completely Knocked Down” factories in order to enter markets such as these. In so doing, vehicles are exported as construction kits before being assembled for sales, or constructed – depending on the extent to which they have been taken apart [93].

The domain of “production” includes the following seven business competences (see Fig. 3.23):

Direct:
- Production process and simulation
- Production planning and management
- Equipment planning

Control:
- Production assurance

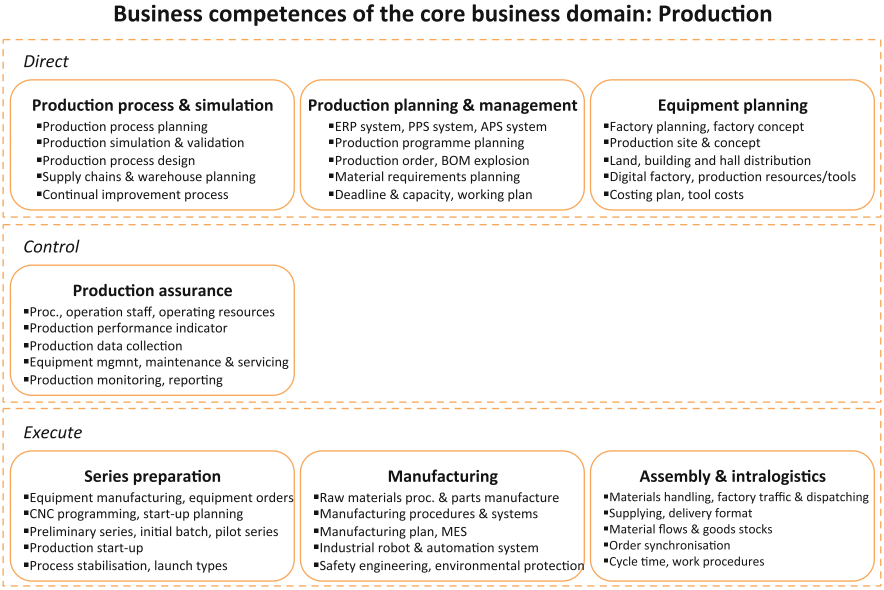

Fig. 3.23 The business competences of the domain "Production"

Execute:
- Series preparation
- Manufacturing
- Assembly and intralogistics

Direct Business Competences

For the management of production, there are the business competences "production process and simulation" – in order to conceive and strategically validate the relevant production techniques; the central "production planning and management" and "resource planning" – which is used to ensure the technical conditions for production.

Production Process and Simulation

In the production process, the products to be manufactured are integrated, along with the factories, production facilities, logistics and manufacturing equipment for the automatical and manual processing and treatment of raw materials and intermediate products. These include long-term *production process planning* for the definition and detailing of the production processes, including their *production simulation and validation* as well as integration with operative production and production logistics controls. The subjects of simulations include, for example, quantity throughput in manufacturing and assembly for certain vehicle variants, in addition to shift operations and scenarios in which machines and facilities break down [11].

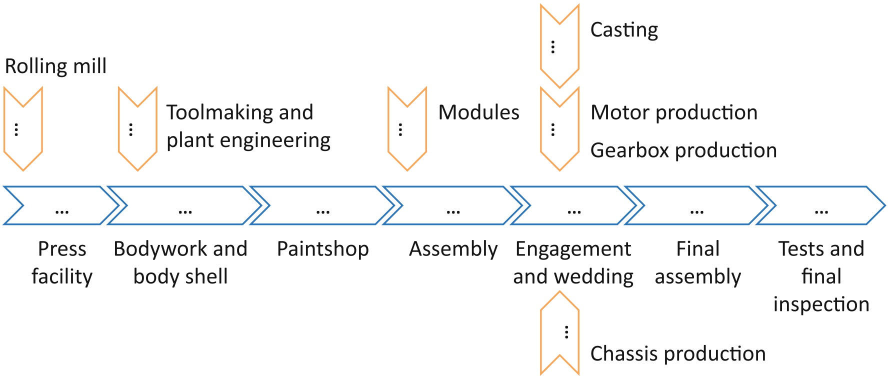

Fig. 3.24 Typical sequence of the main processes (*blue*) in AUTOmobile manufacturing. Auxiliary processes (*yellow*) of components manufacturing and pre-assembly

This is why the *production process design* shapes the heterogeneous main and auxiliary processes of manufacturing, assembly and the necessary production logistics. In particular, *supply chain and warehouse planning* forms the basis for the process of operative production logistics.

Figure 3.24 shows a typical process sequence in AUTOmobile manufacturing. Depending on the vehicle manufacturer and model, the steps may vary or be completely outsourced to suppliers. Inspired by the AUTOmobile manufacture process sequence usually described in the literature [22], we summarise it into the following seven main processors:

1. The manufacturing process of a vehicle starts with the raw material – heavy steel and aluminium rolls from the rolling mill. In the pressing plant, sheets are first unrolled from the large rolls, and cut into appropriately sized pieces. Over the course of several steps in the press line, the sheets are reshaped into the desired form.
2. In the following section bodywork and shell section, industrial robots put together the many sheeting parts to form a bodywork. As part of this, techniques such as spot and laser welding, riveting and bonding are used. Following the washing, processing and quality assurance of the bodywork surfaces, the next main process takes place in the paintshop.
3. In the paintshop, the differently applied layers of varnish not only give the bodywork colour, but also make it resistant to corrosion. After thorough cleaning, rinsing and phosphating in order to create a layer for the varnish to stick to, cathodic dip-painting is carried out – as part of which electrostatics is used in a plunge pool in order to apply the varnish evenly all over the surface. Numerous other steps follow, such as rinsing, drying, polishing, sealing and cleaning. Only when spraying robots apply a base layer and clear varnish does

the bodywork finally get its actual colour. Once the varnished bodyworks have been successfully inspected, they go on the assembly stage.

4. The vehicle bodywork is varnished all over. The doors are removed and are processed in a separate route before the numerous assembly steps in the interior and exterior of the vehicle begin. Many components and modules are procured via suppliers or outsourced components manufacturers, and arrive in the incoming goods department of the assembly factory via inbound logistics. A large proportion of the individual parts and components are put together in advance to form modules such as seats, and are brought into the assembly line at the right time. In motor pre-assembly, for example, the supplied motors and gearboxes are assembled before the "engagement" takes place.
5. The "engagement", as it is known in German, is the step during which the completed motor-gearbox unit is placed onto the front axle of the future vehicle. The climax of the assembly, however, is when the bodywork is joined with the drive system and chassis – which is known in German as the "wedding". The drive system and the chassis are often manufactured and checked at other locations.
6. During final assembly, the following procedures take place: motor cabling, connection of wires, installation of the seats, installation of operating resources, and the assembly of other components such as wheels, for example. Finally, the doors – which have been completed separately – are built in again. Ever increasing significance is being gained by the installation of software for the control units in the vehicle (see Sect. 2.3.1), which is what gives the vehicle its necessary functions in the first place.
7. Finally, numerous functional and optical checks take place in addition to the final inspection, which is managed via the business competence "quality assurance" from the domain "quality". Finally, the finished vehicle is test driven on an in-house test route before being cleaned in the car wash, and being cleaned inside. Final approval for transport occurs once all quality controls have been passed.

Alongside the regular process sequence, there are numerous special treatments in the case of problematic situations or missing parts. Additionally, regular audits with more comprehensive checks on individual vehicles of all variants also take place.

A particular case in point is the support given to operating staff during the *continual improvement process*, also known as Kaizen in Japan (see Sect. 3.1.4). For Kaizen, a whole host of tried and tested methods and tools have been put together [72], which are based on

- mathematical foundations ("The Seven Statistical Tools"),
- approach methods ("The Five-Step KAIZEN Movement"),
- sets of rules (Toyota production system seven wastes [112]),
- problem solving techniques ("The New Seven Problem-Solving Tools" and "Plan-Do-Check-Action")

and their visualisations.

Production Planning and Management

Nowadays, the business competence "production planning and management" (PPM) no longer concentrates solely on exclusively in-house planning of production processes, but also on the management of the manufacturing company's supplier network – especially by continually outsourcing the value creation share to suppliers (see Sect. 1.3). Nowadays, the more comprehensive *ERP system* (see Fig. 2.17) is often used as a core component along with the production-side-oriented *PPM system*.

A PPM system is a computer-aided production planning and management system which is used to plan the production programme, quantities, deadlines and capacities, and to prepare and manage orders. Recently, PPM/ERP systems have also started to be coupled with Advanced Planning and Scheduling systems (APS), in order to broaden the bill of materials explosion with relationships between parts and customer contracts [152]. In this way, it can be guaranteed that only those orders which have sufficient materials allocated to them will reach the manufacturing stage, and that the overall throughput in the factory is optimised. *APS systems* are especially necessary in build to order production, because they can be used to plan and manage distributed manufacturing of different intermediate products, and assembly which is to take place over different production locations and automation concepts.

Production programme planning involves determining primary needs in the case of rough plans and prognosis calculations for the vehicles to be manufactured. When the sales orders are handed over and changed into *production orders*, the sales requirements of the production team are created, which demand that they produce vehicles by a certain deadline or in a certain quantity. During the very time-consuming *BOM explosion* [134], the bill of materials of primary requirements is used to determine the secondary demand for components and individual parts, on the basis of valid explosion rules (see Sect. 2.3.1). This results in *material requirements planning*, which establishes the manufacturing orders with procurement calculations for externally procured materials and those produced in-house. In order to make the best possible use of the available manufacturing and assembly sites, *deadlines and capacities* are planned in the form of the levels throughput scheduling, capacity needs determination, capacity definition, order planning, and capacity quote determination [52]. More precise plans take place in the business competence "procurement optimisation" from the domain "procurement and inbound logistics" as the result of comparing a very broad range of criteria. From this, factory-specific deadline and occupancy plans are created, as is the *working plan* for *production deployment control*, after which manufacturing orders are approved. In the PPM system, an overview is provided of orders and their fulfilment.[38]

[38] For a more detailed look, please see the literature [68].

Equipment Planning

This business competence forms the technical conditions for production by focusing on the planning and conception of factories, production facilities and other resources such as series tools. Operating equipments include, for example:

- plots of land, factory premises,
- buildings, production halls, office spaces,
- machines, production facilities, tools,
- operative and business equipment (office furniture, storage and factory hall facilities).

The typical occasion for *planning a factory* is replanning – a part of the strategic planning of *production sites and concepts*. More frequently, however, a change to planning is needed if an existing production site is to see a renovation, or a modernisation or expansion of existing facilities. As in such cases, the changes affect existing structures and technical facilities, their planning cannot be viewed in isolation from running operational processes.

In factory planning, the necessary spatial, technical and organisational conditions are created in order to realise a planned production programme. It extends from the planning of operational sites to the launch of production. The extent of factory planning can be limited to the replanning of a single machine along with its auxiliary devices, or may extend to include the establishment of a new factory. The "equipment and supply" business competence from the domain "infrastructure" takes care of the administration of the factory as a property, and its construction. Nowadays, there are three main goals to be achieved with the planning of a factory:

1. economic viability of production thanks to throughput times which are as short as possible, in order to supply and dispose of materials and products while keeping stocks at a minimum,
2. flexibility of facilities and implementable processes, in order to make it possible to make rapid adjustments to changes in demand in terms of product type and quantity, and
3. an environmentally-friendly factory with motivating work design possibilities which are prescribed in the context of the business competences "goals, values, principles" and "environment" from the domain "corporate leadership".

The *factory concept* includes *land, building and hall distribution*, production logistics and the necessary production facilities and operating equipment. A closer look at factory planning can be found in the literature [171].

Already as the late 1980s, factory planning in the automotive industry was affected by digitalisation, and expanded via all production-relevant manufacturing equipments, for example by Volkswagen's hall-layout system "HLS", and Daimler's factory planning and information system "FAPLIS". These were the first, fundamental steps towards computer-aided factory planning – when the conception and planning of facilities such as conveyor belts, platform technology, varnishing technology, and climate technology became possible using CAD systems. The IT systems developed at the time have essentially remained the same to this today.[39]

The planning options, however, have been brought together in the more far-reaching concept of the *digital factory*. In accordance with [19] and the principle of German Association of Engineers guideline VDI 4499, we define the digital factory as follows:

> "The digital factory is a generic term for a comprehensive network of digital models, methods and tools – including, among others, simulation and three-dimensional visualisation – which are integrated using consistent data management. Its aim is the holistic planning, evaluation and continuous improvement of all main structures, processes and resources of the real factory in connection with the product." [162]

For example, the digital factory not only involves the planning of production lines with robots in assembly, but also the simulation of processes involving supply and disposal by transport vehicles. Nowadays, nearly all production processes are planned and managed digitally before they are implemented physically. As a result, this business competence is closely linked to the business competence "production process and simulation", and has different focuses in both of the competences. More detail can be found in the further description of the digital factory in the literature [19].

Manufacturing planning is, to a great extent, identical to "production planning and management", but it goes into more detail about the manufacturing of parts, in particular the planning and conception of *production resources/tools*. The production resources include tools, devices, measuring and testing equipments which can be used to carry out certain procedures in the production process (see Fig. 3.24). In practice, rough and fine-tuned planning of the production systems takes place through work on the production processes, evaluation and selection of the variants right up to the creation of a plan for realisation [123]. In the corresponding *costing plan*, the *tool costs* for the assurance of the production costs are calculated – see the additional literature on manufacturing planning [36].

Control Business Competences

The entire production process must be assured through corresponding controls. Where the order-anonymous part transitions to the order-related part of production (see Fig. 2.2), however, the business competence of "production assurance" gains another focus. In production, this point is referred to as "engagement" in German, because it is from this point onwards that a relationship between the customer order

[39] https://efaplis.supplier.daimler.com/wiki/. Accessed: 23 December 2014.

and production order is created. In addition to the production assurance, from this point onwards the implementation of individual customer wishes is also ensured.

Production Assurance

This business domain is about assuring production with its *processes, operating staff and operating resources*, but not about the product – which is assured during its creation by the business competence "Testing and validation" from the domain "research and development" and the business competence "quality assurance" from the domain "quality".

In production in particular, there are numerous *production performance indicators* [10]. Indicators are indispensable in order to continually optimise production processes, but require reliable *production data collection*. The complexity is, however, less due to numbers alone than it is about the relationships between the indicators, and how actual effectiveness and efficiency can be measured in a way which is close to actual practice. One example is the many-layered model of measured values between the planned times and actual main use times of tools, inspired by Association of German Engineers guideline 3423 [163] (see Fig. 3.25). Meanwhile, many indicators have been defined using the calculation bases, and have been standardised as part of the international norm ISO 22400-2:2014 [76]. However, production monitoring of the factory-specific indicators, and those which apply to more than one factory, for the measurement of economic viability of production and production logistics, are not the only ways of identifying weaknesses in the operational process.

For example, operating *equipment management* offers the opportunity to guarantee regular *maintenance and servicing* of the production facilities and tools being used – from simple cleaning or lubrication to work-intensive servicing – thus assuring production in a preventative manner. In so doing, for the operating equipments – as is the case with the product, specific regulations, state laws or ordinances must be complied with – which are checked by external auditing organisations such as the German Technical Inspection Association "TÜV". Assurance also involves testing the availability and durability of operating equipments.

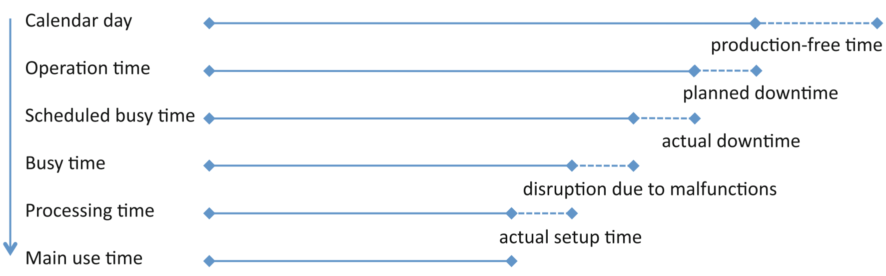

Fig. 3.25 Multi-layered model of measured values between the planned times and actual main use times of tools

Nowadays, many tasks from consolidated *production monitoring and reporting* are standardised by ERP systems [9].

Execute Business Competences

As shown in Fig. 3.18, the manufacturing of vehicles divides the material flow into the following three areas [168]:

Raw materials processing	includes all procedure-related processes for the chemical and physical alteration of shapeless materials.
Parts manufacturing	usually produces intermediate products which, from the point of the vehicle, are unfinished products.
Assembly	brings together externally procured or in-house produced intermediate products in several steps until the finished vehicle is assembled.

From the point of view of business competences, we summarise the operative preparation of vehicle manufacturing from all three manufacturing fields. We divide series production into two business competences – "manufacturing", which includes the administration of facilities and manufacturing equipments, and "assembly and intralogistics".

Series Preparation

The business competence "series preparation" focuses on production development and scaling up in the product development process (see Fig. 2.4). The series launch is the beginning of product manufacturing, and is therefore the first carrying out of the vehicle production process, which is later to be carried out regularly in series production.

In the operative preparation phase of production, the planned operating resources must be constructed and manufactured. The majority of *equipment manufacturing*, for example for special series tools, takes place via external procurement from suppliers – who often also take on the installation, training and commissioning of the production site. The necessary operating *equipment orders* for this are processed via the business competence "purchase awarding and contract" from the domain "procurement and inbound logistics", while the appropriate *CNC programming* of the machine tools can be developed by the OEM. Throughout the whole manufacturing process, this is crucial for a seamless series launch. Changes to the programmes for the fine tuning of several production facilities during the pilot series, however, are always needed.

Alongside operating equipments, *start-up planning* is also crucial for the preparation of series production, with the planning of start-up scenarios. The start-up curves are rough time plans for the preliminary series. This is when it is determined when which test cases can be carried out using which vehicle variants. The start-up curve describes the production volume which it is planned will take place each day during the production start-up. Figure 3.26 shows a series launch and a start-up

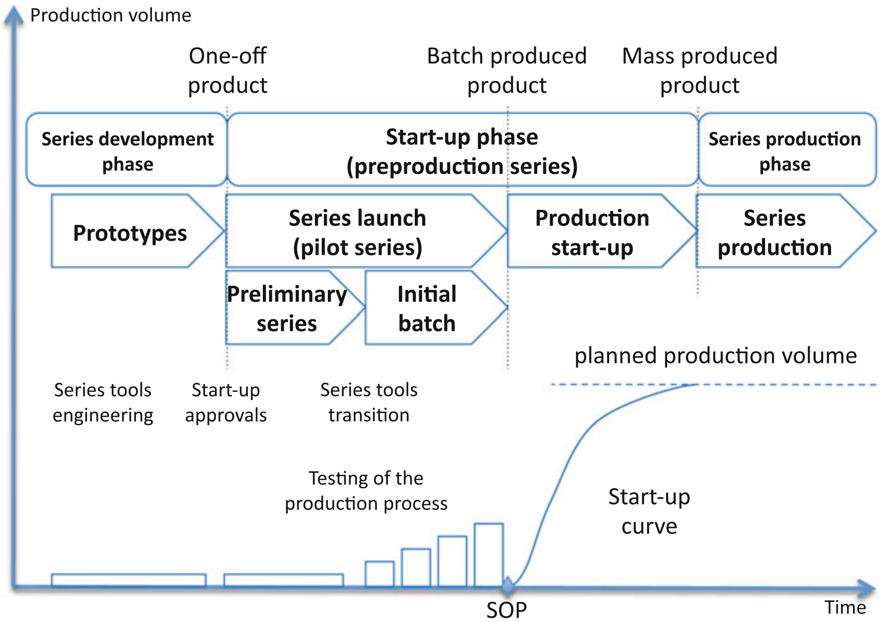

Fig. 3.26 The series launch in the three main phases of preliminary series, initial batch and production start-up

curve. The start-up phase is divided into the following three sub-phases [140]:

1. The first main phase in the series launch is the *preliminary series*, as part of which prototypes are produced in larger numbers in series-like conditions, but not all components are made using series tools. This phase demands a very high degree of flexibility, because many special processes still need to be carried out. The launch is yet to occur, and many processes take place under conditions which might be similar to those in a car repair shop. Compared with the focus on the product alone in the case of building prototypes before the preproduction series, however, (see Fig. 3.14), the goals of the pilot series are to achieve functionality of the manufactured vehicle, and to test the necessary manufacturing and assembly processes. Coordinating the delivered parts demands particularly close collaboration with the suppliers.
2. The second main phase of close-to-serial production is the *initial batch*, which comes after the preliminary series. Just like the preliminary series, the initial batch is known as part of the *pilot series*. The focus is on production processes which make it possible to achieve the conditions needed for series production. In the initial batch, the externally procured materials and intermediate products come from the series production of the suppliers, and the materials flow and use of tools also take place under series conditions. The production tests are carried out in several separate phases, in which insights are collected so that they can

be implemented in the following phase. The increasing production volume and close-to-serial production with series material means not only that the facilities, processes and tools are tested, but also that the operating staff are trained for their future work.

3. Following the successful scaling up of the pilot series, *production start-up* begins with the SOP. It is only in this phase that the first vehicles are made which can be sold. Some companies refer to this milestone as "Job No. 1". During scaling up, the cycle times are even longer than they are in series production; a larger number of production and logistics faults must also be expected, in addition to lower production volume and a need for increased workloads and more materials. The focus is on *process stabilisation*. As soon as planned criteria such as production volume, quality instructions and production throughput times are achieved in a stable production process, scaling up evolves into series production.

In the automotive industry, there are different classifications of *launch types*. For example, a series launch is also necessary for a newly built factory or new facilities – because the production process changes. In general, one classifies the series launch in terms of process and product changes; the latter are classified as model maintenance or new variants of the vehicle. The complexity is usually a result of the diversity of parts affected, and the associated suppliers. If new suppliers become involved, then process changes also take place in production and the necessary facilities.

Manufacturing

The business competence "manufacturing" brings together *Raw materials processing and parts manufacturing* – even though, from a technical point of view, they should be looked at separately. Logically speaking, however, both processes use defined surfaces to create unfinished intermediate products, and are similar to one another both in terms of how they gradually change the form and materials properties, and in terms of the main areas of production technology (energy, manufacturing and procedure technology). The primary focus of the competence is on manufacturing techniques which create and alter forms using *manufacturing procedures and systems*, and bring about changes in the properties of materials. In accordance with DIN 8580 [40], a distinction is made between manufacturing systems which create original forms, change them, separate them, bring them together, coat them; and which change the properties of materials. Figure 3.27 shows just a few manufacturing procedures from the six main groups in accordance with DIN 8580.[40]

The manufacturing line is the spatial sequence of those production systems on which, in chronological order, the manufacturing procedures for the production of the vehicle parts are carried out. The various production systems must be managed

[40]For more in-depth information about manufacturing technology, please refer to the literature [61].

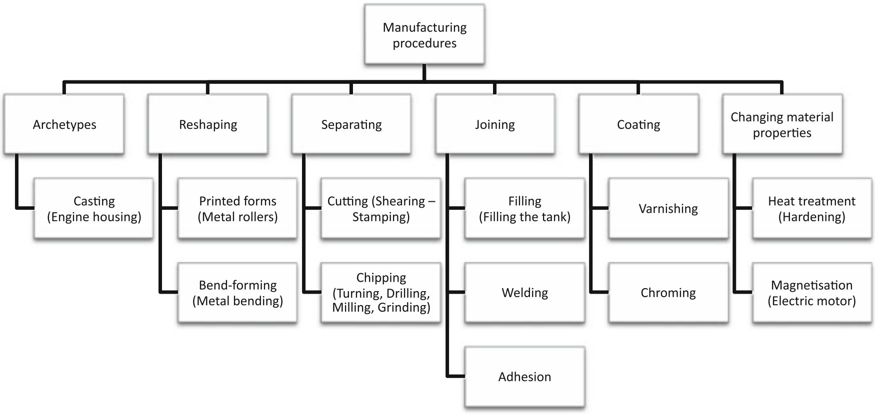

Fig. 3.27 Just a few of the manufacturing procedures of the six main groups in accordance with DIN 8580 [40]

holistically for the operation and optimisation of the production site, as is the case in the Toyota production system [112], for example. In production operations, the management systems are divided into several levels. The standard DIN 62264-1 [41] defines a model consisting of five levels, in which the *manufacturing plans* are described – from the company level to ERP systems and the facilities-specific field level. By contrast, the Association of German Engineers guideline 5600 [164], which sets out a task-oriented description of the *Manufacturing Execution System* (MES) only makes a distinction between the following three levels:

Corporate management level	corresponds to the business competence "Production Planning and Management".
Manufacturing control level	includes the MES manufacturing execution system, which is characterised by its direct link to the distributed systems of process automation. In so doing, it integrates the factory with its production facilities, and makes factory-specific production planning and management possible. This includes, for example, the collection of operational and machine data, and data preparation – which, alongside data collection of operating staff, forms the basis for order and machine management in the factory. The production status of the business competence "production assurance" is regularly reported back to the corporate management level.
Manufacturing level	includes the *industrial robots and automation systems* and the production facilities which are often monitored and regulated by robot or CNC

programmes, or a Programmable Logic Controller (PLC). CNC is for the movement control, and PLC is for the functional control (coolant, lubrication, aggregates, protective devices) of the machine tool. According to [41], there are more detailed stages which work at field level to describe in- and output signals, as well as the facilities' display types.

Through the simultaneous use of operating staff and industrial facilities in manufacturing, operational and work safety in the factory is given particular importance. *Safety engineering* concentrates on the risks which are linked to the use of technology, the operation of industrial facilities, and how materials are dealt with, determines potential dangers and evaluates the risks. *Environmental and health protection* is increasingly the focus of the sustainable production of vehicles, and is managed through guidelines of the business competences "environment" and "safety and security" from the domain "corporate leadership". These include, for example, a safe way of handling pollutants and hazardous substances, as well as environmentally aware energy technology, and the disposal logistics of production residues and packaging.

Assembly and Intralogistics

The focus of this business competence is on the operative processing of assembly orders with their in-house materials and goods flows. In-house logistics, or intralogistics, can not always be simply separated from the business competence "production supply" from the domain "procurement and inbound logistics". Intralogistics means the production logistics presented in Fig. 3.18, excluding inbound logistics. It includes materials handling systems from *materials handling*, internal *factory traffic and dispatching* to *supplying* the operating staff at the assembly line with the necessary parts. Each assembly space is also supplied with the appropriate *delivery formats*, such as container sizes.

Buffer supports are common at larger production sites which are between two consecutive production stages, in order to ensure a production process which runs as smoothly as possible. In order to achieve this, *material flows and goods stocks* must be managed in the production warehouses with their capacities, parts and special requirements messages, and commissioning in terms of input and output. In the case of build to order in particular, which is associated with a high variant diversity of the parts to be assembled, the supply of the assembly process must ensure *order synchronisation* (often referred to as "Just-in-Sequence production").

Using the working plan and the prescribed *cycle time*, the assembly of the allocated *work processes* takes place at the respective work stations. Each of them is equipped with the corresponding resources, and is supplied with the necessary materials and goods at regular intervals. Depending on the production process being planned, there are different assembly sections – both manual and automatic, including pre-assembly for the completion of the motor-gearbox unit, final assembly, and final inspection.[41]

3.6.5 Marketing and Communication

The business domain "marketing and communication" is about the internal and external communication of the company – which does not, however, take on all operative communications between the companies and the various reference groups in the market. "Financial market communication", for example, takes place in the business domain "finance and controlling", while supplier communication takes place as part of the business competence "supplier relationship" from the domain "procurement and inbound logistics".

In the case of the latter domain, a shift of focus takes place in the chain of core business domains from the procurement market to the sales market (see Fig. 3.7). Marketing orients itself towards customers and competitors in the sales markets, and thus represents a crucial preparation phase for sales. This domain includes the following seven business competences (see Fig. 3.28):

Direct:
- Corporate communication
- Corporate and brand identity
- Marketing concept

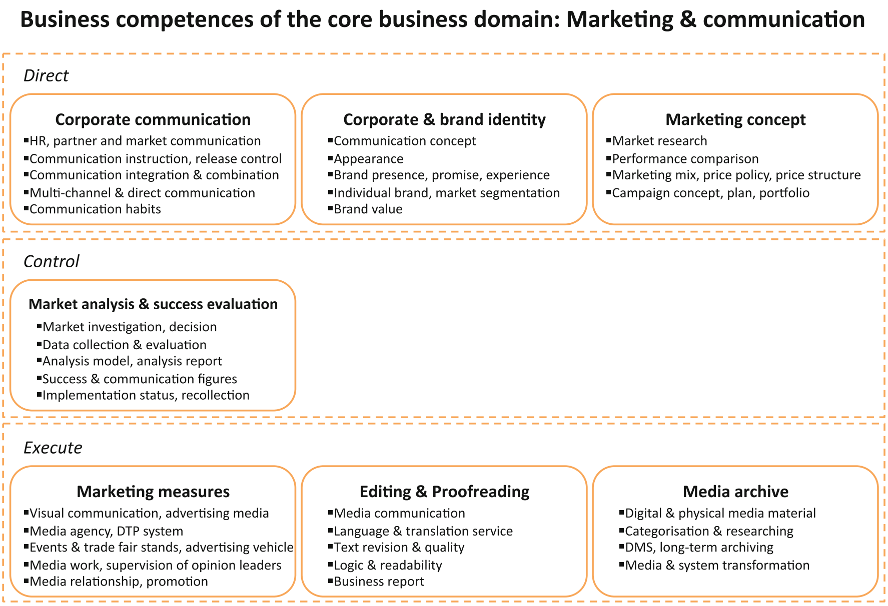

Fig. 3.28 The business competences of the domain "marketing and communication"

[41] For a closer look at assembly technology, please see the literature [94].

Control: • Market analysis and success evaluation
Execute: • Marketing measures
• Editing and proofreading
• Media archive

Direct Business Competences

The direct business competences must market channel-specific communications of the company, and those which span more than one channel, along with the corporate identities.

Corporate Communication

A company's reputation is heavily dependent on its communication; direction is provided principally by the business competence "goals, values, principles" from the domain "corporate leadership". Building on this, corporate communication can be divided into six reference groups with different orientations, which also have a complementary effect (see Fig. 3.29):

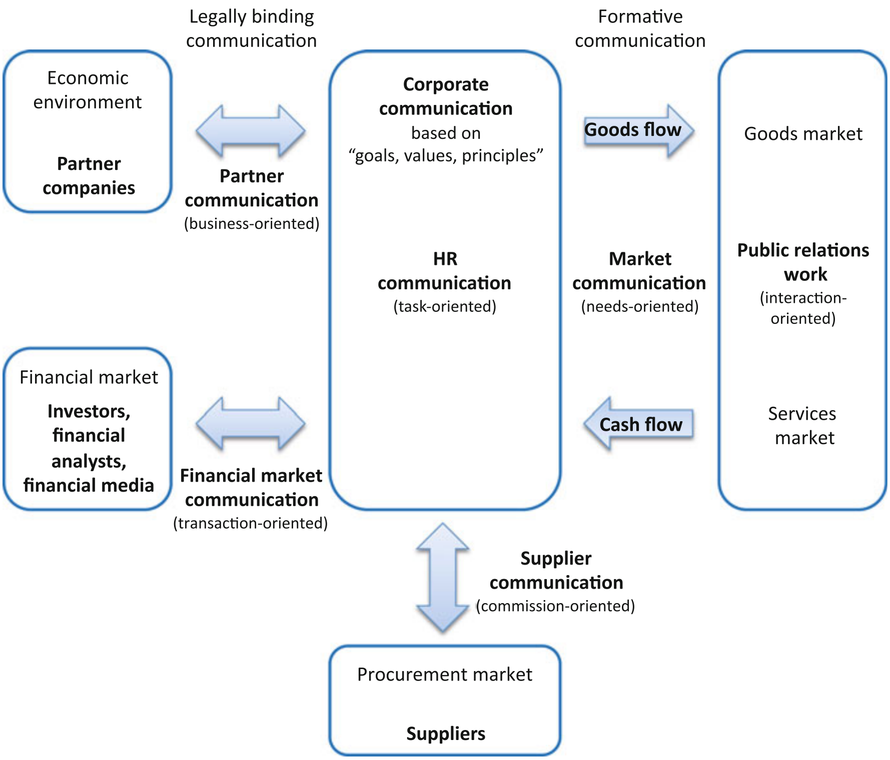

Fig. 3.29 Company communication for six reference groups with different orientations

- Task-oriented *human resources communication* not only follows internal information requirements. The dialogue with and between employees has the aim of designing a continuous flow and exchange of information, in order to influence motivation and identification with the company positively. In certain cases, both internal and organisation-specific communication can limit itself to selected target groups, such as individual locations or certain specialist fields. In times of crisis, it is indispensable.
- Business-oriented *partner communication* takes places between two or more cooperating partner companies which are legally and economically independent from one another, and which share a common goal [29]. More broadly speaking, communication between manufacturers and dealers can also be classified as belonging to this category.
- Need-oriented *market communication* is a crucial part of the value creation chain, and is managed via the design skills of the business competence "marketing concept". The reference group is made up of existing and potential customers.
- Transaction-oriented financial market communication is subject to legal regulations and constraints. It represents an obligatory form of communication to the investors, and forms the basis for financial analysts and the financial media as multipliers. The business competence "financial market communication" is part of the domain "finance and controlling".
- Public relations work has the aim of creating a relationship with a broad range of reference groups in an interaction-oriented way, which only has indirect effects on business success. In the foreground is the whole image of the company; this means that a link exists to the business competence "corporate and brand identity". Public relations work includes, for example, the promotion of social, cultural or sporting events. There is a lot of freedom in terms of how this type of communication can be shaped, and it is defined by the business competence "marketing measures".
- Order-oriented supplier communication is managed by the business competence "supplier relationship" from the domain "procurement and inbound logistics".

Using different information and communications systems and the integration of new communications channels and technologies, it is possible to achieve higher productivity in terms of contacts with the respective reference groups, to whom certain portals are allocated, such as an employee portal,[42] a supplier portal,[43] a portal for development-related information and applications,[44] a customer service portal[45] or a portal aimed at end customers.[46]

[42] "Daimler Employee Portal" http://enter.daimler.com. Accessed: 23 December 2014.

[43] "Daimler Supplier Portal" http://daimler.portal.covisint.com. Accessed: 23 December 2014.

[44] "Daimler Engineering Portal" https://daimler.portal.covisint.com/web/engineeringportal. Accessed: 23 December 2014.

[45] "Mercedes-Benz XENTRY Portal" http://xentryportal.i.daimler.com. Accessed: 26 July 2015.

[46] "Mercedes me" http://mercedes.me. Accessed: 23 December 2014.

In doing so, company communication must speak with a "single voice" and not contradict itself. There are clearly documented *communication instructions* with *release controls* for content, and internal and external uses of communications channels. Particularly critical are statements on current developments within the company – which is why there are clear rules for how employees should behave on social media, and a standardised concept for the use of systems for *communication integration and combination*, since digitalisation opened up a very broad range of possibilities in terms of *multi-channel and direct communication*.

In this context, the diversity of the generations plays a role in terms of their *communications habits* – especially when automotive companies need to target many different generations with similar products in the goods and services market.[47]

Corporate and Brand Identity

The business competence "goals, values, principles" from the domain "corporate leadership" gives direction in terms of a corporate identity which is distinguished in all its characteristics, and differentiates itself from other companies. The strategic orientations of the automotive sector include, for example, technology orientation or product and market fields. As such, the corporate identity represents a *communications concept* as part of which the relationship to employees, customers, suppliers, competitors and various external stakeholders is clarified. It can also result in attractiveness for the employer (see Table 2.1).

In order to guarantee that the company has a standardised *appearance*, rules and guidelines are used to establish and make available communications templates for various media and uses, such as

- the logo (colours, layout, proportions) and its use in combination with other logos,
- the fonts used,
- the selection criteria for images and diagrams,
- the nomenclature used in a broad range of language versions, and
- the colour palettes for the various communication methods.

For a more in-depth look at corporate identity, see the literature [15].

Even more than the company's appearance and behaviour, consumers perceive the *brand presence* through the *brand promise* and the resulting *brand experience*. Each brand represents both a symbolic and functional use. In many markets, vehicles are not used for the purpose of travel alone, but also represent a certain status in society. This is why brand identity continues to have a very high level of importance for vehicle manufacturers. The big players in the sector bring together different *individual brands* which are shaped differently and positioned in the market. Often, however, what is missing is an overlapping brand presence of the combined product and service ranges, such as that practised by Daimler with its brands moovel, car2go,

[47] For a closer look at company communication, please refer to the literature [176].

Blacklane, smart, Mercedes-Benz etc. via the corporate and brand communication "Mercedes me".[48]

In the automotive markets, attempts are made to classify customers with broadly homogeneous needs structures together, in segments. The most obvious segments are those vehicle classes available on the market (see Sect. 1.3). In terms of segments, many vehicle manufacturers continue to depend on technical criteria such as form, dimensions, performance data or equipment. Within the framework of the brand orientation for *market segmentation*, however, the vehicle models must be developed in accordance with the different lifestyles and the buying behaviour of potential customers. Single people, for example, display different buying behaviour to families, and cannot be allocated to a particular segment on the basis of technical criteria only. This is why criteria for segmentation must be selected on the basis of both emotional and rational purchasing needs.

The *brand value* is an important basis for customer perception in terms of strategic competition. In 2014, for example, Mercedes-Benz, BMW, Volkswagen and Audi were listed among the ten most valuable German companies by Interbrand.[49] On a global level, Toyota, Mercedes-Benz, BMW and Honda are among the 20 most valuable brands. A total of 16 automotive brands were listed in Interbrand's Top 100 in 2014.

For a more in-depth examination of the brands and their strategies, please see the literature [86].

Marketing Concept

The marketing concept deals intensively with sales markets. It takes care of market-appropriate communication and design of products and services, and of the corresponding market-appropriate prices. It therefore defines the basic structures which are related to the following three different characteristics:

- the whole company, with all sales markets and market services,
- a product brand or business unit with selected market segments and target groups, or
- a single market service with – for example – a particular market entry as motivation.

Daimler could be named as an overall company in this context, while a focused product brand would be Freightliner, and a single market service would be "Mercedes-Maybach Pullman".

In practice, concept creation starts with *market research*, which is often coordinated with external surveys or observations. *Performance comparisons* with other companies are usually carried out for the same sector in order to analyse the

[48] "Mercedes me" http://mercedes.me. Accessed: 23 December 2014.

[49] "2014 – Best Global Brands – Interbrand" http://bestglobalbrands.com/2014/ranking. Accessed: 23 December 2014.

current situations from it, to forecast possible relevant developments, and draw resulting conclusions from them. These conclusions can, for example, be ways of explaining the buying and use behaviour of customers, or be important indicators for determining prices. The actual analysis takes place as part of the business competence "market analysis and success evaluation".

The marketing concept establishes a combination of measures which can be used, based on the four fundamental instruments of marketing "Product, Price, Place, Promotion" [107]:

Product:	What is being offered, and what is expected?
Price:	On what conditions is the offer being made?
Place:	Where and how is the offer being made?
Promotion:	How are customer contacts maintained?

The combination of the instruments used is referred to as a *marketing mix*. This can create either individual measures or campaigns with a specific focus on more precise planning in terms of content and planning. *Price policy* in particular, with its setting and optimising of *price structures*, offers numerous ways of influencing sales, revenue and profits in a positive way. The price process for the regional and country-specific first price positioning of new models and model series often begins by analysing competitors' prices. Raising or lowering first price positionings in retrospect is only possible to a limited extent. Without IT systems, the price optimisations are not very manageable at all when it comes to price gaps between different motors, alternative drive concepts, series and special equipment, financing conditions etc. Usually, technical differentiation criteria are taken into account in the price setting decision, as shown in Table 3.2. For more on "improving yield on the market side", see [44].

Depending on the target group of the *campaign concept*, the *campaign plan* defines an implementation which is free of overlaps and contradictions via the *campaign portfolio*. Possible portfolio channels include, for example, advertising spots in radio and television, brochures, or the internet. Depending on the possibilities offered by the advertising channels, campaigns can be adjusted more subtly and optimised.

By shifting the product-centric view of the vehicle manufacturers to a customer-centric view in the mobility industry, a search for "customers for campaigns" turns

Table 3.2 Examples of technical differentiation criteria, as the basis for price setting decisions in accordance with [44]

Technical criterion	To be priced lower ...	... than
Dimensions	Stainless steel exhaust 30 cm	Stainless steel exhaust 50 cm
Material	Metal cross brace	Aluminium cross brace
Function	Unheated exterior mirror	Heated exterior mirror
Innovation	Windscreen	Windscreen with rain sensor

into "campaigns for customers". Along with the change of the user promise of the business model from an AUTOmobile to an autoMOBILE, this would mean a complete change to the company's marketing concept – especially as what was until now the largest emotional potential of the AUTOmobile is disappearing among customer groups of the autoMOBILE.

More in-depth treatment of the marketing concept is provided by further literature [108], in particular that [44] which focuses on further looks at marketing with the trends of the automotive industry.

Control Business Competences

The control business competences include market analyses, success evaluations and instruments, which are necessary in order to build up a long-term, continuous appearance in the interest of the company.

Market Analysis and Success Evaluation

Often, commercially operated market research institutes are commissioned with giving support in a *market investigation or decision* – for example, in terms of the development of a test market, the help of which it is expected will lead to the acceptance of a new vehicle, or in terms of a decision at an earlier stage of product development, at which the basic expansion of the product programme with a new vehicle is to be analysed.

The process is always similar, to a large extent. First of all, the orientation and conditions of the examination are determined, before the *analysis models* are defined for *data collection and evaluation*. Once the data collection and analysis have been implemented, the investigation is finalised by the *analysis report*, in which the results, conclusions and recommendations for action are recorded. The latter can lead to marketing measures, the successful implementation of which can be checked using further market analysis.

Marketing which is based on studies always results in uncertainties. Especially in terms of trend topics, market research institutes try to use surveys, statistics and studies to create representative inquiries and forecasts, so that they can make more general statements. To be precise, however, everything relies on random samples which are meant to be a "representative" subset with an equal distribution of all the characteristics which are characteristic for the investigation. In practice, random samples cannot be realised. But the precise criteria behind a quota sample are often only partially published, and are influenced by different interests. How can representative samples be determined if it is only through the investigation itself that it can be established which characteristics are really relevant for a forecast? How can it be guaranteed that, in surveys, replacement actions are not placed in the foreground or that a survey only confirms or answers what it wishes to expects to find out?[50]

[50]There are many uncertainties and issues which we cannot go into more detail about here, which is why we refer to the literature [14] for a more in-depth look at market research.

In the next Chap. 4, we will go into more detail about possible analysis models, taking into account the diverse range of external and internal influencing factors in the environment of the automotive sector.

In practice, attempts are made to control the marketing measures and communications of the company efficiently via *success and communication figures*, by regularly checking and documenting the *implementation status* with an evaluation of effectiveness [115]. In marketing and communication, quantitative measurements are only possible with great difficulty. In terms of quality it is about relevance for target groups – that means how the advertising is understood, and whether it has a motivating effect. Its effectiveness is measured by the level of *advertisement recollection* – because even the best advertising becomes irrelevant if it is not memorable enough.

Execute Business Competences

The execute business competences are "marketing measures", "editing and proofreading" and "media archive".

Marketing Measures

With the marketing mix, which is planned operatively, the goals and strategies of the "marketing concept" are implemented through specific measures. The company has many options in terms of how it chooses to achieve this. In the case of an AUTOmobile, informative advertising is not enough in order to differentiate oneself in the market – instead, the marketing must make it possible to see and experience great emotional potential. One of the most important techniques here is *visual communication*. In the advertising, a conscious choice is made to combine vehicle and people so that the target group can identify with the product. Alongside personal communication, mass communication is traditionally also used – which means, for example, that focuses are placed on specific formalities of the vehicle image.

In the automotive industry, the traditional *advertising media* such as ads and supplements in print media such as newspapers, magazines and books are almost exclusively taken up by *media agencies*. While the computer-aided use of high-quality documents via *DTP systems* (Desktop Publishing) is no longer as complex as it once was, the use of interactive multimedia systems in marketing is still a new phenomenon.

A focus of the advertising budget remains the planning and supervision of *events and trade fair stands*. The five largest automotive trade fairs in the world include:

Germany:	"International Motor Show"
United States:	"North American International Auto Show"
France:	"Mondial de l'Automobile"
Switzerland:	"Geneva International Motor Show"
Japan:	"Tokyo Motor Show"

As a result of interconnections and new digital thematic focuses in the autoMOBILE, these traditional automotive trade fairs are being joined by increasingly significant non-auto events such as the CeBIT IT fair in Hanover, or the entertainment electronics Consumer Electronics Show (CES) in Las Vegas.

At these events, marketing not only coordinates the stands of the presentation and *advertising vehicles* used, but also the rooms, decorations, refreshments, technology, free gifts, entertainment etc. for the journalists and all interested parties. Specialised *media work* and communications are prepared within the framework of the *supervision of opinion leaders* for the press, journalists or VIPs, specifically to increase sales. In addition to large-scale events, there are also a great number of regional events such as press conferences or sports and cultural events – which are equally important for a sustainable *media relationship*, and which require that enquiries from media, journalists and other multipliers be dealt with carefully.

Every vehicle manufacturer has an own museum near its headquarters which is often managed externally. Nonetheless, the responsibility for the implemented appearance lies with the business competence "marketing measures". In the digital era, however, traditional museums are changing too – and with them, the task areas of the business competence. An example is the "Autostadt" attraction about everything to do with Volkswagen – an interactive experience in the German town of Wolfsburg.

The *promotion* of social, cultural or sport institutes must not always be directly connected to the company. The target group of the young, mobile generation would prefer to make use of the products on offer in a self-determined way. In this context, the internet and social media are gaining new significance in terms of marketing – where Google has achieved market penetration which is way out of the league of traditional vehicle manufacturers, who tend to see their potential buyers as being from the older generations.

Editing and Proofreading

As part of *media communications*, vehicle manufacturers create numerous marketing documents such as press releases, presentations or websites. The company has, however, many more types of external information and documents which are created during product development (see Sect. 2.3.3). Instruction manuals and relevant advice, for example, are particularly critical for smooth customer service in dealer's garage all over the world because language barriers must not be allowed to stand in the way of communication. In order to deal with this, *language and translation services* from the business competence "assistance" in the domain of "corporate support service" must be coordinated and integrated.

This business competence has a crucial operative role in the release control of "corporate communication". It is not just about *text revision and quality* or checking content, but also about taking "corporate and brand identity" into account. "Financial market communication" has particular significance in terms of *logic and readability* in the business domain "finance and controlling" when it comes to *business reports*, in which text by a broad range of internal and external authors is brought together in one document.

Media Archive

As part of media communication, the print media and image archives manage all *digital and physical media material* which have been created. They provide support with *categorising and researching* archived communications. Over the past few years, *DMSs* have taken on central importance, because a large proportion of communications can be saved electronically. While physical vehicles are kept and maintained in museums, other problems are posed by the *long-term archiving* of electronic information. Due to the low preservability of data media and data formats, losses of information can occur – for example because the archived data are no longer readable after a *media and system transformation*. Proprietary formats and copyright restrictions can cause difficulties – something which applies, for example, to CAD data.

3.6.6 Sales and Outbound Logistics

Sales and distribution is what joins together the three reference groups of production, dealers and end customers; while products and services are converted into the flow of funds via partner and market communication (see Fig. 3.29). It would actually be more accurate to refer to sales as direct contact with customers. In the automotive industry, however, it is mainly only indirect sales which come about via authorised dealers. Contact with customers only occurs in the case of business and special customers, via direct sales. These can include authorities, large customers who own a vehicle fleet, employees, VIPs or journalists.

We introduced the business domain "marketing and communication" as the domain in which there is currently a shift in focus from the procurement market to the sales market in the chain of core business domains. Sales must link the sales concept with the marketing concept for the customer (see Fig. 3.30). Traditional vehicle manufacturers orient themselves primarily towards their sales concepts –

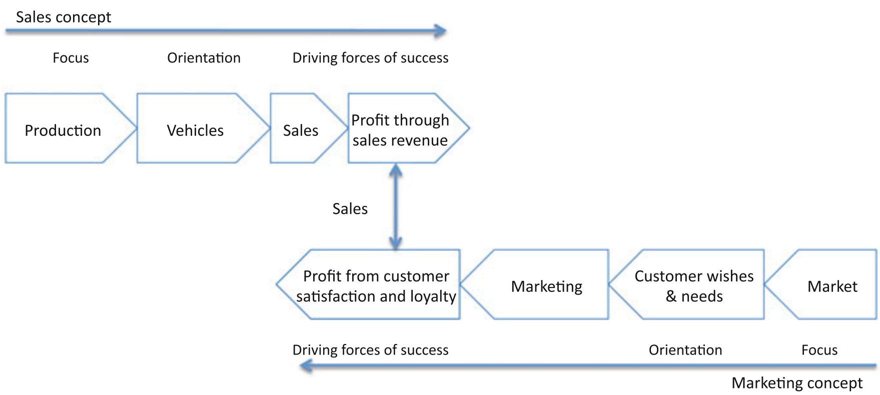

Fig. 3.30 Linking the sales concept to the marketing concept

which means that sales strive to generate a profit through revenue. The marketing concept, on the other hand, orients itself primarily towards customers' wishes and needs, with the aim of generating profit by achieving customer satisfaction and loyalty. With the development of a mobility industry at the latest, sales must link the two concepts with each other in a coordinated way, because mobility service providers primarily orient themselves towards the marketing concept. Sales is therefore broader in our scope – because fundamentally, sales only include the customer care which is directly linked to closing a sale.

In [134], August-Wilhelm Scheer makes it clear that the "Procurement and Distribution Logistics" he lists are similar to each other in terms of many functions and processes, or that this was certainly the case when the book was published – even if they tend to be dealt with separately in business economics. By detailing business competences and as a result of the changes occurring in digitalisation, we can see that inbound and outbound logistics cannot – not even just parts of them – be classified as being part of a separate business domain.

The domain of "sales and outbound logistics" includes the following eight business competences (see Fig. 3.31):

Direct:
- Sales strategy and client
- Sales, demand, stock
- Distribution system

Control:
- Sales performance
- Distribution optimisation

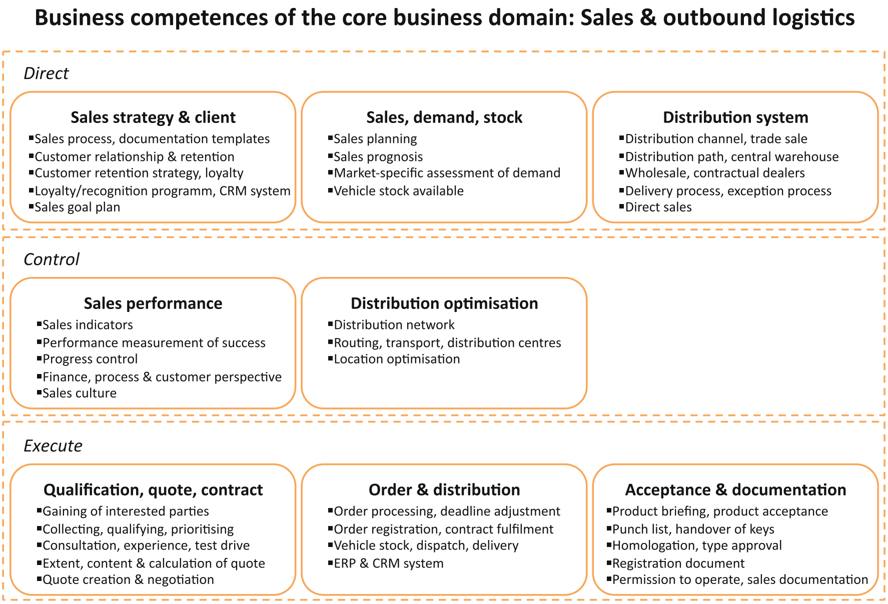

Fig. 3.31 The business competences of the domain "sales and outbound logistics"

Execute:
- Qualification, quote, contract
- Order and distribution
- Acceptance and documentation

Direct Business Competences

The numerous new digital media demand that automotive companies develop new sales strategies so that vehicles can be made accessible to customers and potential new customers in new ways. In addition to the increasingly customer-oriented business competence "sales strategy and client", planning competences such as "sales, demand, stock" and the sales-logistical management of the "distribution channel" are also necessary.

Sales Strategy and Client

As part of the sales and distribution strategy, the *sales processes* are designed and are each adapted to the market and product. A central process is sales – which is overwhelmingly managed in the three phases of pre-sales, sales and after-sales. Automotive companies have differently formed sales processes in the three sales phases – beginning with a potential which is identified, and from which a qualified interested party, and then a customer, can develop. In particular, the process of selling services is different to that of selling products – because the customer's buying process is different. Differences in vehicle sales can also be seen when a comparison is made between build to order with build to stock. Figure 3.32 shows a simplified sales process over the three sales phases. The sales measures throughout the process mainly use the possibilities offered by the marketing mix, which necessitates close collaboration with the business competence "marketing concept" from the domain "marketing and communication". As part of this collaboration, on the one hand all documents are given a standardised appearance, while on the other, their completeness and quality is guaranteed using *documentation templates*. In this

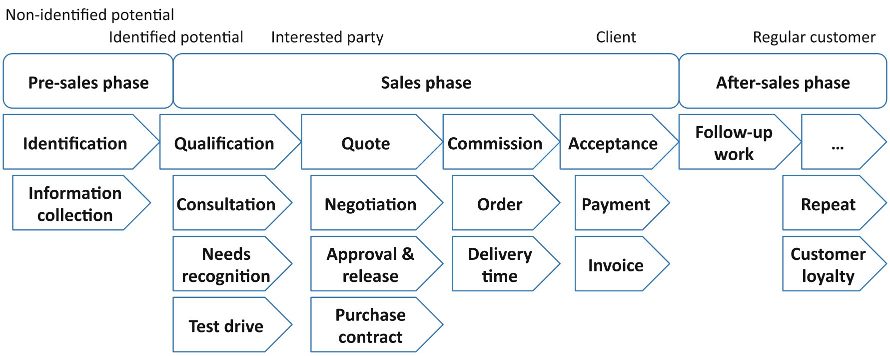

Fig. 3.32 Simplified sales process with some measures spanning the three sales phases of pre-sales, sales and after-sales. The distribution measures throughout the process focus mainly on the possibilities offered by the marketing mix

way, exemplary contracts are defined – the content of which is created while taking into account legal constraints.

The development of the *customer relationship and retention* to a regular client takes longer than is suggested in Fig. 3.32. Ever since the connected vehicle has been around, the customer relationship has been about more than just the sale of the vehicle – which means that direct and sustainable customer contacts give a business more significance. Salespeople who act solely in accordance with the sales concept (see Fig. 3.30) will only be trusted by clients to a limited extent. While it may nowadays be debatable whether customers make purchase decisions based more on reason or not – what is for sure is that buyers now often go through sales halls in a more goal-oriented way than they used to, because they are already better informed about products than was possible before the digital era.

A *customer retention strategy* includes much more than just the administration of the customer's entire contractual history in order to gain a *customer's loyalty*. The sales concept must create spaces and sustainable qualifications among sales representatives, so that they understand clients and can develop a relationship based on customer loyalty. The customer segment of the classic brand buyers with whom a salesperson with simple training simply carries out transactions, is becoming increasingly smaller. Due to the demand for the individualisation of products and due to changing purchase behaviour, new types of sales training are becoming relevant – as demonstrated by BMW through its introduction of the role of "Product Geniuses" in its corporate strategy (see Sect. 3.1.1).

The automotive sector still finds it difficult to create *loyalty/recognition programmes* such as those which have been common for years in retail or with airlines. Should it be possible to collect points for the number of kilometres driven or the number of visits made to the dealer's repair shop? And if so, what should it be possible to use the points for? It would surely not be a good idea to offer even more discounts in a sales-driven industry. This would mean that a mobility industry could develop more quickly.

On the other hand, more long-term approaches from traditional vehicle manufacturers for the management and carrying out of all interactive processes with customers are based on Customer Relationship Management (CRM) IT systems. With the help of customer loyalty processes in addition to customer information such as potential, profitability, satisfaction and connection, the focus of *CRM systems* [121] is only consistently orienting company activities towards the needs of customers in terms of holistic customer care. Even today, however, implementation in practice – via a huge range of communication channels and the customer contacts of an automotive company with its extensive distribution channels – has only occurred in certain areas. While vehicle manufacturers have created the internationally standardised Vehicle Identification Number (VIN) with which every vehicle can be clearly identified, they have no 100 %-secure way of identifying customers.

A *sales goal plan* for the orientation of sales services provides more familiar models for sales management in order to turn clients into regular customers in traditional ways. In accordance with the segmented target groups established in marketing, operative sales management guides potential ways of generating revenue and allocated the funds needed to reach the goals which have been set. The resulting operative plan of measures for sales contains specific actions, often with goals for each month or quarter.

For a more detailed discussion of sales strategy and how to gain customer loyalty in the automotive industry, please see the literature [139].

Sales, Demand, Stock

Sales planning must be used to guarantee that the products and services being offered can be sold for a profit. The following are crucial for each product which needs to be sold:

- the *sales prognosis*, which forecasts the future market and sales volume of the product,
- *market-specific assessment of demand* from the point of view of sales, and
- the *vehicle stock available* in the dealer network.

When new vehicle models are brought onto the market, sales forecasts can be based on the analysis results of the test markets which were developed through the business competence "market analysis and success evaluation" from the domain "marketing and communication". The market-specific assessment of demand is carried out in close cooperation with the business competence "procurement optimisation" from the domain "procurement and inbound logistics", because the market-oriented sales view must be compared with the possibilities of stationary production sites and their inventories. In the case of place-bound vehicle stocks, used vehicles are also taken into account. Sales can influence the market situation through the configuration of used vehicles which are less than a year old.

Sales and demand planning are obviously just as relevant for build to order as for build to stock. The basic mathematical models are similar to the descriptions in the business competence "procurement optimisation". However, plans in sales are less precise and must take into account many other circumstances – such as the "distribution system", in addition to markets. Similarly, campaigns from the business competence "marketing concept" from the domain "marketing and communication" can have tangible influences on forecasts.[51]

Distribution System

In order to guarantee the physical availability of its products for the end customer, the sales team plans and leads the goods flow via various *distribution channels*. The automotive industry usually uses the channel of *trade sales*, as part of which several levels of indirect sales occur via wholesale and further contractual or independent dealers. Within the channel, many different *distribution paths* are possible in order

[51] For a more in-depth look at sales and demand planning with specific cases from German vehicle manufacturers, please see the literature [46].

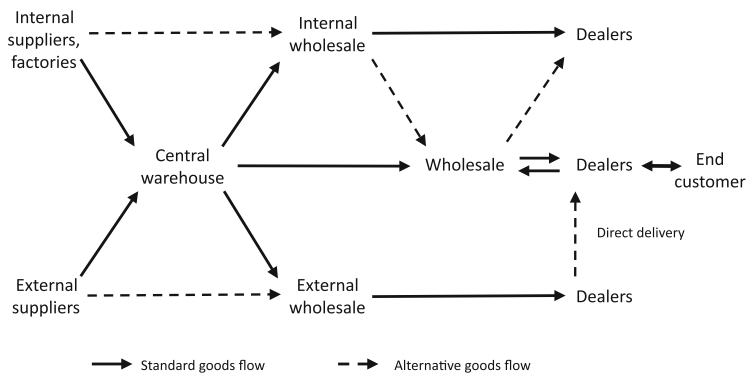

Fig. 3.33 Example of indirect distribution on many levels, via wholesale and further contractual dealers or independent dealers

to deliver the goods produced to the end customer via the dealer. In planning, the structure of the distribution paths is designed and documented via *central warehouses, wholesale and contractual dealers* or independent dealers, as shown in Fig. 3.33. A central warehouse is only used by globally organised automotive companies in order to group goods flows, and therefore to reduce inventories and floor space required in the overall system. In the case of Daimler, for example, the three-level distribution system is set up centrally with a holistic stock and warehouse plan. The central warehouse "Global Logistics Center"[52] delivers to 280 locations in 160 countries, including all wholesale warehouses. As a second level, wholesale supplies dealers and customer services with parts which are needed by the market. Alongside the standardised *delivery process*, there are also alternative goods flows or individual special solutions such as an *exception process* for more rapid deliveries in the event of a bottleneck.

Figure 3.33 also shows the possibility of direct delivery between dealers – something which, depending on the market, can be critical for efficient procurement, but also affords dealers greater flexibility. In Australia, for example, direct delivery between dealers is very common in practice, because delivery of spare parts from overseas would take too long for most customers. For this reason, Australian dealers distribute all relevant spare parts over their warehouses, and help each other out in case of shortages. Operative logistics for the carrying out of orders takes place as part of the business competence "Order and Distribution".

During the planning of indirect distribution, conflicts of objectives in the manufacturer-dealer relationship must be taken into account. These could involve a manufacturer demanding that the dealer be loyal exclusively to his brand, while the dealer wishes for a certain degree of independence and freedom to make his own

[52] "Mercedes-Benz Global Logistics Center" http://aftersales.mercedes-benz.com/info/logistik. Accessed: 26 July 2015.

economic decisions. Furthermore, not every dealer will want to be responsible only for those areas of the market which the manufacturer suggests.

The opposite of trade sales are *direct sales*, as part of which the goods produced are sold directly from the manufacturer to the end customer. This type of distribution channel is not yet widespread in the automotive branch, but is becoming more and more attractive for manufacturers thanks to the internet and direct mobile interaction with the end customer [43]. BMW, for example, wishes in particular to build up a new customer interface for the BMW i brand – using a mobile sales team, the internet, and telephone-based information and customer services (see corporate strategy in Sect. 3.1.1). It also remains to be seen how it will be possible to introduce direct sales in the United States. As early as a decade ago, Ford and General Motors tried this on the American market, but failed because of the numerous state regulations which intervene in direct sales. More recently, however, Tesla Motors has tried to implement direct sales.[53]

In summary, the following are the five main definitions and documentation fields for the planning and management of the distribution system:

Structure	of the distribution channels and paths,
Processes	of delivery and order processing, including special cases with special delivery service,
Warehousing	about the number of warehouses required, their locations, size, company form (in-house or external), warehouse design and size of respective stocks,
Transport	through the selection of transport modes, transport routes and company form (in-house or external) and
Packaging	of the different modes, with functions for transport, warehousing or general protection.

The overall concept of the distribution system includes the integration of the distribution channels.

As shown in [134], these planning areas are very similar to the business competence "logistics planning and management" from the domain "procurement and inbound logistics" (see Fig. 3.21). The significant difference is in that the focus of logistics moves from the product to the end customer. Additionally, distribution and logistics have different expectations in terms of delivery, especially in direct sales.[54]

[53] http://www.autonews.com/article/20140616/RETAIL07/306169943/state-franchise-laws-sparked-by-tesla-go-too-far-other-automakers. Accessed: 19 December 2014.

[54] For a more in-depth look at the logistics of distribution and spare parts, see the literature [93].

Control Business Competences

Sales and distribution can be optimised using many quantitative and qualitative measurement methods. We will only address a few possibilities from the business competences "sales performance" and "distribution optimisation".[55]

Sales Performance

What is sales performance? A short definition would be the ratio of a dealer's revenue and the number of his salespeople during a defined period. So, is the goal to sell as many vehicles as possible with as few salespeople as possible? This can be easy to achieve if the price is low enough, but in this case the profit margin will be probably be low too. This is why *sales indicators* are needed. In this combination they are not so easy to achieve, but can be measured easily – for example, if many vehicles are sold and a high profit is achieved by not giving many discounts. In this case, the performance would be defined as a clear *measurement of success*. Combinations like these can also mean different sales performances – depending, for example, on whether the customers are new or regulars. However, sales processes with many measures (see Fig. 3.32) take place over three phases – which means more than just a single action. As a result of this, in addition to success measurement, documented *progress control* is also required in order to monitor the longer sales process – especially when the aim is to achieve a more long-term customer relationship and customer satisfaction via the business competence "sales strategy and client". The *financial perspective* of sales management therefore broadens to include a *process and customer perspective*. Of course, in those cases in which the sales process concentrates on purchase or non-purchase only – for example in the case of used vehicles – walk-in customers are served too. But even customers such as these can be prepared to make further purchases if the sales department highlights the right customer information.

If one considers that the pre-sales phase begins with the first personal contact with the salesperson, then in the automotive industry, sales controls are still set up in a traditional way with their sales indicators systems. Many people know that salespeople are driven by external forces – because their pay varies depending on their success measurement. This leads to mistrust, and suggests the use of the internet as a first source of information. As such, the actual competition for interested parties begins with the Google search. But even in the digital age, it is well known that the results given by search engines are controlled by external parties, and are not always in the interests of the customer. What is crucial is that both the sales processes and the *sales culture* be constantly broadened and improved with new media.

[55]For a more detailed look at distribution control with improvement measures, please see the literature [99].

Distribution Optimisation

A global automotive company has a double-digit number of production sites, and delivers to thousands of dealers and repair shops worldwide. In practice, over the years, many distribution paths and transshipment points have come about in multi-level sales which were originally not planned. Often, new, alternative goods flows develop alongside the originally planned standard goods flows (see Fig. 3.33), with the result that complex *distribution networks* are created – whether they are organised centrally or are decentralised. Models and procedures from *routing, transport, and distribution centres* must be developed from different perspectives in order to pursue the chronological process of the goods flows step-by-step and to optimise them in a targeted way – a business competence which is usually taken care of mainly by logistics companies. It is the automotive companies, however, who bear responsibility for delivery to the end customer – and are the decision-makers in the case of optimisation measures, for example in the case of *location optimisations*. But "smaller-scale" measures can have effects on other business competences too, such as improved packaging which is more lightweight, or more environmentally-friendly constituent parts which must also be suited to the developed product.[56]

Execute Business Competences

The main execute business competences "qualification, quote, contract", "order and distribution" and "acceptance and documentation" operationalise the sales process (see Fig. 3.32). The operative sales phase is concluded when the product is handed over and accepted. The after-sales phase is covered via the documentation.

Qualification, Quote, Contract

The pre-sales phase can also be seen as part of the marketing, because the *gaining of interested parties* can take place through contacts or reactions to "marketing measures" from the business domain of "marketing and communication". Interested parties can contact sales by sending an enquiry, or by registering with them. Only after the *collecting, qualifying and prioritising* of the enquiries, however, can the actual sale begin with the *consultation*. The usual qualifications include clarifying the interested party's price framework, and working out which time period his investment decision is planned for. Many digital possibilities and systems support sales with information and new *experiences*, for example with an interactive showroom such as that made possible by Audi in its strategy (see Sect. 3.1.2) with the digital sales format "Audi City". Nonetheless, potential customers often only whether they want a specific quote after a real *test drive* in their desired vehicle. Could it be that the test drive is the crucial reason why traditional dealers still exist? Obviously, test drives are difficult to implement through online direct sales. It would be conceivable that mobility service providers could take over the provision of test drive vehicles through their car-sharing programmes. In Sect. 3.1, we showed that BMW and Daimler offer their own car-sharing programmes.

[56]Please see the literature [143] on improved optimisation of distribution networks.

The crucial sales phase is the clarification of the *extent, content and calculation of the quote*. In order to be able to create a quote, the customer's wishes are coordinated with the technical, scheduling-related and legal feasibility, as well as with the enterprise-wide provisions. It is still too often the case with dealers that a quote is only calculated once the extent and content have been clarified. This process usually has technical reasons, but nonetheless restricts both customer and salesperson during the *quote creation and negotiation* in order to agree on a price. Customers would much rather be able to see their own individual price for several quote variants during an interactive conversation about extent and content. Numerous conditions – such as market dependencies, list prices, discount classes – and customer wishes – such as price frameworks or the part exchange of the used vehicle – do not constantly undergo total change, and therefore need no new overall calculation.

During quote creation, the sales department integrates all of the customer's wishes. The strictly regulated finance and insurance products, however, are taken on by the business competence "evaluation and sustainability" from the domain "financial service", by which the creditworthiness of the interested party is defined, for example.

A binding quote which includes a contractual document must be subjected to specified approval guidelines and signature regulations. In a CRM system, it is not only quote adjustments which are managed in cooperation with the customer, but also the contractual history and communications which accompany the contract. In this way, the current quote and contractual stocks remain easy-to-understand. It can also be the case that changes need to be made to existing quotes and contracts. This is the case, for example, for legal conditions which have been changed.

Order and Distribution

When agreement is reached and the contract between the interested party and the salesperson is signed, the order is created. The business process of *order processing* along with product development (see Sect. 2.2) provides the structure of the vehicle manufacturer's value creation chain. The *deadline adjustment* for vehicle delivery varies after the decoupling point of the order-anonymous and order-related parts of the value creation chain (see Fig. 2.2). There are different reference models for how to coordinate sales process, customer order processing and product development with one another; please refer to the further literature [26].

From the point of the *order registration* onwards, the process of *contract fulfilment* is monitored. Irrespective of the usual status checks by sales, customers who can be contacted via their mobile devices should be involved much more. Many current measures are conceivable in order to make the pre-sales phase more rich in experiences for the interested party, but it is all too rare that the fulfilment of the contract is made into an experience for the customer. Why shouldn't customers be able to follow the assembly of their build to order vehicle in real time on their smartphone? But even if it is just about calling up existing *vehicle stocks*, customers could be able to experience the *dispatch* or *delivery* of their future vehicles – from distribution logistics to handover.

In the case of build to stock, vehicle stock management can take place centrally or in a decentralised way. Central administration and management makes it possible to balance out local vehicle stocks, even across market and country borders – which also applies to spare parts.

ERP and CRM systems are usually used in combination in order to manage and implement the sales and distribution processes. A more detailed description of the interplay between systems can be found in the further literature [87].

Acceptance and Documentation

Alongside *product briefing*, the usual processes in vehicle handover include accompanying the *product acceptance* by the customer. Some dealers have their own repair shops, and are therefore closely linked to the business domain of "after-sales support". This guarantees the presence of specialist who register *punch lists* and deal with them in the short term.

In traditional vehicle sales, the *handover of the keys* is still celebrated as the "key experience". For particularly "emotional" handovers, there are artisan craftspeople who have specialised in creating a case for the keys in high-grade wood, silver or gold, and can even decorate the case with diamonds. Such a special key experience cannot be created directly or visibly by a digital key used at handover, when all that is handed over is a code. The key experience then tends to take place during very comfortable use – for example when the whole family is in the vehicle, or in the case of a car-sharing vehicle when it is used in public, business-related or private fleets.

A part of the handover is also the customer invoice which has been prepared. Invoicing and accounting for the purchased vehicle take place as part of the business competence "accounting, financial statement" from the domain "finance and controlling", which takes into account the accounting rules and contract-specific discounts. Depending on the company structure, however, the sales department may take care of customer-specific communication in the case of payment arrears.

Before handover, the sales department guarantees country-specific *homologation* for the approval of the vehicles and vehicle parts being sold. On the other hand, the business competence "testing and validation" from the domain "research and development" takes care of the general *type approval* of vehicles and vehicle parts in more than one country. Independently of the contract design, it tends to be the sales department which takes care of getting the vehicle approved by the local registration authority.

The sales department brings together all the documentation – such as test results and *registration documents* – which is needed in order to prove that the vehicle sold has *permission to operate*. The *sales documentation* also includes all information which is made available for the sales process, and has been created during the course of it – such as sales-relevant vehicle descriptions and price structures, with market-specific rules about equipment options. Quotes, contracts, orders and invoices, on the other hand, are created at the same time as first production, and the modification history. When all documents are brought together centrally, it is not just about putting them in a DMS, but also about automated verifications on data quality and completeness, in accordance with the templates defined by the business competence "sales strategy and client".

3.6.7 Financial Service

The aim of the "financial service" domain is to promote the sale of the product to be sold by the automotive company and its dealers, for example by way of leasing and financing offers for customers. Most vehicle manufacturers have built up their own banks for this purpose as subsidiary companies, in order to strengthen the sales-oriented part of the value creation chain, and some of them expand their automotive financial services with additional business areas and investments or credit cards for private customers, such as "Daimler Financial Services" or "BMW Bank". In contrast, the "Toyota Credit bank" ("Toyota Financial Services") concentrates on financing and insurance for automobiles.

American vehicle manufacturers are known as pioneers when it comes to establishing banks with links to manufacturers. They recognised very early on that the possibility of paying in instalments considerably increases vehicle sales, because many potential customers do not have the liquidity to pay the whole sum at once. As early as 1926, Ford established the first bank linked to a manufacturer in Germany, while Volkswagen began by creating a financing company in 1949. It was not until 1966 that the first German automobile leasing society was founded by Volkswagen. It followed the American method of vehicle procurement. BMW followed suit in 1971 with its own bank. Finally, in 1979, Daimler-Benz AG founded Mercedes Leasing GmbH, which became Mercedes-Benz Finanz GmbH in 1987 when it became a financing company.

The domain of "financial service" includes the following seven business competences (see Fig. 3.34):

Direct:
- Financial service strategy
- Guideline, process, risk

Control:
- Evaluation and sustainability
- Performance measurement

Execute:
- Financial service contract
- Bank and credit
- Insurance

Direct Business Competences

Business in financial services must fulfil other regulatory requirements than those that vehicle development or vehicle sales must. As such, the direct business competences in this domain in particular have very different focuses to those in the other business domains of the automotive industry (see Fig. 3.7).

Furthermore, the business domain "financial service" is mainly digital. As an IT system failure tends to have wide-reaching effects on and costs for the company

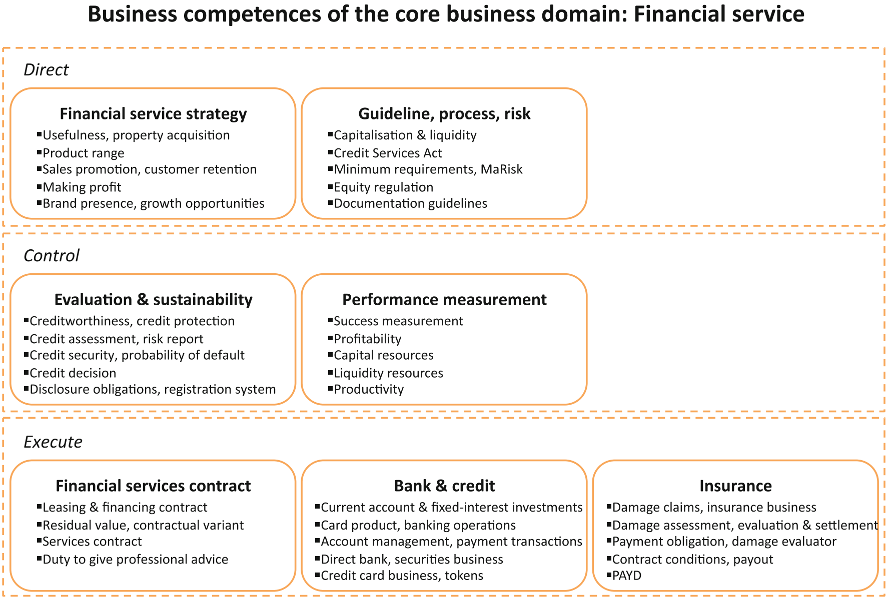

Fig. 3.34 The business competences of the domain "financial service"

affected, this business domain is not only business-critical in comparison to the others – it is extremely critical for the company. A failure of business-critical IT systems tends to have wide-reaching effects on the company affected, and is associated with high costs. A failure of company-critical IT systems, meanwhile, can be almost catastrophic. Banks, for example, must close if they become insolvent – whether this is because of their lack of liquidity or due to the relevant IT systems not working.

Financial Service Strategy

In the business competence of "corporate strategy" from the domain "corporate leadership", the basic product and service portfolio is strategically designed. Even today, however, financial services already have special status and not only derive a mid- to long-term strategy from their corporate strategy, but also give it new orientations in some automotive companies. German automotive banks in particular focus more and more on the idea of *usefulness* rather than on *property acquisition*. The concept of leasing was only the first step here. Today, the *product range* offered by Daimler Financial Services not only consists of the usual leasing and financing offers and financial services for dealers' businesses, but also manages vehicle fleets, develops mobility services, and offers insurance and bank services. The Daimler Annual Report 2013 lists the following range of services:

Financing:	Monthly instalments, flexible contractual duration, flexible advance payment, final instalment financing
Dealer financing:	Financing of stock vehicles, properties, repair shops, insurance for operational risks
Leasing:	Flexibility in terms of mileage, flexibility in terms of the monthly payment, operate lease/finance lease, full-service leasing
Insurance:	Vehicle insurance, warranty extension, industry insurance, employee insurance
Fleet management:	Fleet full service leasing, fleet (mobility) services, fleet insurance, fleet reporting
Investments and credit cards:	Time deposits, money market accounts, saving plans, credit cards
Mobility services:	Route planner moovel, Carsharing car2go, taxi orders myTaxi etc.

This product range is a strategic concept in order to expand direct sales in every part of the automotive company. By financing and insuring dealers, it supports the business domain "sales and outbound logistics" and the dealers who are served by "after-sales support". Financing and leasing also bring about more advantages in terms of *sales promotion, customer retention* and *making profit*. Customer retention is a direct result of the contractually regulated customer contacts in regulated financial business. Investments and credit cards can help to gain new customers more easily, and to reduce the risks associated with the creditworthiness of the party interested in making a purchase.

Fleet management and, in particular, mobility services, broaden the service range of the domain "financial service" in a whole host of business models – such as the Mercedes-Benz Rent captive car rental, the Mercedes-Benz Driving Academy safety training fleet, or the CharterWay rental fleet for commercial vehicle transport demands. One of the main effects is that the *brand presence* is strengthened in commercial vehicle fleets.

Furthermore, the mobility services no longer apply solely to the company's own vehicle manufacturing. In moovel, for example, many other mobility options are integrated for route planning. Via the telematics solution by Daimler FleetBoard, the management supports a vehicle fleet which must not necessarily be made up exclusively of Mercedes-Benz commercial vehicles.

It is understandable that business models such as these, which can only be developed in the business domain of one of today's vehicle manufacturers, have particular significance for the realisation of new *growth opportunities*. Just to expand the business domain nominally with finance and mobility services – as Daimler does with its Financial Services business branch – cannot be a long-term solution. New value-added services must be able to develop away from the strictly regulated financial services.

Guideline, Process, Risk

By offering finance and insurance products, the regulatory requirements made of *capitalisation and liquidity* must be fulfilled, along with the implementation of strict processes in order to comply with the German *Credit Services Act (KWG)*. On the one hand, this law aims to ensure and maintain the functionality of the credit industry – but on the other hand, it must also protect creditors from losing their deposits. Alongside default risks, automotive banks must also manage regulated processes for the administration of client accounts and insurance products. For *minimum requirements*, the financial market authorities use instruments such as *MaRisk*, which are aimed at credit institutes and the insurance industry. Bank regulations also include *equity regulations* such as Basel III. We refer to further literature [59, 150], which goes into more detail about the processes for complying with the requirements of regulatory guidelines.

The *documentation guidelines* and reporting channels of all processes and activities are coordinated with the business competences "integrity and law" and "risks and Finance" from the domain "corporate leadership".

Control Business Competences

Particularly critical for the existence of any company in the financial services industry is the auditing business competence of "evaluation and sustainability". The overlapping "financial control system" provides the monitoring instruments which are necessary for the industry's operation.

Evaluation and Sustainability

Depending on the automotive bank's strategic orientation, the services it offers will serve different groups of customers – whose *creditworthiness*, reliability and solvency must be defined and evaluated for the purposes of *credit protection*. This happens with the help of *credit assessments*, a credit report or self-disclosure from private individuals, by obtaining external reports about business customers, and evaluating business customers on the basis of their balance sheets. "Financial market communication" from the business domain "finance and controlling" consolidates the *risk reports* for investors as part of the business reports which are published. These evaluations are not an one-off – instead, they must be checked regularly and kept up-to-date with new evaluations. If the security values change too much, this can also lead to the adaptation of supplementary requirements during the contractual period. In the case of commercial customers, an overall view also needs to be created which includes the customers linked to him – so that their *credit securities* can also be taken into account in the calculation of the *probability of default*. It is only then, on this basis, that a documented *credit decision* takes place.

In addition to credit reports, there are also numerous other regulated *disclosure obligations* which are prescribed in order to ensure the stability of the financial system. For the *registration system*, most automotive banks use standard software.[57]

[57] A more in-depth insight into the reporting of credit institutes is given by the literature [80].

Performance Measurement

Regulations have led to a degree of complexity in the field of financial services which means that *success measurement* can no longer take place without indicators. The number of regulations increased due to the constant development of IT systems and their digital measurement methods – to such an extent that they now have to be reduced to a number that is manageable for banks. In the literature, [18] there are over 100 key indicators just for *profitability, capital resources, liquidity resources and productivity*. In practice, one finds systems in the developed structures of the automotive companies which have well over 100 key indicators. But the definition and provision of key indicators alone is not enough to identify those which are relevant for the management of the product range and the associated contracts.

Many more experience values are needed, however, for the targeted management of investments in mobility services. Only in very few cases is it possible to limit oneself to profitability alone in the case of topics which are still new.

Execute Business Competences

The execute business competences include respecting the regulations and legislation in the context of all contracts in the field of financial services and the operative processing of agreements which have been concluded. We will not list mobility services as a business competence in their own right. While, nowadays, they are placed in this business domain from the point of view of services, they should not let themselves be limited by the regulated environments of the financial services.

Financial Service Contract

Leasing and financing contracts are regulated by law. Usually, customers only pay a part of the procurement costs alongside the financing costs. At the end of the contract, the *residual value* of the vehicle can be different from the sales revenue which was achieved. For this purpose, there is either a *contractual variant*

1. with fixed residual value and distribution of additional revenue, or
2. with a limited number of kilometres, and compensation to be paid or received in the case of more or fewer kilometres having been driven.

Usually, it is not only favourable conditions which are offered in terms of promoting sales – it is also combined with other *service contracts* directly in the vehicle sales process – usually with maintenance, repair, warranty services and insurance. Additions to new types of contracts for mobility services would also be possible here – which could replace a family's second car. In order for this to happen, however, goals and appropriate training are needed for consultation staff – even if to begin with, it is only about getting customers to register. Certainly, these types of contracts are used to build up formal customer relationships which it is desirable to continue with attractive follow-up contracts in order to avoid clients changing to other brands.

However, the focus of this business competence should remain on the contract processing of legally regulated services, while the business competence "qualification, quote, contract" from the domain "sales and outbound logistics" continues to concentrate on sales of products. Mobility service contracts do not fit perfectly in either of the business competences. The execution processes in financial services are too complicated, while in vehicle distribution, there is a lack of experience in dealing with services.

All leasing, credit, bank and insurance contracts are administrated and archived – from customer quotes to the decided and concluded variant with customer-specific contractual conditions. All adjustments to contractual data before and after the conclusion must be filed in an easy-to-understand way. This includes not only the respective changes to the contractual period, payment method etc., but also the fulfilment of the legally regulated *duty to give professional advice* with the help of trained staff, which must also be filed in the form of proof that the private customer has been advised.

Bank and Credit

Automotive banks mainly concentrate on the operative sales promotion of vehicles, and are therefore not just any normal banks. Some vehicle manufacturers broaden their service range, however, to include classic bank services such as *current account and fixed-interest investments*, as well as *card products* such as credit cards or cashless payments via fuel cards for private and business customers. Nonetheless, not all vehicle manufacturers want this extended business competence – which is associated with additional regulation – in order to build up new customer relationships.

This business competence concentrates on the operative processing and documentation of *banking operations*. *Account management*, along with *payment transactions*, are central. As part of it, it is often only core services which are provided, which are added to with externally procured services. Automotive banks are usually *direct banks*, which set up their financial services without having their own network of branches, and which usually process transactions with clients via the internet, fax or telephone. Those automotive banks which offer banking services often offer *securities business* services too, which are processed via the internet in accordance with the direct bank model.

Particular significance is gained by card products. Alongside the traditional processing and documentation of *credit card business*, the link to service cards also gains more importance for customer loyalty and the collection of detailed customer information. It is usual to process business with fuel cards for commercial fleet vehicles. In the field of mobility services, there are still many possibilities developing which use a service card as a *token* for many functions of overlapping mobility service ranges, while travel is something to be highlighted as a status symbol – just like the car keys which are often a status symbol for the ownership of a vehicle of a certain brand.

Automotive companies act in a non-standardised way when it comes to allocating sales accounting to a business competence, but often it is the business competence "accounting, financial statement" from the domain "finance and controlling" which is used for the creation and recording of customer invoices. This also includes the commercial evaluation of invoicing for vehicles, spare parts and other services.

For captive automotive banks in Germany, there is the umbrella organisation "Working Group of Banks and Leasing Societies in the Automotive Industry" (AKA), which deals with economic, fiscal and legal issues.

For more on captive banking business, please see the literature [150].

Insurance

Right up until the present day, the operative processing of automobile-related insurance is still at the centre of this business competence. The most common insurance cases include *damages claims* for in-house and indirect *insurance business*. The process usually comprises the *damages assessment*, reporting of the course of events, a detailed financial *damages evaluation* and the conclusion of the *damages settlement*. During the assessment, the reporting of the events is documented, and the question of *payment obligation* is answered in terms of who is at fault. The damages evaluation and the documentation of the damages costs are carried out by externally commissioned *damages evaluators*. On the basis of their calculations, the sum in paid in accordance with the applicable *contractual conditions*. Finally, the process is completed when the damages sum is *paid out* and the documentation of all correspondence is ensured.

Nowadays, insurance can be integrated into mobility service ranges, for example with car-sharing car2go. In further combinations, other models would also be possible which are adapted to the customer's use behaviour. In this case, there would be no fixed price per minute or per kilometre driven – instead, there would be a variable price which would orient itself according to how, where and when a person drove. Thanks to connected vehicles and their data, vehicle manufacturers have the option of developing the insurance models Pay-as-you-Drive (based on mileage and amount of vehicle use, PAYD for short) and Pay-how-you-Drive (based on driving behaviour and type of vehicle use, PHYD for short). It is already apparent that, in the context of insurance, the following four different types of vehicle manufacturers will develop:

1. Will not become core business, and will be left as a business field to the existing insurance sector.
2. Licensing and sales of driver data to insurance companies.
3. Cooperation with insurance partners in order to be able to offer PAYD and PHYD products as part of the vehicle manufacturers' brand.
4. Completely in-house product design for linked PAYD and PHYD insurance offers with risk assumption and settlement of damages.

Due to the imminent full connection of vehicles and the associated increase in data volumes with the possibilities that this will entail, it will become difficult to continue to only sell non-attached insurance products on the market. This is why there is currently a lot of movement among traditional insurance companies.[58] However, insurance will increasingly insure the driver rather than the respective vehicles, so that in a mobility industry, individual driver insurance can be used for all types of travel.

Due to the increasing number of driver assistance systems, it would be easier for automotive companies to link safety systems – such as parking aids – with the prospect of attractive insurance tariffs. Through this combination, the frequency of claims can be lowered, while at the same time new equipment can be sold.

3.6.8 After-Sales Support

For most vehicle manufacturers, the value creation chain is, to the greatest possible extent, finished when the product is handed over to the customer as part of the business competence "acceptance and documentation" from the domain "sales and outbound logistics". The business in spare parts can still mean attractiveness in the sales market for the vehicle manufacturer, if the parts are not exclusively procured by suppliers, and if there are no strong competitors on the market in terms of spare parts. The business in spare parts, however, can be processed via the business competence "order and distribution" from the domain "sales and outbound logistics".

Only very few vehicle manufacturers have a concept for those branches whose employees carry out operative maintenance. And it is precisely those people who own these branches, such as BMW and Daimler, who want to sell them.[59] Practically all the responsibility is handed over to independent car repair shops and selected contracted dealer's garage, who then usually also take care of the disposal of the defective parts which have been replaced, and of the entire vehicle. The relationship to contractual dealers is managed via the business competence "distribution system" from the domain "sales and outbound logistics". With today's vehicle manufacturers, all that remains are the product-related basic services – which either have to be fulfilled in accordance with basic requirements, or are seen as indispensable by the customer. These include, for example, the information and tools needed in order to maintain the vehicle.

Overall, the market can therefore be seen as independent from the vehicle manufacturer once the vehicle has been handed over to the end customer.

However, as a result of the connected vehicle and the amount of data available, a strategic movement is developing in this business domain – something which is

[58] "The first insurance to be dependent on driver behaviour" http://www.welt.de/finanzen/versicherungen/article121912643/Die-erste-vom-Fahrverhalten-abhaengige-Versicherung.html. Accessed: 23 December 2014.

[59] "Sales of Daimler branches: Quick decision unlikely" http://www.wiwo.de/unternehmen/auto/das-ende-der-autohaendler-der-grosse-kahlschlag/8519022-3.html. Accessed: 23 December 2014.

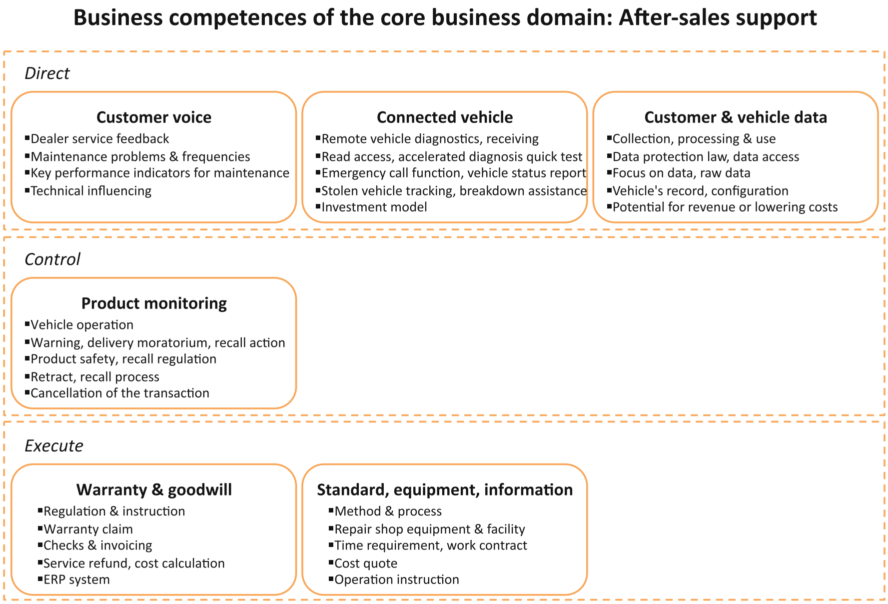

Fig. 3.35 The business competences of the domain "after-sales support"

appropriate not only to after-sales support. Nowadays, however, it is the last domain of the vehicle manufacturers in the core business domains which represents the product lifespan of the vehicle. The added value of the connected vehicle only comes about after handover. In practice, most vehicle manufacturers concentrate on remote diagnosis as part of the connected vehicle, which is once again appropriate in this business domain.

The domain of "after-sales support" includes the following six business competences (see Fig. 3.35):

Direct:
- Customer voice
- Connected vehicle
- Customer and vehicle data

Control:
- Product monitoring

Execute:
- Warranty and goodwill
- Standard, equipment, information

Direct Business Competences

What kind of strategy can a vehicle manufacturer have if he only provides the product-related basic services which have to be fulfilled in accordance with legal requirements?

In the digital era, vehicle manufacturers should let themselves be led more strongly by the "customer voice". This is why we are including it as a direct business competence. We see the "connected vehicle" and the "customer and vehicle data" it creates as two business competences in the domain which are young and still developing, but are nonetheless direct competences.

Customer Voice

Customer services come into daily contact with vehicle users, and are therefore very close to the current mood of end customers in terms of their vehicles. This is why *dealer service feedbacks* about identified *maintenance problems and frequencies* are particularly important. These must not necessarily be quality or product problems which have come about in development or production – they can also be indicators of inadequate documentation or training which has come about as a result of the conditions of new vehicle functions.

Often, however, it is only lots of small things which are noticed during repair which can be improved in accordance with a concept like Kaizen (see Sect. 3.1.4) via digital communication channels in the distributed network of manufacturer and repair shops. The models of cooperation between a repair shop and a manufacturer are however, not to be compared with the manufacturer-supplier relationship. Repair shops must generally solve ad hoc situations, serve their waiting customers, and cannot always comply with all processes. At the very least, a central database is needed – in which, for example, overly complicated maintenance or more targeted repair advice is collected. This feedback cannot just be collected, however – it must be evaluated and allowed to affect product development. In this context, the VDI guideline 2893 [161] and the DIN standard 15341 [39] help to develop *key performance indicators for maintenance*.

It can also be inspiring for designers, developers and builders if heed is paid not only to suggestions made by specialists from the repair shop, but also from the masses of end customers. BMW, for example, uses the publically accessible Portal "BMW Group Co-Creation Lab"[60] for the *technical influencing* of development plans.

Connected Vehicle

Automotive companies are not yet in agreement as to which of the following long-term strategies should be pursued with the connected vehicle (see Fig. 3.36):

1. As a vehicle manufacturer, to only follow the well-known processes of product development and to see the internet as a further feature in the vehicle, is a vehicle-centric view of the connected vehicle – as part of which one uses network communications in order to integrate it into the processes of customer service.

[60]"BMW Group Co-Creation Lab". http://www.bmwgroup-cocreationlab.com. Accessed: 23 December 2014.

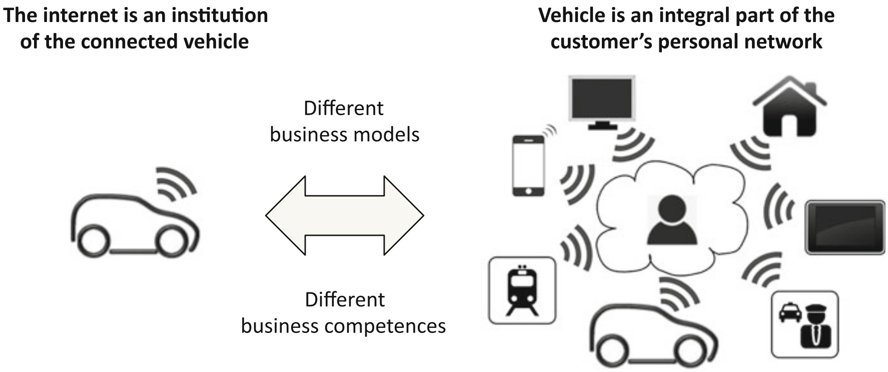

Fig. 3.36 Two different models of the connected vehicle. On the *left*, the internet is seen as a further facility in the vehicle. On the *right*, the vehicle is an integral part of the customer's personal network

2. A completely different perspective would be the result if the vehicle were to be developed to become an integral part of the customer's personal network. In this case, not only would the vehicle manufacturer have to give new direction to the business domain "after-sales support" – the customer service would also have to adapt itself and its business model. We will go into more detail about this in Chap. 4.

The vehicle manufacturers are agreed on one thing at least – that the connected vehicle should represent a business competence in its own right.

The business competence "connected vehicle" described here concentrates on the first model – left-hand model in Fig. 3.36 – with a focus on *remote vehicle diagnostics*, which is about wireless access to vehicle diagnostics data. In Fig. 2.14, we presented the wired vehicle connection via OBD-II for the diagnostics bus. Therefore, all that is different is the way in which the diagnostic data are *received* – and not the evaluations and actions which follow – which continue to be covered by the business competence "standard, equipment, information". However, only *read access* is possible wirelessly.

Thanks to wireless access to the vehicle by repair shops, the manufacturer or other service providers, maintenance work can be managed actively via an integrated service – for example in order to avoid car breakdowns, or to optimise the arrival of a vehicle at a repair shop with a *accelerated diagnostics quick test* [16]. Other relevant customer services in the context of the connected vehicle would be automated *emergency call functions*, the transmission of *vehicle status reports*, *stolen vehicle tracking*, and *breakdown assistance*. This is just the tip of the iceberg in terms of the new possibilities which will develop in the years to come.

For the second model – shown on the right in Fig. 3.36 – the business competence "planning, requirement, change" from the domain "research and development" has to be given a new orientation, because until today, any investment in a new function of a product is evaluated with a direct sales potential. A platform for the collection of user-oriented data does not fit into the existing *investment model* of the development.

Customer and Vehicle Data

Is this business competence redundant?

- Customer data is covered via the business competence “sales strategy and client” from the domain “sales and outbound logistics”.
- Vehicle data is covered via the business competence “product data and documentation” from the domain “research and development”.

In this business competence, it is about vehicle data which are created after the vehicle has been handed over to the customer. The customer data are only to be seen as directly linked to the vehicle, and contain no master data, for example.

But who does the vehicle data belong to?

This is intangible information which is therefore not subject to any property or ownership regulations. In Germany, the *collection, processing and use* of vehicle data principally takes place in accordance with *data protection law*. More detailed information is available in the literature [129]. In this context, there are many questions which are related to the classification of data, claims to this data and liability for incorrect processing of data. Some examples include:

- Which data belongs to the driver because he/she is the one using the vehicle?
- Which data belongs to the passengers because they are travelling in the vehicle?
- Which data belongs to the owner or keeper of the vehicle?
- Which data belongs to the manufacturer, or to the supplier, because they are both liable for the vehicle which has been constructed?
- Which data belongs to the public or to the state if the vehicle is located on a public road, or is involved in a crime?
- And how does all of this change when the car is taken to another country?

Most vehicle manufacturers clarify the question of *data access* with a contract as soon as the new vehicle is sold, while customer service does this by collecting approval before maintenance is carried out. The connected vehicle makes open dialogue between manufacturer and customer particularly important.[61] Some vehicle manufacturers are already broadening their “corporate strategy” with a *focus on data*. Even if the raw data from the numerous sensors and control units in the vehicle can only be interpreted by engineers and were not designed for end customers (see Sect. 2.3.1), they will still feel uncertain about what happens with their data – some

[61]“Daimler in dialogue: Connected vehicle and data protection” http://auto-presse.de/autonews.php?newsid=250560. Accessed: 23 December 2014.

of which is personal. A certain degree of trust is definitely needed in order to give the manufacturer of a utility object so much insight – and to a certain extent even access – into a person's life. Daimler CIO Michael Gorriz, however, thinks the whole issue is not so dramatic: "Strictly speaking, car drivers have been placing their lives in our hands for years – whenever they sit in our cars and race along at 60 km/h or more. This is much more serious than giving out some much less important information."[62]

Strictly speaking, as the connected vehicle architecture is today (see Sect. 2.3.2), not all *raw data* created by the vehicle can be tapped. The data which is recorded by the sensor keys still has to go through an analogue to digital transformer, a data filter and the control unit, before the remaining fraction of data can be tapped in the CAN bus system. Furthermore, there is still no standardisation of the data of different vehicles and parts. AUTOSAR does not take care of data architecture and structures. There are only first efforts – as, for example, for telematics data via NGTP (see Sect. 2.5.2). Admittedly, with all its standards and systems, vehicle diagnostics is at its most developed with OBD-II [132]. Even here, however, there are different interpretations as to how the fuel level in the tank should be measured and interpreted, for example. To this day, every company still has its own solution for the collection and processing of vehicle data in the form of a *vehicle's record*, in which all changes made to the *configuration* during maintenance are documented.

In this business competence, the societal, technological and legal factors are joined by an economic perspective, because the question of the value of the data collected and its valuation is not easy to answer. A detailed look is needed in order to be able to better estimate the *potential for revenue or lowering costs*. For example, what is the value of early recognition of a fault compared with the costs which would have been incurred by having to recall a product? Which value can be attributed to a new service which, today, is perhaps not essential in relation to the core product?

Control Business Competences

Both independent and contractual dealers hardly let themselves be audited by the manufacturer in terms of customer service. Active monitoring and well prepared communication, however, can avoid both high recall costs and damage to the image of the company – the value of which cannot be calculated. As a result, the auditing business competence of "product monitoring" takes on a central focus in this domain.

Product Monitoring

No vehicle manufacturer can rule out the possibility that, despite the intensive business competence "testing and validation" from the domain "research and development" and "quality assurance" from the domain "quality", there may still be other faults within the vehicle which only become apparent during *vehicle operation* after it has been handed over to the end customer.

[62] "Daimler expands its digital customer service" http://www.computerwoche.de/a/daimler-baut-seinen-digitalen-kundenservice-aus,3066395. Accessed: 23 December 2014.

Automotive companies monitor their vehicles on the market by systematically collecting and evaluating numerous different types of information which, for example, are created as a result of complaints, goodwill gestures, repair services, uses of spare parts, and reports of damage. Depending on the evaluation results and gravity of possible faults, different measures must be taken – from a *warning* to *delivery moratorium* to *recall actions*. In the case of certain abnormalities and measures, close cooperation with publically approved monitoring authorities – such as the German Technical Inspection Association or "TÜV" – is prescribed by law. It is already too late if it is the monitoring authority which is the first to establish that *product safety* is not sufficient. In this case, the manufacturer can be forced by law to recall the product – or even to *retract* it. The German Product Safety Act expressly prescribes a *recall regulation* in the sense of pro-active action if safety defects are recognised which could lead to potential damage and an accident which could constitute grounds for liability claims. The business competence "corporate communication" from the domain "marketing and communication" is responsible for communicating risks. Before every communication, however, the *recall processes* must be clarified completely, documented and guaranteed internally, in addition to being – in emergencies – specifically consulted about with decision-makers.

The manufacturer must not, however, always accept liability for every complaint. In order to clarify this, the monitoring must also be able to reveal improper use or misuse, or deliberate ignoring of warnings.

A particular case in point is that of the so-called "Lemon Laws" in America, in accordance with which end customers no longer have to accept just repairs, but can demand a *cancellation of the transaction*. From the point of view of IBM, targeted analyses can be used to identify such cases even before they occur.[63]

Execute Business Competences

In order to guarantee the operation of the delivered vehicle, two execute business competences are relevant for the vehicle manufacturer. He must set standards relating to the situation as part of "warranty and goodwill" and, furthermore, support the fundamental operative measures in maintenance of the vehicle through the business competence "standard, equipment, information".

Warranty and Goodwill

This business competence evaluates and manages customer claims, and processes them using the contractually regulated warranty and any goodwill which is forthcoming. Suppliers are often the primary contacts in the case of warranty and goodwill questions, while the OEM must take on the warranty – which is legally clarified in a clear way. As the legal bases and processes of procedures vary in different markets, the OEM must provide car repair shops with documented

[63] "IBM Showcases Big Data and Analytics for Business" http://www.ventanaresearch.com/blog/commentblog.aspx?id=4011. Accessed: 23 December 2014.

regulations and instructions for how to deal with warranty and goodwill cases. The OEM usually provides dealers and repair shops with the systems for *warranty claims* and the necessary *checks and invoicing* for the *service refunds* via protected websites. Although the markets are processed differently, a trend towards global IT systems can be recognised among automotive companies. This is especially the case because of *cost calculations* for the refunds, and central monitoring possibilities, in addition to "product monitoring". *ERP systems*, for example, are appropriate for this.

Standard, Equipment, Information

The OEM must prescribe the *methods and processes* for operative measures in maintenance, inspection and servicing. For this purpose, the provision of appropriate *repair shop equipment and facility* is necessary. Especially in the case of complex electr(on)ics and embedded software, a diagnosis with corresponding data evaluation and the required servicing is now impossible without the right equipment. The "development and engineering" of the repair shop equipment takes place as part of the business domain "research and development".

For operative administration, the OEM must provide systems as part of which *time requirements* for maintenance activities for each vehicle model are made available. On this basis, repair shops must be made able to create a standardised compilation of *work contracts* with the corresponding *cost quotes* for the invoice to be issued later. The instructions must also, however, give a certain space for different processes in the repair shops all over the world.

The technical product documentation created as part of the business competence "product data and documentation" from the domain "research and development" (see Sect. 2.3.3) must be provided for the repair shops and end customers as part of this business competence. The *operation instructions*, for example, constitute a central document which is about much more than just its content. Customer services come into simultaneous contact with many different generations – who need to be provided the same information in different ways as part of direct customer contact.

It is only natural that a guide for this should be provided digitally. What is crucial, however, is the product context – and the user – which leads us to the question: Who actually reads the operating instructions of a vehicle? Of course, there are legal requirements in terms of the documentation – which must not only be fulfilled by the manufacturer, but can also be very important for the driver in critical situations. The only problem is that different generations prefer different communication modes and formats.

The "traditionalist" generation (born before 1946, according to the US Bureau of Labor Statistics) can be expected to continue to trust in paper formats, because they grew up with books. The "baby boom generation" (born between 1946 and 1964) grew up with the television, and can be expected to prefer a smart screen in the vehicle which informs them about how to operate it. While an additional connection to the internet can bring about further advantages in terms of getting up-to-date information, it does not change how the vehicle is used. What, however, do the next generations of "those who have always been online" (born from 1997) expect from an information interface when they use a vehicle? Of course, it should be possible to use everything intuitively, and for communication with the manufacturer to be possible at any time via online media.

In addition to the information needs of different generations, there are also special customers with particular needs – the military, for example.

3.6.9 Human Resources

All organisations have the "human resources" business domain – which concentrates on providing goal-oriented human resources, and involves all staff-related design and administration competences in the company.

Employees usually expect their employers to provide appropriate pay, varied work, the possibility of developing their career, a degree of co-determination, and a secure work. As employees do not go to their human resources department for answers to technical problems from their everyday work, the expectations employees have of human resources department are independent of the automotive industry – we are therefore describing a competence which is independent of its industry sector. To a great extent, this corresponds to the reality. We refer to the work of Michael Beer [13], which presents the human resources department thoroughly using numerous real life examples (including some from the automotive industry).

Which characteristic particularly distinguishes employees in the automotive sector?

1. Complexity and size of the organisation in comparison to international competition,
2. a growing number of regulations and state influences,
3. transformation of values and expectations of the employer from the level of "blue-collars" to "white-collars" or "knowledge workers".

Human resources already has well-matured process concepts for the implementation of the first point. The challenges lie more in implementation, in terms of the "hierarchies" which have built up over time in the factories – where each factory location justifies its own human resources department with individual processes. According to Porter [117] automotive companies must make the fundamental decision between human resources management which is adapted to the country in question, or which is internationally oriented for globalisation. The second point is to be seen in relation to human resources in combination with the third point, because it is via this point that the co-determination rights and focuses of activities of the very industry-heavy works councils will be changed. The third point is especially critical if vehicle manufacturers want to transform themselves in order

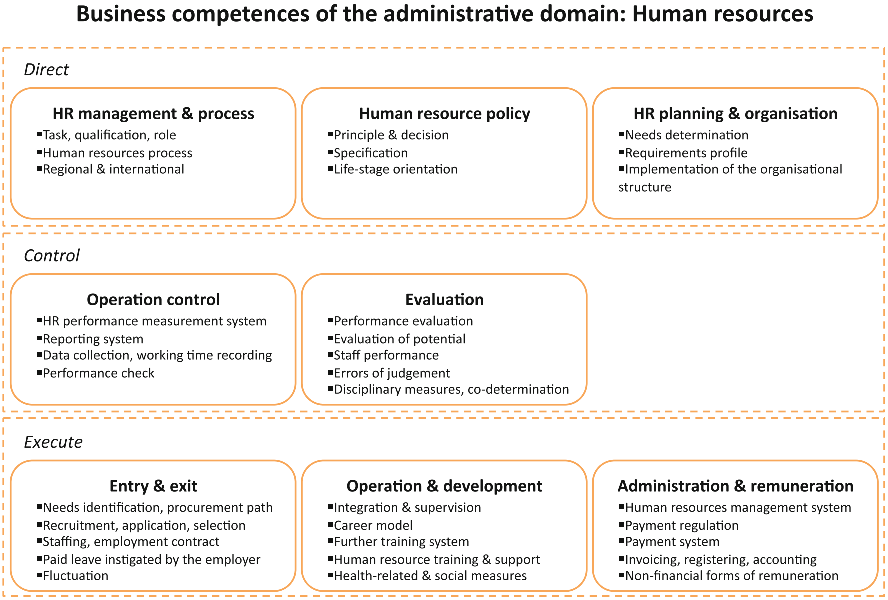

Fig. 3.37 The business competences of the domain "human resources"

to be part of the mobility industry. Innovative buildings which integrate assembly factories and office space[64] are just the beginning.

The domain of "human resources" includes the following eight business competences (see Fig. 3.37):

Direct:
- Human resources management and process
- Human resource policy
- Human resources planning and organisation

Control:
- Operation control
- Evaluation

Execute:
- Entry and exit
- Operation and development
- Administration and remuneration

Direct Business Competences

Companies manage their employees with the help of the human resources department. The principles of humanity and economic viability serve the purpose of the business, and form the basis for all action taken in human resources:

[64]For example, the BMW factory in Leipzig http://www.bmw-werk-leipzig.de/leipzig/deutsch/lowband/com/de/index.html. Accessed: 23 December 2014.

Humanity	means that the working conditions are adapted to the needs of employees, and the management style is cooperative.
Economic viability	means that the competences, creative abilities and passions of the employees are used to generate competitive advantage for the company. The relationship between pay and the resulting employee performance is what determines the economic viability of the human resources department.

Human Resources Management and Process

The company goals and strategies are implemented with the help of human resources management. Managers who are responsible for human resources take care of the corresponding goals, motivations and support, and try to create team spirit while avoiding hierarchical conflicts. Conflicts are not always the same as criticism. Good human resources management means allowing – or even hoping to receive – criticism. Kaizen (see Sect. 3.1.4) is a successful example of human resources management which orients itself primarily towards employees rather than towards tasks. It is characterised by cooperative management – as part of which the employees take part in decisions, meaning that own initiatives are particularly encouraged.

Human resources management defines the main *tasks, qualifications, roles*, and models adapted regional and global career concepts in order to be able to implement the company's promise to its users. This involves clear descriptions of roles, tasks and responsibilities while taking into account cultural aspects for the integration of all the employees. Only in this way can global vehicle manufacturers gain access to the international labour market, and achieve an internal transfer of skills in the international business of promising growth markets.[65]

The procedures of all "human resources" business competences are oriented towards defined *human resources processes* [137]. Every company must decide for itself the extent to which it standardises or individualises its human resources processes in terms of the global competition. Companies such as SAP or Oracle offer business software packages including process models for the worldwide standardisation and optimisation of procedures in human resources. In doing so, they demand an economic way of thinking which is fundamental to the management of employees for the company's business success – be it management which is adapted to the *country in question, or international*.

Human Resource Policy

Human resource policy includes all *principles and decisions* which take into account the business competencies "goals, values, principles" from the domain "corporate leadership", and legal provisions. Human resource policy-related *specifications* such as behavioural rules and guidelines are recorded in the company statutes or – among other things – in a list of business, work or operational rules. A distinction is made

[65]For more detail on international human resources management, please see the literature [53].

between fundamental decisions and individual decisions. Fundamental decisions give direction, and are established as guiding principles of the corporate leadership. Individual decisions, on the other hand, serve to implement the fundamental decisions in specific cases in individual fields. For example, the general model of performance-related pay is a fundamental decision which must, however, be adapted through individual decisions in individual regions due to legal provisions.

People are at the heart of human resources – for the development of their creativity, qualifications and ability performance for the sake of a competitive advantage for the company. This is also how the need to keep company traditions alive comes about. But they are not the only thing which is important nowadays in making employers attractive for different groups of people. The concept of *life-stage orientation* in human resource policy [130] is gaining increasing significance in global companies. Human resource policy must provide a clear framework in order to avoid too many important decisions having to be made by employees at the same time – so that management and motivation can be made appropriate to the life-stage of those involved. The productivity of younger staff in particular is inhibited by thoughts about changing direction in one's job, by possibilities of promotion, changes in residence, or starting a family.

Human Resources Planning and Organisation

Human resources planning is the mental anticipation of what could happen to the company in the future in terms of staffing. It determines and plans future staff needs – something which is defined by many different influencing factors. A distinction is made here between internal and external influencing variables. Internal variables include, for example, workforce, organisational structure, staff performance capability, level of training, age structure, fluctuation, rationalisation measures, and absence rates. External examples include economic situation, economic development, labour market, demand situation, skilled personnel pool, population structure and development. All these variables are used to determine quantitative and qualitative staff needs. As part of quantitative *needs determination*, it is identified whether there is a shortfall (staff need to be recruited) or surplus (staff need to be let go) in the list of jobs. Once the quantitative staff needs have been determined, qualitative planning must be used in order to establish which qualifications the future employees need so that they can implement the company goals and strategies in different places and at different times; from this are derived the *requirements profiles* for the job advertisements for the staff needed. There are a broad range of qualifications which provide the basis for a requirements profile which is meant to fulfil an effective and successful function in an organisation. A holistic view is needed in order to carry out a consolidated comparison of different local capacity needs with the staff who are already employed.

Corporate leadership provides the framework for a global organisation. The actual *implementation of the organisational structure* takes place as part of the business domain "human resources", because each organisation has its own developing culture. As a result of this, long-term, comprehensive development and alteration processes are needed for the design of organisational structures. An organisational transformation can be planned and supported, or it can take place unnoticed, and be unintentional. Management psychology overwhelmingly deals with human resources management and with understandings of the roles of human resources managers in complex organisations. Processes and tools can only be of help to a certain extent in this context, and are outside the scope of enterprise architecture.[66]

Control Business Competences

Companies are only successful if they are attractive to different groups of people who are prepared to use their knowledge and skills to help the company. What does it mean if human resources management or personnel deployment is sub-optimal? How can staff performance be measured, and how can it be avoided that decision-makers have fewer professional achievements in their sights than people who are similar to them, or well-known to them?

Different auditing and evaluation mechanisms create transparency about the contribution being made by staff and human resources department to the success of the company. On the one hand, the business goal can demand decreases in staffing costs, fluctuation and absence rates, and on the other hand, an increase in work productivity.

Operation Control

Staff deployment means the allocation of employees to jobs of a company. It begins when they are recruited, and ends when they leave.

Deployment auditing is based on a *human resources performance measurement system* in which a distinction is made between qualitative and quantitative indicators. As their basis, the quantitative indicators use values which can be measured discretely – such as revenue, number of employees, or number of dismissals/instances of notice given. They are target/actual comparisons which simply find out the differences. By itself, an indicator says nothing about why, for example, there is high fluctuation within the company. It simply points towards problems and dangers by using value ranges.

- Very common are percentage-based indicators such as personnel cost rates, overtime rates, absence rates, illness rates or accident rates.
- Average indicators include, for example, age of the staff or length of time working for the company.
- Financial indicators always have great significance – such as recruitment costs, pay level or costs of further training.
- Helpful, more complex indicators give information about structural developments – such as stock, and changes to staff structuring or the qualification structure of the staff.

[66] Please see the literature [153].

For a closer look at human resources indicators and the *reporting systems* based on them, please refer to the literature [63]. Qualitative indicators may point to the causes of problems and dangers – for example, how satisfied staff are within the company. They are, however, harder to measure – and cannot be defined or documented as precisely.

The indicator systems are only as good as the data they are based on. A central system for *data collection* is the *working time recording* of employees. The working time recording of employees looks at:

Working time data	such as attendance, overtime, holiday, absences and absences due to training, maternity etc.
Working time rules	such as flexitime and core time range, breaks, instructions for trainees, probation period, legal and operational instructions.
Tariffs	such as piecework, night shift and Sunday extra pay

In the automotive industry in particular, the system for recording times is essential to the operative use planning and *performance checks* in the production factories. Systems such as these have a long history of ensuring fairness in how employees are remunerated. The limitations of systems like these come about as a result of a transformation from working towards tasks alone, to knowledge-based working. For example, in the framework of such systems, it would be fair to plan to implement innovations thought up by staff at a certain time, for a pre-determined period. This means that every staff member would have the same opportunities to make a contribution to the company. With classic, incremental improvement systems such as Kaizen (see Sect. 3.1.4), actions such as these are possible. In the mobility industry, however, it will hardly be possible to always develop pioneering innovations on Fridays between 2 and 3 p.m.

Evaluation

The evaluation of employees can have different focuses. For example, regular *performance evaluation* is very common, as is the *evaluation of potential* in order to promote talent. The evaluation conversation about *staff performance* is had about what has happened – by comparing the agreed-upon goals with the results which have been achieved; on the other hand, potentials are estimated in terms of prospective support. There are numerous different procedures for evaluation, each of which have certain advantages and disadvantages, as well as *errors of judgement* such as perception bias and deliberate distortions. In particular cases, *disciplinary measures* can be taken against employees – such as warnings, for example. The procedures for evaluation are independent of the automotive industry.[67]

It is not only individuals, however, who are evaluated. Evaluations of entire organisations are crucial for the future success of a company. These include, for example, workforce developments, capacity needs and coverage, developments in

[67] This is why we will not go into any more detail here – instead, we refer to the literature [110].

employees qualifications and labour markets, employee satisfaction and needs for information. Plans and implementations which result from such evaluations are always coordinated with company *co-determination*, which represents the interests of employees.

Execute Business Competences

The main execute business competences of the "human resources" are based on the concept of finding people for the company and business, before making them want to stay, and developing their skills.

Entry and Exit

As part of *needs determination*, a range of local capacity needs are consolidated before the sufficient number and quality are determined for the requirements profiles described. The *procurement path* is defined after a comparison between internal capacities and qualifications. Inside or outside the company, one can use selected channels to look for candidates whose skills or suitability profiles meet the staff requirements. Seeking and finding potential candidates for particular needs is referred to as *recruitment*. From the *applications*, the organisation selects the applicant who is best suited to the position in question. During the *selection*, however, legal provisions must be adhered to – such as equal opportunities law. Usually, a pre-selection is made first by looking at application documents, before interviews are carried out in order to assess candidates. Once all information about the skills and attributes of the applicants has been collected and evaluated, a final decision is made about which applicant should be chosen for *staffing*. Upon the legally binding signing of the *employment contract*, the recruitment process is complete. The legally binding recruitment of applicants may not, however, take place without taking into the account co-determination rights of the works council.

The main challenge in terms of staff recruitment is transparency and understandability, which is why in reality the process is more complex and is associated with many checks. Additionally, comparability in terms of the selection and commitment of applicants is important – something which can also mean international comparability in the case of work abroad. In this context, standardised application and contractual templates can be a way of optimising services for different countries.

There can be many reasons why an employee might decide to leave a company. They are usually recorded in the human resources information system. There are, however, no major processes which would be relevant to the scope of our subject. The measures for *paid leave instigated by the employer*, on the other hand,[68] are the result of a staff surplus in the company. The surplus may be qualitative, quantitative, place-related or time-related. A distinction is made between internal and external paid leave instigated by the employer. In the case of a quantitative surplus, it tends

[68]Employer-instigated paid leave is a one-sided order from the employer or a consensual agreement between the parties of the employment contract which frees an employee from the duty of carrying out his work permanently or temporarily.

to be external paid leave which is instigated by the employer – mainly by getting rid of positions which are not absolutely necessary. There are two types of employer-instigated paid leave – which have to follow different staff processes, and usually mean the ending of the employment relationship:

- A smooth transition by ceasing recruitment, exploiting fluctuation, contract expiration, ceasing temporary employment, retirement, early retirement, or incentives to quit.
- A sharp transition by not extending contracts, termination agreements, operation-related or behaviour-related dismissal.

Internal paid leave instigated by the employer, on the other hand, does not mean getting rid of jobs – instead, it means adapting the use of the workforce at company level when there is a qualitative, place-related or time-related surplus. In the case of a qualitative surplus, training or re-training may be given; while, in the case of a place-related surplus, the relocation of staff would be a possibility. Place-related surpluses often come about as a result of a site being closed or moved. Time-related surpluses occur more often when there are shortages in the factories of the automotive industry. Some examples of possibilities are short-term work, shortening working hours, creating part-time positions, or holiday planning.

In contrast to employer-instigated paid leave, a *fluctuation* is unplanned – and therefore cannot be represented in such a structured way in staffing processes due to the many different causes it may have. Only from a short-term point of view can it be helpful for getting rid of jobs. It is rather unlikely that unmotivated employees will want to leave the company in order to make room for employees who are "able to perform better".

Operation and Development

In accordance with staff planning, quantitative and qualitative allocations for filling positions are also carried out in conjunction with staff deployment and allocating staff to jobs within a company. This is compounded by the fact that deployment also has a time-related element – in particular in terms of shift work in factories, or when deploying part-time workers. Staff deployment is a continual process which also follows recruitment – in order to introduce and train new staff.

Staff development ensures that staff qualifications are maintained and improved. This begins by *integrating and supervising* staff in their *career model* in the company. Particularly in the case of highly specialised professionals, cooperative development of successors is important. Staff development does not apply to individual employees alone, such as particularly highly qualified or gifted talents, however – instead, it can also include the holistic development of organisations such as site groups, specialist departments, or the whole company. Regulations, instructions and ensuring diversity must also be taken into account in staff development – and not only in terms of procurement, for example orientation towards demographics.

In a *further training system*, staff training measures are planned and managed, such as training and further training, or retraining. *Human resource training* is one of the basic tasks of staff development. It can happen within the company – at the workplace – or outside the company, and be conducted by external training providers. *Human resource support*, on the other hand, is more individual – it supports the personal developments and skills of managers or talented specialists in the company. It is particularly necessary in order to change jobs and work content within the company. Career planning within global automotive companies should also make successive professional or international changes possible which can be taken advantage of during the development of a career. Transferring special tasks is also a measure which can be used in order to let a learner become active in fields he is unfamiliar with. Cross-sectional tasks involving problems from several operational fields which work together in an overlapping way, are particularly suitable for up and coming managers. Due to the great range of sales markets, tasks involving travel abroad are particularly effective for providing professional, social and intercultural qualifications.

In the strategy examples in Sect. 3.1, BMW [12] and Daimler [32] show that staff development supports employees with *health-related and social measures*. These include, for example, preventive, sport or rehabilitation measures, in addition to consultations on how to juggle professional, private and family life if there is stress in the workplace or emotional exhaustion. In addition to making information and programmes available, safety and protective measures are also needed which go beyond the individual responsibility of employees. This includes, for example, designing workspaces so that they are ergonomic.

Administration and Remuneration

Staff administration enter the data of all employees into a *human resources information system* – from their arrival, to their developments and then finally their departure. A central system for the standardised management of human resources data can have many advantages in global companies. Only some master data and organisational information tends to be made accessible via a employee portal; access to more sensitive data from human resources files is made possible depending on the people and tasks involved.

Payment is a central management task. It means the processing of all monetary payments which the company makes to its staff. In the automotive industry, however, informal reference is still made to two different types:

- An employee's wage is generally based on a model as part of which earnings are calculated using a fixed hourly rate, and the number of hours worked during the time period in question. Types of wage include time wages, task wages, premium wages and investment wages. This means that monthly pay can vary.
- An employee's salary tends to be a fixed payment per month, the amount of which is agreed upon in the employment contract. The actual number of hours worked is not taken into account there.

Historically, there has been a difference between those who receive a wage, and those who receive a salary. In recent years, standardised *payment regulations* have been introduced for all employees in the German electrical and metals industries as part of the Framework Agreement on Pay ("Entgelt-Rahmenabkommen") – according to which no differentiation should be made between the treatment of workers and employees in terms of work and social law.

Essentially, *payment systems* consist of the following three basic elements [166]:

1. Value of the activity according to a defined payment level which presents the significance of activities, and the reach of the goal agreements in the company
2. Evaluation of personal performance in accordance with given performance levels.
3. Level of company goals achieved

It is based on these fundamental definitions and concepts in the systems that the operative preparations and processing take place. These include administrative functions such as *Invoicing, registering, accounting* as well as the consideration and adjustment of taxation, insurance, collective wage agreements, old age care etc.

In addition to monetary payments, over the past few years, *non-financial forms of remuneration* have also gained increased importance. In principle, this is nothing new – even in the past, for example, it was possible to get an extra day off work granted by the employer. In the automotive industry, it is very popular to pay in kind with a company vehicle – which means that employees can get a larger, better equipped vehicle than they could otherwise afford on their own. This type of remuneration does, however, still have a monetary aspect – because private use is a payment in kind which is therefore taxable. Purely non-monetary forms of compensation, which are based on the trust of the employer, include the employee being given the freedom to decide when and where they work, as well as when they take holiday. There would then be no need for holiday applications. Another form of remuneration could be more freedom for decision-making, or opportunities for professional training or further training. Types of remuneration such as these do have a commercial purpose – because otherwise, global companies would not be able to implement the intensive international activities of their employees in an attractive way. International activities no longer demand just that a person's working and private lives be harmonised – they now must be completely integrated. For employees, non-monetary remuneration can be a very important part of overall payment. It includes huge potential for the employee to increase their performance and identify with the company, but it is not always easy to measure.

3.6.10 Quality

The business domain "quality" is primarily responsible for ensuring that the vehicle has no defects following development and manufacturer; and that when it is put up for sale, it can be used reliably for a long period of time. This should lead not only to the customer being won over with the value proposition – the customer should also be kept in a permanent business relationship in the long term. Quality not only includes services which are visible to the customer, however – it also applies to all types of measures in the whole company which serve the quality of products and services. In the case of both sales and use, it is no longer just about the quality of the product – but also about the services of an organisation in a very demanding environment. It therefore becomes part of a company culture, and permeates all areas of a company as part of the staff's way of thinking – in a similar way to the Japanese management philosophy Kaizen (see Sect. 3.1.4). Philip B. Crosby [30] demonstrates that hard work and good intentions alone do not automatically mean that quality will be achieved. On the way to the goal of perfection, he has identified 14 steps towards a zero defects programme, with the help of which everything should be done correctly the first time.

In the automotive industry, quality problems[69] are dealt with great attention and care, as they have an effect on society. At the end of the day, we are all putting our lives in the hands of the manufacturers whenever we get into a vehicle. This is why customers' requirements and needs are very high priority – even if nowadays this seems to be stating the obvious. The fundamental, tried and tested procedures for vehicle manufacturers are described in the Technical Specification ISO/TS 16949:2013 [156], which orients itself towards the well-founded methods of the industrial quality thinking of Walter A. Shewhart [146] and W. Edwards Deming [37,38]. Furthermore, the Technical Specification is also inspired by several standards which apply to several industries, such as ISO 9000:2005 [73], which are used to define general principles and terms for quality management systems. A further standard, ISO 9001:2008 [74], regulates the demands and requirements for quality certifications, and guarantees conformity with the requirements and quality values of our society. An update of the standard ISO 9001:2015 [70] is planned for autumn 2015, with a stronger focus on risk-based thinking. Through risk-based thinking, the orientation of the quality competences can, similarly to the competences "risks and finance", "safety and security" and "environment", be developed into a domain of "corporate leadership".

Our description of the business domain is in line with the guideline for the standard ISO 9004:2009 [75], a more comprehensive concept than ISO 9001:2008. It addresses the demands and expectations of all interested parties, and systematically and continually improves the overall performance of the organisation. The extended model of process-oriented quality management in accordance with ISO 9004:2009 is shown in Fig. 3.38. The standard ISO 9004:2009 cannot simply be seen as an extension of ISO 9001:2008. They were developed further so as not to contradict each other, and can also applied independently of one another. The standard ISO 9004:2009, for example, is not intended for certification purposes or use by authorities or in contracts; instead, it is meant to provide recommendations in order to encourage companies to look at quality in a holistic way. The customer should perceive quality as an overall impression – as a concept, execution, in sales

[69] "The Top 5 Automotive Quality Management Failures of All Time" http://www.cebos.com/the-top-5-automotive-quality-management-failures-of-all-time. Accessed: 23 December 2014.

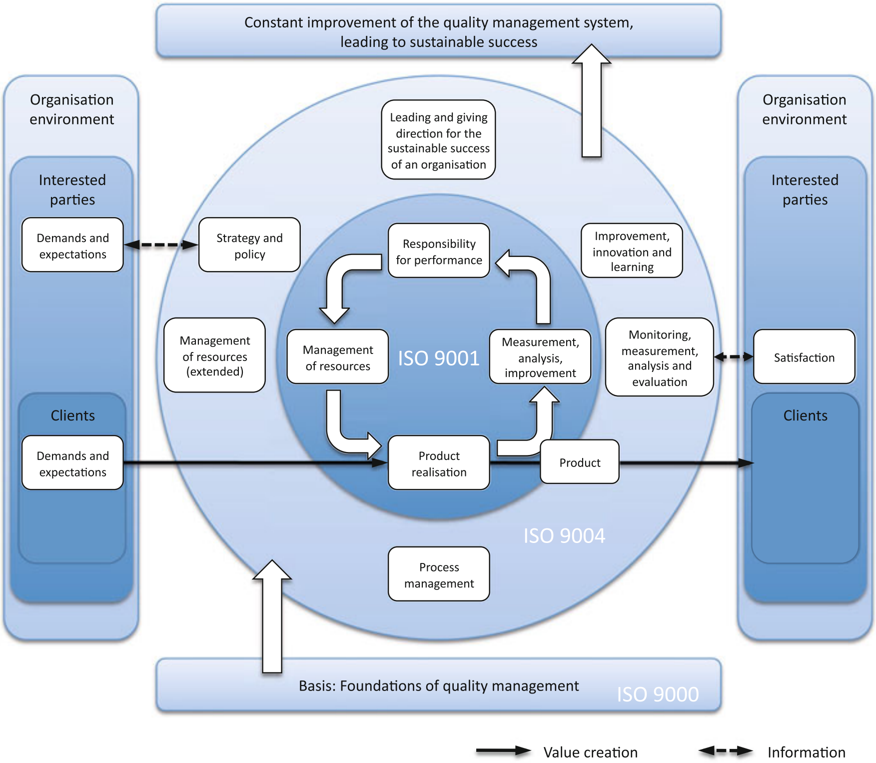

Fig. 3.38 Extended model of process-oriented quality management in accordance with ISO 9004:2009 [75]

and during the whole use phase of the vehicle – something which many companies would like to achieve [25], but the reality can be different. This is why the business domain summarised in this section could definitely be a goal to work towards. In reality, the processes for quality control, assurance and improvement are often spread out over the whole company – which makes it impossible to look at quality in a holistic, comprehensive way. The literature (i.e. [35, 51]), on the other hand, refers to Total Quality Management – as part of which quality is seen as a central part of the company philosophy. At Toyota,[70] where, for the 60 years that the "Creative Idea Suggestion System" has been in place, over 40 million suggestions for improvement were made up to August 2011, the issue of continual improvement is given particular focus.

[70] http://www.toyota-global.com/company/history_of_toyota/75years/data/company_information/management_and_finances/management/tqm/index.html. Accessed: 23 December 2014.

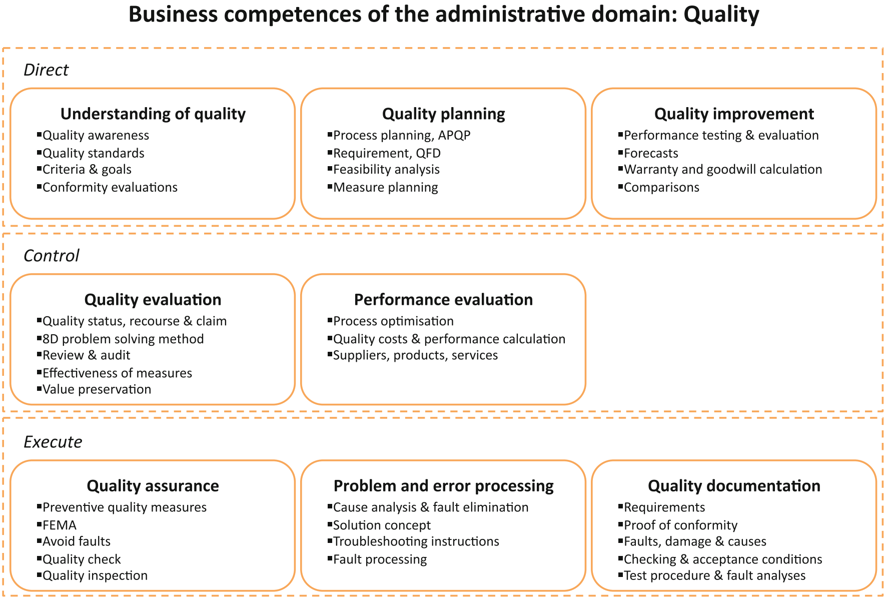

Fig. 3.39 The business competences of the domain "quality"

The domain of "quality" includes the following eight business competences (see Fig. 3.39):

Direct:
- Understanding of quality
- Quality planning
- Quality improvement

Control:
- Quality evaluation
- Performance evaluation

Execute:
- Quality assurance
- Problem and error processing
- Quality documentation

Direct Business Competences

A company is responsible for managing relationships between the critical quality factors, and the effect they have on business development.

The following five driving forces serve the business purpose:

1. Improving customer satisfaction by surpassing quality claims.
2. Reducing costs caused by lacking quality [66] by recognising faults early.
3. Reducing the number of customer complaints by ensuring high product quality.

4. Fast orientation towards goals by collecting quality-relevant data for the purposes of distance diagnostics.
5. Strengthening of customer loyalty by preventing faults.

Understanding of Quality

The understanding of quality represents what a company can and wants to do. Every automotive company needs a framework for the *quality awareness* it would like to represent in its orientation. Alongside the foundations of the normalised *quality standards* such as ISO 9000:2005 [73], companies must also think about the *criteria and goals* they need in order to achieve far-reaching quality on the markets [71]. Limitations on the company's capabilities come about for the company as a result of the skills of staff members, and processes. This is how the company's understanding of quality is derived, and it recognises the areas it needs to take action in.

For products which are subject to basic legal safety requirements – as is the case with vehicles – the *conformity evaluation* has crucial significance in terms of being able to prove compliance with legal requirements internationally, and achieving approval in different target markets.

Quality Planning

Prevention is the basic principle of quality planning – the implementation of which is an important element of quality in the automotive industry in order to be able to turn requirements into specific quality characteristics. The quality required is guaranteed by test procedures and methods on the basis of *process planning*. For this purpose, American vehicle manufacturers have created the reference handbook "Advanced Product Quality Planning and Control Plan (APQP)".[71] A similar approach for German vehicle manufacturers can be found in the German Automotive Industry Association volume 4 [155].

The systematic collection of a broad range of *requirements* as a basic quality planning concept using "Quality Function Deployment (QFD)"[72] dates back to the Japanese planning specialist Yoji Akao in 1966 [3]. In collaboration with the supplier, a *feasibility analysis* of the manufacturability of all requirements from different sources must be carried out and documented. This includes, for example, the suitability of the design and material, in addition to the possibilities provided by machines and processes in order to manufacture products to comply with the required specifications.

As part of quality assurance-focused *measure planning*, one concentrates on the influencing factors of flexible elements throughout the entire value creation chain – deviations from which are recognised early so that measures can be introduced to counteract them.

[71] http://www.aiag.org/source/Orders/prodDetail.cfm?productDetail=APQP. Accessed: 23 December 2014.

[72] QFD Institute Germany e. V. http://www.qfd-id.de/en/index.html. Accessed: 23 December 2014.

Quality Improvement

Quality improvement should constantly ensure that the quality of the product is increased – with the help of suitable measures within the company. An important element in this is the building up of corresponding structures which promote the involvement of employees. A considerable contribution to improvement measures (which lead to quality) was presented on page 204 using the example of Toyota.

Alongside preparation and planning, the criteria for the *performance testing and evaluation* of results are significant in terms of goal-oriented, long-term quality development. There are numerous models which can be used to achieve a higher degree of precision in *forecasts*. The following questions usually play a role in predicting the behaviour of the system in the event of quality problems which can be expected to occur:

- How many and which faults can customers expect to encounter after the vehicle has been delivered?
- Under what circumstances and in which system parts can faults occur?
- Which risks are hidden behind faulty system parts?

While vehicles fulfil high quality requirements, they are not free from faults. This is why a *warranty and goodwill calculation* is indispensable in order to evaluate risks. Often, the evaluation of warranty cases to be expected is calculated on the basis of experience values and payment flows from over the past years. On the one hand, *comparisons* on the market are important in order to market what makes a product stand out – on the other, they are also vital for identifying measures which are necessary to improve quality on the market. Internal benchmarking is also important in order to bring about successful learning from past mistakes. Things become difficult when we come to the connected vehicle – which constantly features new functions which nobody has experience of.

Control Business Competences

The economic viability of the quality strategy which has been implemented is checked. The commercial aim of the control business competences is to be found in the transparency of the calculation of quality costs and performance, using a broad range of indicator systems [172].

The following four driving forces serve the business purpose:

1. Improving the understandability of quality defects by checking that the process flow is seamless
2. Reduction in the number of quality enquiries and measures by avoiding faults thanks to the discovery of potential cause and risk analyses
3. Increase in economic viability thanks to constant optimisation and lowering costs, while increasing maturity for high perception of quality
4. Lowering costs in order to comply with laws and regulations through sustainable quality controls

Quality Evaluation

The *quality status* is monitored using quality indicators from target and actual statuses. The figures collected show, for example, how high the percentage of fault-free performance units is in comparison to the overall number of products made or sold. Using these evaluations, a desired quality level can be planned, managed and controlled. The systematic complaints evaluation of *recourse and claims* pursues the goals of safeguarding endangered customer relationships, while also improving the quality of products, services and processes. This can be the case, for example, using the *8D problem solving method* [25], the report of which is standardised by the VDA.

Specifically planned *reviews and audits* check the *effectiveness of measures* in quality planning, and all business competences in execution. If a high enough degree of effectiveness cannot be proven, then the measure planning needs to be looked at again.

Long-term quality includes vehicles' durability and reliability. From this follows an optimal *value preservation* of used vehicles – the checking of which demands comprehensive quality evaluation.

Performance Evaluation

The performance evaluation is oriented towards operative and tactical control, and has the aim of maximising profit in the short to medium term. It therefore orients itself primarily towards the evaluation of in-house *process optimisations* and their economic viability, as well as efforts which need to be made to warranty customer satisfaction. High quality should be guaranteed while keeping costs competitive by using a *quality costs and performance calculation*. This is why continual measurement and evaluation is needed at the in-house interfaces of *suppliers, products and services*.

Execute Business Competences

Quality of execution starts with defect-free and careful processing of the vehicles, and ensuring that they are complete when they are handed over to the customer.

The following three driving forces serve the business purpose:

1. Reducing production waste and post-production by executing manufacturing which conforms to current provisions and plans
2. Improvement of customer satisfaction through efficient internal and external processing of customer complaints
3. Increasing the effectiveness of quality measures

Quality Assurance

Quality assurance refers to all measures which warranty a constant level of product quality. These include *preventative quality measures* in continual execution, with the help of the "failure mode and effects analysis" (FMEA) [167] – a structured, systematic work technique for the recognition of functional contexts in order to *avoid faults* early on. FMEA is standardised as part of the standard DIN EN 60812:2006.

The *quality check* serves to determine the extent to which the test characteristics and requirements of the quality plan are being fulfilled. The *quality inspection* takes place over several phases in order to prevent faulty parts or assemblies from being passed on or processed.

Problem and Error Processing

During problem and error processing in terms of content, the problems identified during quality assurance – individualised, unrelated faults, or far-reaching structural problems – must be formally prepared for the *cause analysis and fault elimination*. Then, after analysis and classification, they must be put on an effective path to a *solution concept* which can lead to *troubleshooting instructions* both within and outside the company. In customer service, dealing with an enquiry rapidly and respectfully during *fault processing* can affect customer loyalty.

Quality Documentation

Principally, all actions and results of the competences in controls, checks and execution are documented to form an integrated view, and are often archived long-term for legal reasons and in order to comply with obligations to provide proof. The *requirements* on quality documentation are regulated by standards, technical instructions and company guidelines. The documentation and records primarily serve to comply with *proof of conformity*, and to fulfil legal requirements. In the case of product liability claims, documented *faults, damage and causes* become relevant if quality measures and their effectiveness for vehicles, parts, services, processes, contracts etc. are proven. A distinction is made between internal and external documentation – something which has a long history, especially in vehicle manufacturing (see Sect. 2.3). In terms of processes, all *checking and acceptance conditions* are documented with the necessary *test procedures and fault analyses* as well as their results.

3.6.11 Finance and Controlling

In today's intensely competitive market, the economics term "controlling" is preferred to describe the commercial checking and controlling as a sub-function of corporate leadership. We introduced a main task which is part of controlling when we talked about the business competence "risks and finance" from the business domain "corporate leadership". This is why we are focusing the content of the business domain "finance and controlling" on the economic-administrative business competences, which ensure that economic facts can be systematically collected, prepared, evaluated and monitored.

The goal of this business domain is to ensure a balanced relationship between the company's financing possibilities, and its current and planned business volumes. In addition to the financial challenges, there are increasingly complex legal and fiscal conditions which are developing – in addition to audit requirements – which demand a lot of the accounting department. This is why we have summarised "finance and controlling" into a single administration domain.

In all economically-oriented organisations in all sectors, there is a "finance and controlling" department. Many large companies have carried out standardisations using ERP systems and processes. In particular, financial accounting was historically one of the first applications when IBM opened the mainframe for independent software manufacturers in the late 1960s.[73] During the past years, more modern concepts have been researched and developed in this sub-field of economic science – but we do not have space to go into their suitability to practice here.[74]

Long-term planned financial investments during the development phase of a vehicle, the high manufacturing costs and the difficult-to-predict warranty and goodwill services after the sale of the vehicle, are what characterise "finance and controlling" in the automotive sector in particular.

The domain of "finance and controlling" includes the following six business competences (see Fig. 3.40):

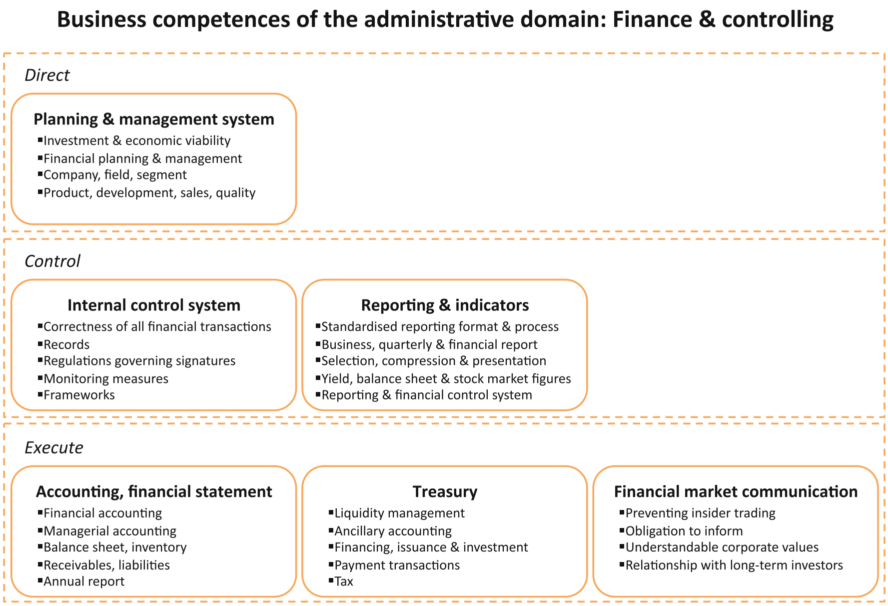

Fig. 3.40 The business competences of the domain "finance and controlling"

[73]Alongside the software company McCormack & Dodge and Management Science America, in 1973, SAP also finished the first application for financial accounting, which became a driving force of the development of ERP systems. http://www.sap.com/corporate-de/about/our-company/history/1972-1981.html. Accessed: 12 January 2015.

[74]For a more in-depth insight, please refer to the literature [100].

Direct:	• Planning and management system
Control:	• Internal control system
	• Reporting and indicators
Execute:	• Accounting, financial statement
	• Treasury
	• Financial market communication

Direct Business Competences

The business domain "corporate leadership" makes basic strategic decisions and determines how the company will progress. The business competences described here work against this – in particular, the implementation of strategic plans.

Planning and Management System

In larger companies, numerous systems support the planning and controlling processes in order to structure complex problem situations on the basis of models. The systems prepare the economic information for strategic or tactical decisions in corporate leadership, and try to make possible effects on entrepreneurial actions easy to understand and plan, and economically viable.

An important business planning instrument is the *investment and economic viability* calculation. It calculates and evaluates the monetary advantages of investments, thereby serving a central function in investment decisions. In addition to investment calculations, contributions to non-monetary company goals can also be taken into account in planning, for example the social or environmental goals from the sustainability reports by BMW [12] and Daimler [32].

An investment is defined as a long-term commitment of financial means in the form of tangible or intangible assets. It can be tied to an object or an effect. Object-related investments include, for example:

Investment in tangible assets	for the acquisition of tangible assets such as technical facilities and machines, stocks of raw materials, plots of land, buildings – especially factories and operational and business equipment which can in particular be used by company-own branches,
Financial investment	as a long-term oriented acquisition of financial assets – such as participatory rights through shares, or other shareholdings such as investor rights through bonds or loans,
Intangible investment	for the acquisition of software, purchase or own creation of patents. These also include investments in staff development, new products or manufacturing procedures, or in measures to increase the value of company brands.

In practice, investments are also different in terms of their cause and effect:

Starting investment	for the setting up of a new company and organisation before revenue can be generated in the sales market from the goods flow created,
Replacement investment	in order to maintain the operational performance capabilities by replacing existing assets,
Expansion investment	in order to increase the operational performance capabilities by broadening the sales possibilities or the product portfolio in a quantitative or qualitative way,
Rationalisation investment	in order to increase the operational performance capabilities by modernising existing assets, with a primary focus on efficient service provision or lowering costs.

Financial planning calculates the future capital needs for financing measures – based on type, amount and time. It orients itself using liquidity and economic viability goals in order to prepare and evaluate financial decisions. *Financial management* builds on strategic and operative financial planning. Strategic planning includes all plans for long-term livelihood security – which, depending on the company and economic viability goals in question, can extend over a period of 3–10 years. On the other hand, operative planning orients itself towards the expected and desired development of the company within the future planning period, within the master data determined by strategic financial planning. This period tends to be 1 year. It orients itself primarily according to liquidity goals, and ensures that the company remains solvent. Sometimes there is also tactical planning – the period of which lies between the operative and the strategic planning.

An important operative process in financial planning is budgeting. This is about setting up a budget in order to make sums of money available for particular goals. The system of budgetary planning often has no detailed measure plans through which managers are allowed some freedom to make decisions and act as part of the budget.[75]

Goals on the level of *company, field, segment* are derived from the strategic company goals. The business domains of the core business (see Fig. 3.7) are in particular focus when the company goals are derived. At the same time, the *product*, *development*, *sales* and *quality* have critical significance for the business. The sales price of a vehicle cannot be calculated solely on the basis of the materials used, development and manufacturing costs, supporting allocation of overhead and revenue surcharges; instead, a market analysis is also relevant in order to calculate the price which potential customers would be prepared to pay. Target costs such as these are shown in the financial plans of core business areas such as procurement and production. *Sales* involves the marketing and distribution of products and services. It is about the financial and volume-related planning and management of goals, in terms of market shares and revenue. This includes strategic aspects such as price, communications and distribution policy, as well as operative aspects such as

[75] For a detailed look at planning and budgeting, please see the literature [127].

turnover and customer planning. What is crucial in terms of *quality* is the collection, evaluation and controlling of quality costs – which include, for example, the costs of internal and external faults which come about as a result of non-fulfilment of quality requirements. External defect costs come about as a result of complaints, recourse, returns, warranty and goodwill. In-house defect costs, on the other hand, become apparent before the product or service is delivered. These include, for example, costs in production which are caused by material or construction errors. Often, the costs of checking for and avoiding faults are calculated into the quality costs.[76]

Control Business Competences

The monitoring of financial services is one of the most critical functions in large companies which operate on a global scale. In the automotive industry in particular, relatively few employees are responsible for moving many large international payment flows which come about through goods revenues; whereas many more employees are required in the development and manufacturing of the goods in question. In terms of vehicle development and the goods flow, regional efficiency is particularly in the foreground – which is why globally standardised risk controls must be a priority.

The following four driving forces serve the business purpose:

1. publication of reliable, complete and verifiable financial reports
2. transparent and controllable processes in order to avoid or recognise abuses in the financial industry
3. continual improvement and auditing of the legality of all financial transactions through process controls, safeguarding, acceptance, and records – at easy-to-understand prices
4. provision of indicators which can be used in order to optimise the company's financial position, and help it to be more easily understood

Internal Control System

All persons working for a company must comply with legal regulations. It is not only managers who have to fulfil corresponding duties of care and supervision. Nonetheless, there is never any shortage of high commission payments, private journeys which are billed as business, fraud scandals, and accusations of bribery. In order to avoid such abuses occurring, internal checking systems have been introduced which monitor, analyse and verify the commercial processes and guidelines in the company in particular. The best known legal provisions anywhere in the world for an internal controlling system are the US regulations in accordance with the Sarbanes-Oxley Act (SOX). Another important example is the German Control and Transparency Act (KonTraG [27]).

[76] A more detailed description of function-related controlling is described in the literature, for example [83].

According to the auditing standards of the Institute of Public Auditors in Germany, depending on needs, the internal auditing systems are either upstream from, equal to or downstream from the work processes in commercial fields, and have the task of

1. ensuring the effectiveness and *correctness of all financial transactions*,
2. avoiding and flagging up damages to assets, in order to protect existing assets from losses,
3. compliance with the legal provisions which are crucial for the company,
4. creation of precise, clear and up-to-date *records*, as well as
5. improvement of operational effectiveness, by evaluating records.

The basic principles of the controls include transparency, the double check principle, and the *regulations governing signatures*.

Alongside the process-integrated *monitoring measures*, the internal control system has also developed further to include process-independent monitoring measures such as internal auditing. In this business competences, we will limit ourselves to the process-integrated monitoring measures – because we have classified internal auditing as part of the business competence "integrity and law" from the domain "corporate leadership".

For more detail about national and international instructions, enterprise-wide tried and tested *frameworks* and practice-based implementations of guidelines for the building up of internal auditing systems, please see the literature [28].

Reporting and Indicators

On the one hand, reporting is the central management basis for any financial decision; on the other, it has a controlling function on the basis of company-specific indicators. It must guarantee enterprise-wide transparency and the comparability of all financial transactions in the company. For this to be possible, the *report format and process must be standardised* so that the managing directors, managers, employees and stakeholders can be informed about selected, important company facts in a targeted way. External reporting includes, for example, *business, quarterly and financial reports* – which serve to cover the stakeholders' information requirements, as well as to prepare and check decisions. The conception of information preparation is crucial – because very different values can be reached depending on whether one does one's accounts in accordance with the German Commercial Code (HGB), in accordance with taxation law, or in accordance with International Financial Reporting Standards (IFRS). The complexity of the data should be reduced so that unambiguous, clear results can be obtained. There are fewer reporting obligations and larger degrees of freedom in the internal reporting of the *selection, compression and presentation* of information, because it is not subject to any legal requirements.

Indicators represent an important instrument in reporting as part of operative controls. Very common, for example, are *yield, balance sheet and stock market figures*. In many automotive companies, external reporting and indicators are about much more than just “finance and controlling”. In the strategic examples in Sect. 3.1, we listed the sustainability reports from BMW [12] and Daimler [32]. External reports such as the sustainability reports – which are about more than just financial indicators – are also provided by other automotive companies. Nonetheless, the financial data with its reach and the risks it draws attention to are still in the primary focus of most stakeholders and report recipients. For a more in-depth look at the business *report and financial control system* and the possibilities they offer for data preparation and target/actual comparisons; or time comparisons as decision aids for “corporate leadership”, please refer to the literature [124]. Fundamentally, in reporting, the benefit and cost involved must be compared with the numerous indicators. Considerations of economic viability should prevent documentation from becoming excessively extensive.

As an example, let us highlight the yield indicator EBIT “Earnings Before Interest and Taxes”, because it permits an evaluation of profitability from operative business operations – independently of the financial structure of the company. This makes it possible to better compare automotive companies which are financed in different ways and which, due to being headquartered in different countries, are taxed at different rates.

Toyota, for example, leads the mass manufacturers with an average EBIT of 1801 € for each vehicle (automotive sector only) which was produced between January and June 2013.[77] In these statistics, produced by the University of Duisburg-Essen in Germany, Hyundai follows with 1027 €, Kia 911 €, Nissan 861 €, Honda 785 €, Chrysler 768 €, Ford 717 €, Skoda 671 €, VW 629 € and General Motors with 604 € per vehicle. Of the premium manufacturers, Porsche leads with 16,590 € ahead of Ferrari-Maserati with 15,000 €, Audi 3821 €, BMW 3495 € and Mercedes with 2011 € per vehicle (automotive sector only).

According to more recent figures[78] from the third quarter, Mercedes-Smart with 3675 € is ahead of BMW with 3330 € and Audi with 2698 €. For the first time, Mercedes has overtaken BMW and Audi in terms of profit per car – it should be borne in mind, however, that these indicators only show a snapshot of what is happening.

Execute Business Competences

The execute business competences form the basis of the financial business within the company, and contribute significantly to the success of the company. The following five driving forces serve the business purpose:

---

[77] This is how much each car manufacturer earns per vehicle http://www.welt.de/wirtschaft/article118779825/So-viel-verdienen-die-Autohersteller-pro-Fahrzeug.html. Accessed: 12 January 2015.

[78] “Mercedes overtakes its premium competitors Audi and BMW in terms of profit per car”. https://www.uni-due.de/~hk0378/publikationen/2014/20141105_Automobil-Produktion.pdf. Accessed: 12 January 2015.

1. Fulfilment of legally regulated accounting and information obligations
2. Minimisation of accounting tasks which must be carried out manually, and which are prone to error, by integrating automated functions and instruments
3. Reduction of the time, effort and costs involved in regular financial statements – by introducing comprehensive automation and global standardisations
4. Efficient, economically viable treasury
5. Slimmed down, effective communication on the financial markets

Accounting, Financial Statement
Accounting is divided into external and internal sections:

1. *Financial accounting* provides an overview of a company's economic position – in chronological order. In it, the company's business transactions during a given time period are recorded in figures – in compliance with laws and "generally accepted accounting principles". Business transactions always bring about a change in a company's assets or capital – for example, the purchase of material, payment of staff, or distribution of vehicles. For European or American vehicle manufacturers, the usual time period taken is the calendar year. For Japanese companies, on the other hand, the business year starts on 1 April. Financial accounting includes all proofs of capital transactions, monetary transactions, assets and debts. The company's profits and losses can be read from the financial accounting as so-called "external accounting", and it forms the basis for profit determination and financial statements.
2. *Managerial accounting* complements financial accounting, as so-called "internal accounting". Its main task is the collection, distribution and attribution of costs and services which are necessary in order to fulfil the company's actual business purpose.

Financial accounting is systematically implemented in ERP systems in processes for all relevant tasks of main, creditor, debtor, investment and bank accounting, and for the financial statements – for example in the SAP module Financial Accounting FI [56]. Managerial accounting is also just as standardised in all tasks relating to overheads, product costs, cost types, cost centre, process costs, profit and loss, and market segment accounting, as well as overhead orders and projects – for example as part of the SAP module Controlling CO [24].

Fundamentally, the *balance sheet* is the financial statement for the accounting department at a given point in time, which compares the company's assets and capital. In the case of the annual financial statement, the point in time in question is the final day of a financial year. There are many different types of balance sheets and corresponding instructions which must be taken into account in the structure and content. The balance sheet is a short, easy-to-understand presentation of the company's assets and debts, their quantity structure – the *inventory* – the index of assets and debts which follows the inventory. In the automotive industry in particular, planned amortisations on investments in tangible assets are an important figure, and an indicator for future investments. Tangible assets include, for example, technical facilities and machines, plots of land, buildings – in particular factories, operational and business equipment, in particular in terms of the sale of company-owned branches. Due to its capital lock-up, tangible assets represent an important item on an automotive company's balance sheet. Due to the high leasing and financing rates in vehicle sales, and sales with residual value guarantee as an instrument of sales financing, *receivables* and *liabilities* from the financial services industry are very significant items on the balance sheet.

In practice, the balance sheet is usually summarised with the profits and losses, and a comprehensive picture of the economic situation and development of the company (status report) to produce a *annual report* – the central instrument for communication with all capital providers, which is managed via the business competence "reporting and indicators".

Nowadays, no large-scale vehicle manufacturer would build up its own in-house accounting department – these only exist in the form of "historical burdens"; smaller companies in the automotive sector, meanwhile, often use their own specific solutions for reasons linked to cost and investments – but these do nothing to differentiate them on the market.

Treasury

The main aim of the business competence "treasury" is to *manage liquidity* throughout the business. Essentially, this is about collecting and managing the existing or incoming financial resources for the internal and external financing of the company – in order to guarantee that it can finance itself. The term "treasury" has established itself in companies to refer to this. In addition to the financing of the company and investing its liquid resources, however, the "treasury" is also responsible for limiting risks associated with interest, currency and commodity prices. We introduced financial risk evaluations when we talked about the business competence "risks and finance" from the business domain "corporate leadership".

Alongside numerous types of *additional accounting*, all core tasks of treasury are closely linked to the financial accounting of the business competence "accounting, financial statement". Also, the payment flows are broken down into several work processes in order to achieve the highest possible level of checks in order to be able to rule out intentional abuses or manipulations as far as is possible.

Inspired by Reisch [126], there are the following three core tasks of treasury (see Fig. 3.41):

1. *Financing* of the business competences in the value creation chain ("core business domains"). For example, through strategic new investments in operating materials and resources in the business domains "research and development", "production" and "sales and outbound logistics" or in financing – such as credit or leasing in the business domain "financial service".

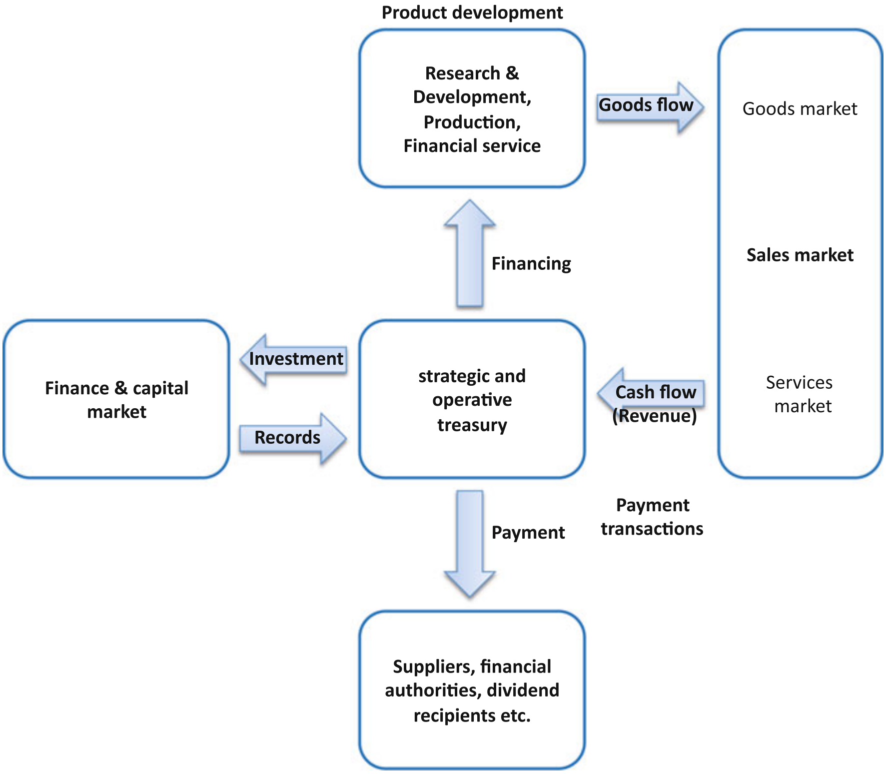

Fig. 3.41 Core tasks of treasury, as inspired by Reisch [126]

According to the principle of model series, product development usually takes 7–8 years,[79] meaning that vehicle manufacturers have to wait for a long time between financing, the goods flow and revenue from the cash flow (for example sale of vehicles, spare parts or vehicle-dependent services). In this way, a profit-oriented value creation chain can use some of the revenue in order to finance the next model cycle, and for running expenses. Any excess funds can be invested in financial and capital markets. If a current model cycle is leading to losses, however, vehicle manufacturers must take extra money from the financial and capital markets in order to finance the next model cycle and running expenses. The task of treasury is to procure funds as cheaply as possible. In doing so, they must weigh up when they need the money, and what the best financial conditions are.

[79]Volkswagen wants to be like Apple and Google http://www.welt.de/wirtschaft/article125408707/Volkswagen-will-so-werden-wie-Apple-und-Google.html. Accessed: 12 January 2015.

In general, financing operations comply with enterprise-wide, standardised financing guidelines for corporate leadership – because they are often closely linked to risk evaluations.[80]

2. *Issuance and investment* in the financial and capital markets, with the financial aim of keeping the capital liquid. Debt repayments, for example, are operative payment obligations to the financial market. A basic strategic decision which has to be made, is whether the treasury team should also make a profit through their own financial and currency exchange trading, and whether they should engage in securities trading. This brings with it opportunities and risks – but also changes to the vehicle manufacturer's business model.
3. Management and checking of *payment transactions* for deposits and payouts at home and abroad (in foreign currencies as well). Examples of operative processes include payments of dividends and taxes, materials purchases, running wage payments to staff, or payments to suppliers for the manufacturing of parts. On the other hand, payments to suppliers in order to safeguard raw materials are managed strategically. Operative payment transactions also include the management of customer deposits.

Often, issues related to *tax* are taken on as an extra core task because, in the international arena, financial investments and issuances are closely linked to tax issues and the resultant tax burdens.[81]

Financial Market Communication

In the case of targeted communication with investors from the financial and capital markets, the following three groups are the main focus:

1. Investors (equity providers and outside creditors)
2. Financial analysts
3. Financial media as multipliers

Financial market communication could be structured as part of the business competency "corporate communication" from the domain "marketing and communication". This is, however, a very specialised, finance-oriented type of communication which is often treated separately. While it must comply with company guidelines and values in terms of communication, and be closely coordinated with external communications, there are also many considerably stricter rules and controls which have been introduced – specifically in order to *prevent insider trading*.

[80] The issue of financing is much more complex than we are able to portray within the scope of this book. Please consult further literature [85].

[81] For a more detailed look at operative and strategic liquidity management, please refer to the literature [126].

In financial market communication, many goals are pursued with varying levels of priority, depending on the company in question. In [111], the following goals were classified according to their relevance:

high priority:	1.	fulfil duty to provide information
	2.	increase value of the share
	3.	increase the number of long-term investors
	4.	increase credibility of the management team
medium-level priority:	5.	decrease volatility of share prices
	6.	increase coverage by analysts
	7.	reduce capital costs
	8.	increase recognition level
	9.	increase the number of purchase recommendations
low priority:	10.	improve access to new capital
	11.	improve price-earnings ratio
	12.	improve price-cashflow ratio
	13.	improve access to strategic partners
	14.	increase diversified holdings

Numerous instruments and applications are needed – in particular, to fulfil the *obligation to inform* in a verified way, to ensure *understandable corporate values* (or share values) and to maintain the *relationship with long-term investors* in a well-managed way.

In [91, p. 18], the main guiding principles in practice for successful interactive communication between company and financial market can be summarised as follows:

1. *Objectivity, Credibility, Promptness*
   In order to retain and strengthen the trust of the capital market, all information must be objectively correct, reliable, open and prepared and made available promptly.
2. *Fundamentality and Completeness*
   Taking into account legal constraints, exclusively information which is to do with a company's business activities or success may be published.
3. *Continuity, Consistency, Comparability*
   Information from the capital market should be made available on a continual basis, and should particularly take into account the previously mentioned second principle of 'fundamentality and completeness'.
4. *Future Orientation*
   Statements which make it possible to draw conclusions about the future success of a business are of particular interest to the capital market.
5. *Equal Treatment*
   All participants in the capital market are treated the same in terms of time and content.

6. *No passing on or exploitation of insider information.*
   Those employed within financial market communication are insiders. Insider information may not be passed on or used.

As part of financial market communication, there are many measures and instruments which can be used. There are two types of communication: obligatory and voluntary. In many countries, annual or quarterly reports are obligatory. An annual general meeting also allows interactive communication. Press releases or conferences, on the other hand, are voluntary – and give companies more freedom in how they shape more personal interaction with specific stakeholders.[82]

3.6.12 Infrastructure

The automotive industry has many complex, large and differently shaped locations for production sites, warehouses, research and development labs and management offices. This domain summarises a high cost factor, and represents the foundation which the business model of the vehicle manufacturers is built on. Most of the business competences are supported externally.

The domain of "infrastructure" includes the following four business competences (see Fig. 3.42):

Direct: • Location planning
Control: • Facility and site safety
Execute: • Equipment and supply
• IT operations

Direct Business Competences

The most important managing business competence is "location planning", as the choice of location has very far-reaching consequences for the company's infrastructure, and has an effect on long-term investments.

Location Planning

The *decision-making process* is dependent on the characteristics of the planned location. For an automotive company, the decision to go for a particular production location has more far-reaching consequences than is the case for office or administration buildings – because once a production location has been selected, it can subsequently only be optimised to a very limited extent. But moving a headquarters, with all its office spaces, can mean a lot of work. Above all, the move is driven by the business competence "goals, values, principles" from the domain "corporate

[82] For a more in-depth look at the increasing significance of financial market communication, please see the literature [91, 122].

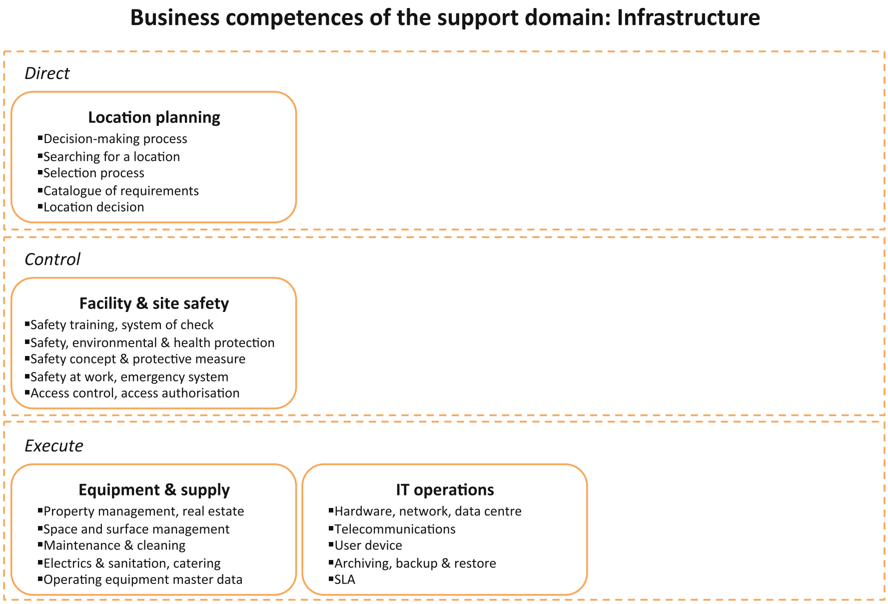

Fig. 3.42 The business competences of the domain "infrastructure"

leadership". We have already mentioned the move made by Daimler's board of directors in this context. Much more work, however, is involved in bringing several locations together into a new headquarters – as was announced by Toyota in 2014.[83]

The process of *searching for a location* in order to expand capacities takes place over several stages – during which alternative choices of location are filtered out by detailing the requirements. As part of the *selection process*, requirements such as staff availability or funds are taking into account as well. For the remaining locations, a precise *catalogue of requirements* is formulated, with factors that have different priorities. Common factors which are important in the choice of a production factory are size of plot, topography of plot, technical supply and disposal, transport exploitation, buildings in the vicinity, proximity to airports, geology of plots, factors which could hinder construction, construction laws, and staff.

All types of *location decisions* must be coordinated internally and externally through the business competence "corporate communication" from the domain "marketing and communication". In practice, it is thoroughly realistic that only 20 % of the staff will agree to a company decision for large-scale relocations of sites.

The in-house location planning of a factory is a particular case in point, because many requirements depend on product development. This is taken on by the business competence "equipment planning" from the domain "production".

[83]"Toyota to Establish New North American Headquarters" http://corporatenews.pressroom.toyota.com/releases/toyota+new+north+american+headquarters.htm. Accessed: 12 January 2015.

In the largest automotive companies around, modernisation of sites is part of everyday business.

Control Business Competences

In terms of infrastructure, control business competences concentrate on safety measures at the locations.

Facility and Site Safety

In this context, the global instructions of the business competence “safety and security” from the domain “corporate leadership” are implemented in the fields of infrastructure and safety documentation. As such, the staff are also given corresponding *safety training*. The *system of checks* takes into account the most important aspects of *safety, environmental and health protection* in the planning phases up to the installation of the operating resources which are used in the different domains. Corresponding *safety concepts and protection measures* are used in order to minimise risks for staff and the company. Depending on the situation, it is also possible that suppliers will have to be involved.

Safety at work is guaranteed by a broad range of measures. These include, for example, checks on fire protection measures, the factory fire brigade, traffic safety on the operating premises, in addition to medical care on the sites in question. The associated *emergency systems* are checked regularly.

This business competence also implements preventive measures for worldwide site protection against attacks from third parties. This includes *access control* and the management of *access authorisations* for staff, in addition to checks on which goods enter and leave the sites.

Execute Business Competences

The operative infrastructure is covered by the business competences “equipment and supply” and “IT operation”.

Equipment and Supply

In the business competence “equipment planning” from the domain “production”, we specifically listed the material resources which are needed for production. Furthermore, especially in administration, these also include intangible resources such as IT and telecommunications. We will present “IT operations” as a business competence in its own right.

Property management also includes the administration of *real estates* while new factories and facilities are being built. In *space and surface management*, for example, it is about facilities, as well as the operative coordination of *maintenance and cleaning*. *Electrics and sanitation*, for example, are part of the technical infrastructure. There are also a handful of automotive companies which have their own *catering* – however, we will list this under “infrastructure” because both restaurants and shops on factory premises are now nearly always run by external companies.

The focus of all administrative tasks of this business competence is on *operating equipment master data*, as part of which all the main data and documents are brought together – such as site plans and architectural drawings, for example.

IT Operation

Nowadays, with their *hardware and networks*, automotive companies often have IT infrastructures which are spread over more than a hundred *computer centres*. Added to these are the networks for *telecommunications*. In practice, every factory has its own IT infrastructures – something which often also applies to larger laboratories as well. Not all IT systems, however, can be centralised. Scanners or printers, as *user devices*, are always required on-site. What can be centralised, however is the administration and management of safeguarding against outages – for example in the case of a malfunction. Important functions here are *archiving* as well as *backup and restore*. The service properties, such as scope, reaction time and speed of processing, are ensured by way of "Service Level Agreements" (*SLA*).

In the automotive industry, it is usually the IT operations – regardless of the scale of the "shadow IT" in the specialised areas – which represents the largest block of costs that a CIO has to deal with. For a more in-depth look at the operation of IT infrastructures, see the literature [131].

3.6.13 Corporate Support Service

This business domain has a supporting role, but in comparison to the other domains, it has no standardised, goal-oriented business competences. It is more of a compilation of different, separate business competences which come together to support the company.

The domain of "corporate support service" includes the following six business competences (see Fig. 3.43):

Direct:
- Knowledge and ideas
- IT planning
- Project, portfolio, process

Control:
- Law and regulations

Execute:
- IT development and documentation
- Assistance

Direct Business Competences

The direct business competences for the support of the company include "knowledge and ideas", "IT planning" and "project, portfolio, process".

Knowledge and Ideas

This business competence collects and develops the company's intellectual property, and makes it available. Without this competence, the automotive company would not

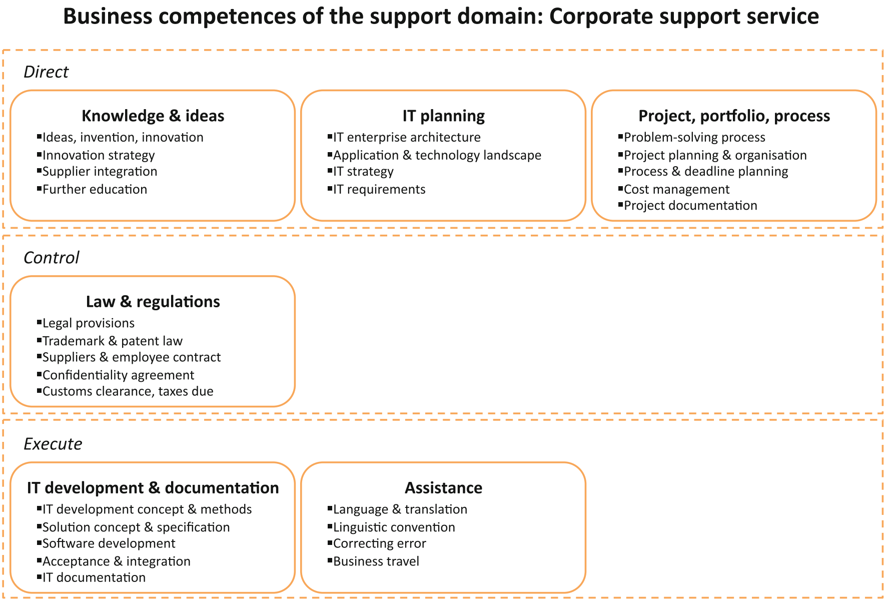

Fig. 3.43 The business competences of the domain "corporate support service"

be able to manufacture a single vehicle. We will not, however, go into more detail about the company knowledge which can be found in its documentation and among its staff – instead, please see the literature [120]. In this context, it is more important to show how new knowledge is created in the digital era, and how it can be used in a targeted way in order to bring about business success. In Sect. 1.3, we showed that the value creation share of suppliers is over 71 % – because nowadays, a great proportion of innovations come about as a result of cooperation with suppliers.

A main distinction is made between the following three terms:

Idea is always a good place to start. By itself, however, it neither changes nor achieves anything in the company.

Invention turns an inspiring idea into reality, but it does not mean immediate business success. In this phase, it is still a patent or a unique prototype.

Innovation creates a value for the company which can be produced, and influences business success.

For example, the continual improvement process Kaizen has become established in the business competence "production process and simulation" from the domain "production". This means that Japanese and German companies have different *innovation strategies* [142], especially in terms of how *supplier integration* takes place [22].

The business competence "operation and development" from the domain "human resources" does not cover professional *further education*. The further development of company-related knowledge is planned and implemented using appropriate training measures. For this, the administration and making available of the right training documents is needed in appropriate institutions.

IT Planning

We are dealing with this business competence separately from the overall IT competence, because it can – in contrast to "IT operations" from the domain "infrastructure" – be crucial in the directing the future of an automotive company [23]. At the centre is the *IT enterprise architecture* which we introduced in Sect. 1.7. It is shaped by the *application and technology landscape*. Here, for example, Daimler has implemented a very central *IT strategy* [125]. The IT strategy orients itself towards the "corporate strategy" from the domain "corporate leadership". The IT-specific processes and methods are used to collect, qualify and detail *IT requirements*.[84]

Project, Portfolio, Process

This business competence is about the planning, controlling, checking and finalising of projects. Throughout the whole company, very different projects are initiated which are supported by this business competence. Both internal and external staff can follow a *problem-solving process*, starting with *project planning and organisation* and moving on to the specification of *process and deadline planning* and to detailed *cost management* including all *project documentations*.[85]

Control Business Competences

Because of international business and the legal liabilities for damages due to automobile recalls, an in-house auditing business competence of "law and regulations" is absolutely necessary.

Law and Regulations

In this business competence, *legal provisions* need to be taken into account and fulfilled, but also optimised in terms of implementation.

Due to the high degree of supplier involvement in "knowledge and ideas", it has an advisory function for the clarification of legal issues in order to protect intellectual property, for example within the context of *trademark and patent law* and the associated regulations. Regular legal consultations and checks must also be made, however, on the thousands of *supplier and employee contracts* with corresponding *confidentiality agreements*. In the case of dishonest passing on of information, legal steps involving damages claims may be taken – depending on the consequences which the passing on of information had.

[84] For a more extensive look at strategic IT planning, see the literature [65].

[85] Please refer to the literature [78].

Alongside *customs clearance*, which is nowadays broadly automated through the use of software, country- and goods-specific information on customs also needs to be administrated. The goods in the international goods flow of the business competences "production supply" from the domain "procurement and inbound logistics" and "order and distribution" from the domain "sales and outbound logistics" must be registered for customs clearance.

For internal calculations, in addition to any customs duties due, any *taxes due* must also be calculated. This business competence does a lot more than just calculating figures and making information available. It manages and influences goods procurement, as well as the business competence "location planning" from the domain "infrastructure", by analysing what room for manoeuvre there is in terms of taxation. This includes evaluating tax payments, such as those for income tax, commercial tax and VAT.

Execute Business Competences

The business competences "IT development and documentation" and "assistance" are both part of the operative support of the company.

IT Development and Documentation

In IT, it is nowadays rather uncommon – especially due to the new, more agile and automated *IT development concepts and methods* – to separate development from the business competence "IT operations" from the domain "infrastructure" [173]. In terms of development, changes or expansions are needed as quickly as possible – while, on the other hand, operations need a stable environment. The environments for mobility services have already created smooth transitions between these two very different competences, as is for example the case at car2go.[86] The automotive branch, on the other hand, which is mainly reliant on product development (see Sect. 2.2), shapes the traditional, supporting IT – where development still has contact with selected business competences, but IT operations are decoupled from the business content.

In contrast to the business competence "development and engineering" from the domain "research and development", in most cases, IT development is taken on completely by suppliers – either through in-house *solution concepts and specifications* or through adjustments to software packages which have been purchased. This business competence therefore mainly concentrates on coordinating and administrating *software developments*. In order to effect the *acceptance and integration* of the software solutions into the existing IT landscape, several different test stages must be completed – as part of which both individual and combined functionalities, as well as non-functional safeguards are tested to measure their load behaviour, standards, integration etc.

[86]"Daimler Subsidiary Moovel GmbH Helps Clients Find the Shortest Route with the IBM Cloud" http://www-03.ibm.com/press/us/en/pressrelease/45251.wss. Accessed: 12 January 2015.

In practice, *IT documentation* is an essential accompaniment to every application – but it is often put together in a painstaking manual process, and becomes outdated faster than the IT application itself. Development systems with automated documentation creation options can guarantee that at least some sub-aspects – such as interfaces – are always kept up-to-date.

Assistance

This business competence includes services for *language and translation*, which are needed for international business – for documentation in different business competences such as "product data and documentation" and "editing and proofreading". In order to achieve this, the company's *linguistic conventions* are managed and assured – especially in terms of specialist terminology. This is not the business competence, however, as part of which stylistic or linguistic assessment, or editing of the information takes place. This is what proofreading is for – as part of communication – while here, it is just about *correcting errors*.

The action areas of all core business domains are active on an international level. As a result of this, many *business travels* are needed – which are booked with the help of agencies. A company-owned airline, as once existed in the form of "DaimlerChrysler Aviation"[87] is an exception in the automotive industry.

Usually, all services of this business competence are provided by external staff.

3.7 Reference Model of the AUTOmobile Business Competences

Let us recall the framework of the enterprise architecture which we set out in Fig. 1.8. We described the business architecture as the central transition from business model and company organisation to business architecture. In Fig. 3.7, we presented the interface "belong to" in the context of the automotive industry – with a reduced number of essential business domains. In the previous section, we described the domains with their business competences and some characteristics of their most important business components. In Fig. 3.44, we summarise the model as our reference model for business architecture for today's AUTOmobile industry. Apart from just a few exceptions on the level of business competences, the reference model can also be applied to the other types of vehicle manufacturers (see Sect. 1.3). In terms of the detail of the reference model, however, we only touched on build to stock for mass production, and build to order for passenger vehicles. While in the case of build to order, the customer puts the vehicle together himself with a few constraints, in the field of commercial vehicles, other business processes are needed in order to guarantee more flexibility in terms of build to order. In an even more specific context, in the case of construction machines and equipments, more

[87]"Daimler-Chrysler sells airline" http://www.auto-motor-und-sport.de/news/daimler-chrysler-verkauft-fluggesellschaft-724842.html. Accessed: 12 January 2015.

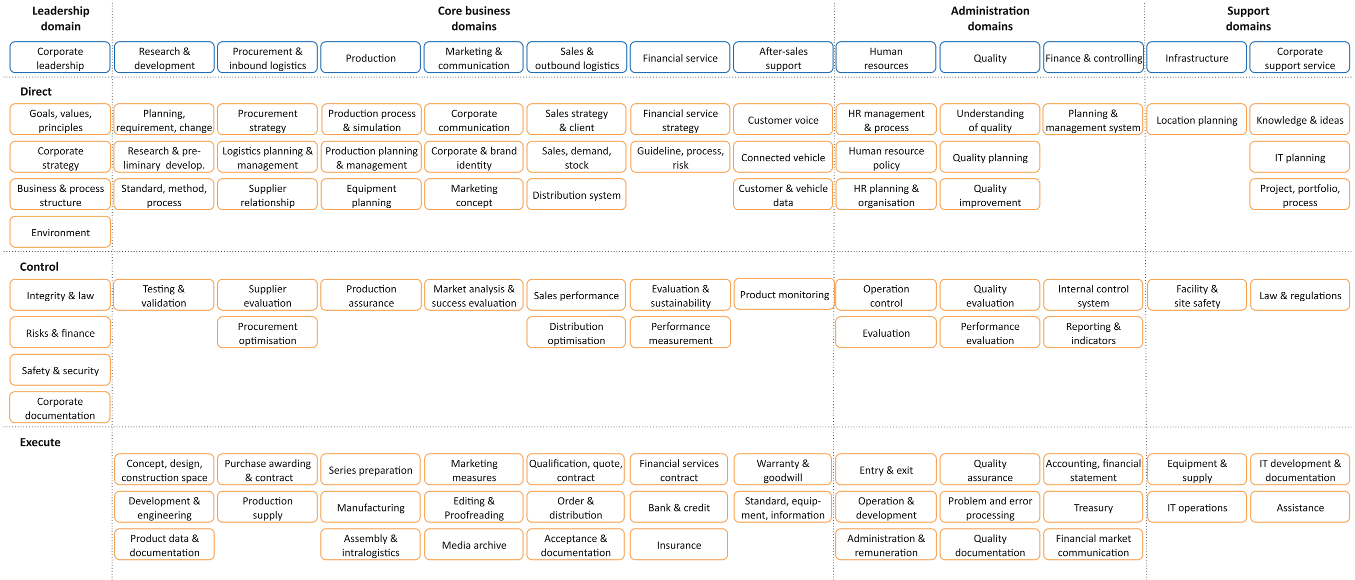

Fig. 3.44 Reference model for business architecture for today's AUTOmobile industry. It represents an overview of some business competences of a fictitious automotive company which manufactures passenger vehicles

complex build to order productions and engineer to order are becoming relevant for fleets. The complex individual production is characterised by the fact that in order to deliver a given product, order-specific changes or even completely new constructions are needed in development (see Fig. 2.2). In the case of such an intention, it is possible, for example, to plan and monitor the cost and revenue situation in the Risks and Finances sections in more depth than we have shown in the reference model.

We make no claims that the description of the business competences of a reference model for a fictitious vehicle manufacturer is complete. It only covers a handful of business components and purposes. Broadly speaking, the reference model is meant to show the business architecture of today's AUTOmobile industry.

The level of business components is the final level of detail of the enterprise architecture that we will go into. For the next level of the business services as a transition to the IT aspects of an enterprise architecture, we would have to introduce the business processes [136] and process modelling [145] in a more intense way. The sub-architectures of the technology, information systems and business services are referred to by the literature as Service Oriented Architecture (SOA), and are described as being broadly independent of specialised industries.[88] It is certainly relevant for the specific transformations a vehicle manufacturer might want to carry out, but it soon becomes company-specific and IT-heavy. We are limiting our scope to a more general look at the problem of how an automotive industry can develop in the direction of a mobility industry.

In this chapter, we have shown that IT plays a vital role in almost all of the business competences. Now, these business competences must be re-orientated from the viewpoint of new business models. Before we go into more detail about this in the next chapter, Chap. 4, we would like to finish this chapter by reflecting on the bad reputation that IT has tended to have throughout history.

Unfortunately, IT is often likened to a slow-moving "belly", rather than being a quick-moving head, for example. To commemorate the decision made by Daimler-Chrysler in 2000 – which is still hard to comprehend today – when the firm (who was then the European market leader in terms of services) sold its IT[89] we would like to conclude the chapter with a poem (inspired by Klaubert et al. [92, p. 40]):

"Be off with you, belly!"
Said throat and head one day
And the other organs chorused too:
"The belly, what on earth's it for?
It's fat and round, and just wants more.
Oh surely, our majestic body
can survive without a belly."
And all the rest decided too:

[88] For more detail, please see the literature [48].

[89] Deal with Debis. DER SPIEGEL 11/2000. http://www.spiegel.de/spiegel/print/d-15930886.html. Accessed: 23 December 2014.

"Good riddance, belly, be off with you!"
. . .
But after just a little while
the body did begin to tire.
The organs, poor defenceless things,
couldn't be bothered to lift a finger.
They got all weak – and, thank goodness
didn't succumb to any illness.
Because they realised: "Heavens above!
What about a belly's not to love?!
. . .
So come back here, you big fat tum,
You really are a useful chum!"

References

1. Aier S, Schönherr M (2007) Model driven service domain analysis. In: Service-oriented computing ICSOC 2006. doi:10.1007/978-3-540-75492-3_17
2. Afuah A (2003) Business models: a strategic management approach. McGraw-Hill/Irwin, New York
3. Akao Y (ed) (2004) Quality function deployment (QFD): integrating customer requirements into product design. Productivity Press, New York
4. Alfabet Meta-Modeling AG (2007) Planung einer serviceorientierten Architektur mittels Best Practices für Enterprise Architecture Management, Berlin
5. Arnold D, Isermann H, Kuhn A, Tempelmeier H, Furmans K (Hrsg.) (2008) Handbuch Logistik, 3. Aufl. Springer, Berlin
6. Arnolds H, Heege F, Röh C, Tussing W (2013) Materialwirtschaft und Einkauf: Grundlagen – Spezialthemen – Übungen, 12. Aufl. Springer Gabler, Wiesbaden
7. Bach N, Brehm C, Buchholz W, Petry T (2012) Wertschöpfungsorientierte Organisation: Architekturen – Prozesse – Strukturen. Springer Gabler, Wiesbaden
8. Bahke T (2012) Normung. In: Czichos H, Hennecke M (Hrsg.) HÜTTE – Das Ingenieurwissen, 34. Aufl. Springer Vieweg, Berlin, S O1–O23
9. Bauer J (2012) Produktionscontrolling und -management mit SAP® ERP: Effizientes Controlling, Logistik- und Kostenmanagement moderner Produktionssysteme, 4. Aufl. Springer Vieweg, Wiesbaden
10. Bauer J, Hayessen E (2009) 100 Produktionskennzahlen. Cometis, Wiesbaden
11. Bayer J, Collisi T, Wenzel S (Hrsg.) (2002) Simulation in der Automobilproduktion. Springer, Berlin
12. Bayerische Motoren Werke Aktiengesellschaft (Hrsg.) (2013) Working Together: Sustainable Value Report 2013, Munich. http://www.bmwgroup.com/com/en/_common/_pdf/BMW_Group_SVR2013_EN.pdf. Accessed 19 Dec 2014
13. Beer M (1985) Human Resource Management. Free Press, New York
14. Berekoven L, Eckert W, Ellenrieder P (2009) Marktforschung: Methodische Grundlagen und praktische Anwendung, 12. Aufl. Gabler, Wiesbaden
15. Beyrow M, Kiedaisch P, Daldrop N (2012) Corporate Identity und Corporate Design: Das Kompendium, 3. Aufl. avedition, Stuttgart
16. Blanz M, Bückle T, Grau G, Lueg R, Rieger M, Scholz M, Traub R, Weiß K (2007) Diagnosesystem mit WLAN-Übertragungsmodul und implementiertem Diagnosenkurztest. Patent DE102006019972A1, Deutsches Patent- und Markenamt

17. Bodemer S, Disch R (2014) Corporate Treasury Management: Organisation, Cash- und Liquiditätsmanagement, Corporate Finance, Risikomanagement, Technologie. Schäffer-Poeschel, Stuttgart
18. Botsis D, Hansknecht S, Hauke C, Janssen N, Kaiser B, Rock T (2015) Kennzahlen und Kennzahlensysteme für Banken. Springer Gabler, Wiesbaden
19. Bracht U, Geckler D, Wenzel S (2011) Digitale Fabrik: Methoden und Praxisbeispiele. Springer, Berlin
20. Bradler J, Mödder F (2012) SAP Supplier Relationship Management, 2. Aufl. SAP Press, Bonn
21. Braess H-H, Seiffert U (Hrsg.) (2007) Automobildesign und Technik: Formgebung, Funktionalität, Technik. Vieweg, Wiesbaden
22. Braess H-H, Seiffert U (Hrsg.) (2013) Vieweg Handbuch Kraftfahrzeugtechnik, 7. Aufl. Springer Vieweg, Wiesbaden
23. Brenner W, Resch A, Schulz V (2010) Die Zukunft der IT in Unternehmen: Managing IT as a Business. F.A.Z.-Institut für Management-, Markt- und Medieninformationen, Frankfurt am Main
24. Brück U (2015) Praxishandbuch SAP-Controlling, 5. Aufl. Galileo Press, Bonn
25. Brückner C (2011) Qualitätsmanagement – Das Praxishandbuch für die Automobilindustrie. Carl Hanser, München
26. Bullinger H-J, Spath D, Warnecke H-J, Westkämper E (Hrsg.) (2009) Handbuch Unternehmensorganisation: Strategien, Planung, Umsetzung, 3. Aufl. Springer, Berlin
27. Bundesgesetzblatt (1998) Gesetz zur Kontrolle und Transparenz im Unternehmensbereich (KonTraG). Jahrgang 1998 Teil I Nr. 24, ausgegeben zu Bonn am 30. April 1998
28. Bungartz O (2014) Handbuch Interne Kontrollsysteme (IKS): Steuerung und Überwachung von Unternehmen, 4. Aufl. Erich Schmidt Verlag, Berlin
29. Child J, Faulkner D, Tallman S (2009) Cooperative strategy: managing alliances, networks, and joint ventures, 2nd edn. Oxford University Press, New York
30. Crosby PB (1996) Quality is still free: making quality certain in uncertain times. McGraw-Hill, New York
31. Daimler AG (2012) Richtlinie für integres Verhalten. Was uns gemeinsam bei Daimler leitet. Unsere Verhaltensgrundsätze und Leitlinien für das Handeln, Stuttgart. http://www.daimler.com/Projects/c2c/channel/documents/1031143_Daimler_Richtlinie_fuer_integres_Verhalten.pdf. Accessed 23 Dec 2014
32. Daimler AG (2013) Nachhaltigkeitsbericht 2013, Stuttgart. http://www.daimler.com/Projects/c2c/channel/documents/2458886_Daimler_Nachhaltigkeitsbericht_2013.pdf. Accessed 19 Dec 2014
33. Daimler AG (2014) Aktualisierte Umwelterklärung 2014. Daimler AG Standort Sindelfingen. http://www.daimler.com/Projects/c2c/channel/documents/2578205_UE2014_SiFi.pdf. Accessed 23 Dec 2014
34. Daimler Trucks North America LLC (ed) (2011) Doing Business with Daimler Trucks North America LLC. A Supplier's Guide to a successful business relationship with Daimler Trucks North America LLC. Revision 02.2011
35. Dale BG, van der Wiele T, van Iwaarden J (2007) Managing quality, 5th edn. Blackwell, Malden
36. Dangelmaier W (2001) Fertigungsplanung: Planung von Aufbau und Ablauf der Fertigung, 2. Aufl. Springer, Berlin
37. Deming WE (1982) Out of the crisis. The MIT Press, Cambridge
38. Deming WE (2013) The essential Deming: leadership principles from the father of quality. McGraw-Hill, New York
39. DIN Deutsches Institut für Normung (Hrsg.) (2007) DIN EN 15341:2007-06: Instandhaltung – Wesentliche Leistungskennzahlen für die Instandhaltung. Beuth, Berlin
40. DIN Deutsches Institut für Normung (Hrsg.) (2013) DIN EN 8580:2003-09: Fertigungsverfahren – Begriffe, Einteilung. Beuth, Berlin

41. DIN Deutsches Institut für Normung (Hrsg.) (2013) DIN EN 62264-1:2013: Integration von Unternehmensführungs- und Leitsystemen – Teil 1: Modelle und Terminologie. Beuth, Berlin
42. Ding S, Puranik A, Vaidya M (2013) From CFO to CEO: new leadership opportunities for senior financial executives in the Asia Pacific Region. A world of insight. Research & Insight, SpencerStuart. http://www.spencerstuart.com/research-and-insight/from-cfo-to-ceo-new-leadership-opportunities-for-senior-financial-executives. Accessed 23 Dec 2014
43. Dudenhöffer K (2012) Internet als Neuwagen-Vertriebskanal. In: Proff H, Schönharting J, Schramm D, Ziegler J (Hrsg.) Zukünftige Entwicklungen in der Mobilität: Betriebswirtschaftliche und technische Aspekte. Springer Gabler, Wiesbaden, S 355–366
44. Ebel B, Hofer MB (Hrsg.) (2014) Automotive Management: Strategie und Marketing in der Automobilwirtschaft, 2. Aufl. Springer, Berlin
45. Eger T, Eckert C, Clarkson PJ (2005) The role of design freeze in product development. In: International conference on engineering design (ICED 05), Melbourne
46. Eggert W (2003) Nachfragemodellierung und -prognose zur Unterstützung der langfristigen Absatzplanung am Beispiel der deutschen Automobilindustrie. Dissertation, Universität Fridericiana zu Karlsruhe
47. Ehrlenspiel K, Kiewert A, Lindemann U, Mörtl M (2014) Kostengünstig Entwickeln und Konstruieren: Kostenmanagement bei der integrierten Produktentwicklung, 7. Aufl. Springer Vieweg, Berlin
48. Erl T, Gee C, Kress J, Maier B, Normann H, Raj P, Shuster L, Trops B, Utschig-Utschig C, Wik P, Winterberg T (2014) Next generation SOA: a concise introduction to Service Technology & Service-Orientation. Prentice Hall, Upper Saddle River
49. Ernst & Young (Mai 2013) Key considerations for your internal audit plan: enhancing the risk assessment and addressing emerging risks. Insights on governance, risk and compliance. www.ey.com/GRCinsights. Accessed 23 Dec 2014
50. Ernstberger U, Weissinger J, Frank J (Hrsg.) (2013) Mercedes-Benz SL: Entwicklung und Technik. Springer Vieweg, Wiesbaden
51. Evans JR (2013) Quality and performance excellence: management, organization, and strategy, 7th edn. South-Western, Mason
52. Favre-Bulle B (2004) Automatisierung Komplexer Industrieprozesse: Systeme, Verfahren und Informationsmanagement. Springer, Wien
53. Festing M, Dowling PJ, Weber W, Engle AD (2011) Internationales Personalmanagement, 3. Aufl. Gabler, Wiesbaden
54. Fischer JO (2008) Kostenbewusstes Konstruieren: Praxisbewährte Methoden und Informationssysteme für den Konstruktionsprozess. Springer, Berlin
55. Fischermanns G (2013) Praxishandbuch Prozessmanagement, 11. Aufl. Verlag Dr. Götz Schmidt, Gießen
56. Forsthuber H, Siebert S (2013) Praxishandbuch SAP-Finanzwesen, 5. Aufl. Galileo Press, Bonn
57. Förtsch G, Meinholz H (2014) Handbuch Betriebliches Umweltmanagement, 2. Aufl. Springer Spektrum, Wiesbaden
58. Girbig P, Graser C, Janson-Mundel O, Schuberth J, Seifert EK (2013) Energiemanagement gemäß DIN EN ISO 50001: Systematische Wege zu mehr Energieeffizienz. Beuth, Berlin
59. Glaser C (2015) Risikomanagement im Leasing: Grundlagen, rechtlicher Rahmen und praktische Umsetzung. Springer Gabler, Wiesbaden
60. Gorriz M, Holzweißig K (2014) Linked Data in der Automobilindustrie: Anwendungsfälle und Mehrwerte. In: Pellegrini T, Sack H, Auer S (Hrsg.) Linked Enterprise Data: Management und Bewirtschaftung vernetzter Unternehmensdaten mit Semantic Web Technologien. Springer, Berlin, S 245–262
61. Grote K-H, Engelmann F, Beitz W, Syrbe M, Beyerer J, Spur G (2014) Das Ingenieurwissen: Entwicklung, Konstruktion und Produktion. Springer Vieweg, Heidelberg
62. Günther H-O, Tempelmeier H (2012) Produktion und Logistik, 9. Aufl. Springer, Heidelberg
63. Hafner R, Polanski A (2008) Kennzahlen-Handbuch für das Personalwesen. Praxium-Verlag, Zürich

64. Hage S (21.01.2010) IBM-Chef warnt vor Kollaps. manager magazin online. http://www.manager-magazin.de/finanzen/artikel/a-673202.html. Accessed 23 Dec 2014
65. Hanschke I (2013) Strategisches Management der IT-Landschaft: Ein praktischer Leitfaden für das Enterprise Architecture Management, 3. Aufl. Hanser, München
66. Harrington HJ (1987) Poor-quality cost. American Society for Quality Control, New York
67. Hellberg T (2012) Praxishandbuch Einkauf mit SAP ERP, 3. Aufl. SAP Press, Bonn
68. Herlyn W (2012) PPS im Automobilbau: Produktionsprogrammplanung und -steuerung von Fahrzeugen und Aggregaten. Carl Hanser, München
69. Heß G (2010) Supply-Strategien in Einkauf und Beschaffung: Systematischer Ansatz und Praxisfälle, 2. Aufl. Gabler, Wiesbaden
70. Hinsch M (2014) Die neue ISO 9001:2015 – Status, Neuerungen und Perspektiven. Springer Vieweg, Berlin
71. Hoyle D (2009) ISO 9000 quality systems handbook: using the standards as a framework for business improvement, 6th edn. Routledge, London
72. Imai M (1986) Kaizen: the key to Japan's competitive success. McGraw-Hill/Irwin, New York
73. ISO 9000:2005 (2005) Quality management systems – fundamentals and vocabulary. International Organization for Standardization, Genèva
74. ISO 9001:2008 (2008) Quality management systems – requirements. International Organization for Standardization, Genèva
75. ISO 9004:2009 (2009) Managing for the sustained success of an organization – a quality management approach. International Organization for Standardization, Genèva
76. ISO 22400-2:2014 (2014) Automation systems and integration – key performance indicators (KPIs) for manufacturing operations management – Part 2: definitions and descriptions, Genèva
77. Jahns C (2005) Supply Management: Neue Perspektiven eines Managementansatzes für Einkauf und Supply. Wissenschaft & Praxis, Sternenfels
78. Jakoby W (2013) Projektmanagement für Ingenieure: Ein praxisnahes Lehrbuch für den systematischen Projekterfolg, 2. Aufl. Springer Vieweg, Wiesbaden
79. Janker CG (2008) Multivariate Lieferantenbewertung: Empirisch gestütze Konzeption eines anforderungsgerechten Bewertungssystems, 2. Aufl. Gabler, Wiesbaden
80. Jelinek B, Hannich M (Hrsg.) (2009) Wege zur effizienten Finanzfunktion in Kreditinstituten. Gabler, Wiesbaden
81. Johnson G, Scholes K, Whittington R (2011) Exploring corporate strategy, 9th edn. Pearson Education Ltd., Harlow
82. Jung T (2013) Optimierung der Lieferantenintegration in der Produktanlaufphase am Beispiel des Kaufteilemanagements der AUDI AG. In: Göpfert I, Braun D, Schulz M (Hrsg.) Automobillogistik: Stand und Zukunftstrends, 2. Aufl. Springer Gabler, Wiesbaden, S 207–226
83. Jung H (2014) Controlling, 4. Aufl. Oldenbourg, München
84. Käber A (2014) Warehouse Management mit SAP ERP: Effektive Lagerverwaltung mit WM, 3. Aufl. SAP Press, Bonn
85. Kaiser D (2011) Treasury Management: Betriebswirtschaftliche Grundlagen der Finanzierung und Investition, 2. Aufl. Gabler, Wiesbaden
86. Kapferer J-N (2012) The new strategic brand management: advanced insights and strategic thinking, 5th edn. Kogan Page, London
87. Kappauf J, Koch M, Lauterbach B (2015) Logistik mit SAP: Der umfassende Einstieg, 3. Aufl. SAP Press, Bonn
88. Katzenbach A, Steiert H-P (2010) Engineering-IT in der Automobilindustrie – Wege in die Zukunft, Informatik-Spektrum. doi:10.1007/s00287-010-0502-y
89. Keuper F, Sauter R (Hrsg.) (2014) Unternehmenssteuerung in der produzierenden Industrie: Konzepte und Best Practices. Springer Gabler, Wiesbaden
90. Keuper F, Hamidian K, Verwaayen E, Kalinowski T (Hrsg.) (2010) transformIT: Optimale Geschäftsprozesse durch eine transformierende IT. Gabler, Wiesbaden

91. Kirchhoff KR, Piwinger M (Hrsg.) (2009) Praxishandbuch Investor-Relations: Das Standardwerk der Finanzkommunikation, 2. Aufl. Gabler, Wiesbaden
92. Klaubert K, Brennholt S, Rekersdres N (2014) Motivation Gesundheit: Themenvorschläge und Materialien für gesundheitsfördernden Unterricht der Klassen 1-4. Sarastro, Paderborn
93. Klug F (2010) Logistikmanagement in der Automobilindustrie: Grundlagen der Logistik im Automobilbau. Springer, Berlin
94. Konold P, Reger H (2003) Praxis der Montagetechnik: Produktdesign, Planung, Systemgestaltung, 2. Aufl. Vieweg, Wiesbaden
95. Kothes L (2011) Grundlagen der Technischen Dokumentation: Anleitungen verständlich und normgerecht erstellen. Springer, Berlin
96. Kramer F (2009) Passive Sicherheit von Kraftfahrzeugen: Biomechanik – Simulation – Sicherheit im Entwicklungsprozess, 3. Aufl. Vieweg+Teubner, Wiesbaden
97. Krampf P (2014) Beschaffungsmanagement: Eine praxisorientierte Einführung in Materialwirtschaft und Einkauf, 2. Aufl. Vahlen, München
98. Kühlmann TM, Dowling PJ (2005) DaimlerChrysler: a case study of a cross border merger. In: Stahl G, Mendenhall M (eds) Mergers and acquisitions: managing culture and human resources. Stanford University Press, Stanford, S 351–363
99. Kühnapfel JB (2013) Vertriebscontrolling: Methoden im praktischen Einsatz. Springer Gabler, Wiesbaden
100. Küpper H-U, Friedl G, Hofmann C, Hofmann Y, Pedell B (2013) Controlling: Konzeption, Aufgaben, Instrumente, 6. Aufl. Schäffer-Poeschel, Stuttgart
101. Lampel J, Mintzberg H, Quinn JB, Ghoshal S (2014) Strategy process: concepts, contexts, cases, 5th edn. Pearson Education Ltd, Harlow
102. Lauterbach B, Metzger DM, Sauer S, Kappauf J, Gottlieb J, Sürie C (2014) Transportation management with SAP TM. SAP Press, Bonn
103. Lewin T, Borroff R (2010) How to design cars like a Pro. Motorbooks, Minneapolis
104. Liker JK (2004) The Toyota way: 14 management principles from the World's greatest manufacturer. McGraw-Hill, New York
105. Mack R, Frey N (2002) Six Building Blocks for Creating Real IT Strategies. Gartner Research, Strategic Analysis Report R-17-3607
106. Matthes F, Buckl S, Leitel J, Schweda CM (2008) Enterprise Architecture Management Tool Survey 2008. Software Engineering for Business Information Systems (sebis), Technische Universität München
107. McCarthy EJ (1960) Basic marketing: a managerial approach. Irwin, Homewood
108. Meffert H, Burmann C, Kirchgeorg M (2014) Marketing: Grundlagen marktorientierter Unternehmensführung Konzepte – Instrumente, 12. Aufl. Springer Gabler, Wiesbaden
109. Mikus B (1998) Make-or-buy-Entscheidungen in der Produktion: Führungsprozesse – Risikomanagement – Modellanalysen. Springer, Wiesbaden
110. Müller R (2013) Systematische Mitarbeiterbeurteilungen und Zielvereinbarungen, 3. Aufl. PRAXIUM-Verlag, Zürich
111. Nix P, Wolbert J (2005) Kapitalmarktkommunikation in Deutschland: Investor Relations und Corporate Reporting. Kirchhoff Consult AG, München, PricewaterhouseCoopers, Frankfurt am Main
112. Ohno T (1988) Toyota production system: beyond large-scale production. Productivity, Portland
113. Osterwalder A, Pigneur Y (2010) Business modell generation. Wiley, Hoboken
114. Paul D, Cadle J, Yeates D (eds) (2014) Business analysis, 3rd edn. BCS, Swindon
115. Pepels W (Hrsg.) (2003) Marketing-Controlling-Organisation: Grundgestaltung marktorientierter Unternehmenssteuerung. Erich Schmidt Verlag, Berlin-Tiergarten
116. Pohle G, Korsten P, Ramamurthy S (2005) Component business models – making specialization real. IBM Institute for Business Value, Somers
117. Porter ME (1986) Competition in global industries. Harvard Business School Press, Boston
118. Porter ME (1996) What is strategy? Harvard Business Review (November–December 1996), Boston, pp. 61–78

119. Porter ME (2004) Competitive strategy: techniques for analyzing industries and competitors, 1st export edn. Free Press, New York
120. Probst G, Raub S, Romhardt K (2012) Wissen managen: Wie Unternehmen ihre wertvollste Ressource optimal nutzen, 7. Aufl. Springer Gabler, Wiesbaden
121. Rapp R (2000) Customer Relationship Management: Das Konzept zur Revolutionierung der Kundenbeziehungen. Campus, Frankfurt am Main
122. Rapp M, Wullenkord A (2014) Unternehmenssteuerung durch den Finanzvorstand (CFO): Praxishandbuch operativer Kernaufgaben, 2. Aufl. Springer Gabler, Wiesbaden
123. REFA, Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.) (1987) Planung und Gestaltung komplexer Produktionssysteme. Carl Hanser, München
124. Reichmann T (2011) Controlling mit Kennzahlen: Die systemgestützte Controlling-Konzeption mit Analyse- und Reportinginstrumenten, 8. Aufl., Vahlen, München
125. Reimann W, Wedeniwski S (2005) Building Enterprise applications with a pro-active infrastructure at DaimlerChrysler. Internet Process Syst Interdiscip Res 2005 Vol 1. http://think-automobility.org/documents/Building%20Enterprise%20Applications%20with%20PAI.pdf
126. Reisch RD (2009) Konzern-Treasury: Finanzmanagement in der Industrie. Oldenbourg, München
127. Rieg R (2015) Planung und Budgetierung: Was wirklich funktioniert, 2. Aufl. Springer Gabler, Wiesbaden
128. Robertson B (2013) To assess the impact of change, connect process models With business capability models. Gartner, Stamford
129. Roßnagel A (2014) Fahrzeugdaten – wer darf über sie entscheiden? SVR Straßenverkehrsrecht, Zeitschrift für die Praxis des Verkehrsjuristen 2014, Heft 8. Nomos Verlagsgesellschaft, Baden-Baden
130. Rump J, Eilers S (Hrsg.) (2014) Lebensphasenorientierte Personalpolitik: Strategien, Konzepte und Praxisbeispiele zur Fachkräftesicherung. Springer Gabler, Berlin
131. Rumpel R (2012) Planung und Realisierung von IT-Infrastrukturen – ein prozessbasierter Ansatz. Oldenbourg, München
132. Schäffer F (2012) OBD On-board-diagnose in der Praxis. Franzis, Haar bei München
133. Schantin D (2004) Makromodellierung von Geschäftsprozessen: Kundenorientierte Prozessgestaltung durch Segmentierung und Kaskadierung. Deutscher Universitäts-Verlag/GWV Fachverlage GmbH, Wiesbaden
134. Scheer A-W (1997) Wirtschaftsinformatik: Referenzmodelle für industrielle Geschäftsprozesse, 7. Aufl. Springer, Berlin
135. Schlaich G, Wenger R (2007) Webgestütztes Lieferantenmanagement bei Mercedes Car Group. In: Brenner W, Wenger R (Hrsg.) Elektronische Beschaffung: Stand und Entwicklungstendenzen. Springer, Berlin, S 245–266
136. Schmelzer HJ, Sesselmann W (2013) Geschäftsprozessmanagement in der Praxis: Kunden zufriedenstellen, Produktivität steigern, Wert erhöhen, 8. Aufl. Carl Hanser, München
137. Schmidthausen M, Prause P (2014) Personalprozesse planen, steuern und kontrollieren, 5. Aufl. Merkur Verlag Rinteln
138. Schneider M (2008) Logistikplanung in der Automobilindustrie: Konzeption eines Instruments zur Unterstützung der taktischen Logistikplanung vor "Start-of-Production" im Rahmen der Digitalen Fabrik. Dissertation, Universität Regensburg
139. Scholly V (2013) Kundenloyalität im Automobilhandel. Springer Gabler, Wiesbaden
140. Schuh G, Stölzle W, Straube F (Hrsg.) (2008) Anlaufmanagement in der Automobilindustrie erfolgreich umsetzen: Ein Leitfaden für die Praxis. Springer, Berlin
141. Schulz MD (2014) Der Produktentstehungsprozess in der Automobilindustrie: Eine Betrachtung aus Sicht der Logistik. Springer Gabler, Wiesbaden
142. Schweikle R (2009) Innovationsstrategien japanischer und deutscher Unternehmen: Eine vergleichende Analyse. Gabler, Wiesbaden
143. Sebastian H-J (2013) Optimierung von Distributionsnetzwerken. Edition am Gutenbergplatz Leipzig, Leipzig

144. Seidel M (2005) Methodische Produktplanung: Grundlagen, Systematik und Anwendung im Produktentstehungsprozess. Reihe Informationsmanagement im Engineering Karlsruhe Bd 1-2005, Universität Karlsruhe (TH)
145. Shapiro R, White SA, Bock C, Palmer N, Muehlen Mz, Brambilla M, Gagné D (2012) BPMN 2.0 handbook second edition: methods, concepts, case studies and standards in business process modeling notation (BPMN). Future Strategies Inc., Lighthouse Point
146. Shewhart WA (1931) Economic control of quality of manufactured product. D. van Nostrand Company, New York
147. Siebenpfeiffer W (Hrsg.) (2014) Leichtbau-Technologien im Automobilbau: Werkstoffe – Fertigung – Konzepte. Springer Vieweg, Wiesbaden
148. Software AG (2014) Converging business and IT to transform to the digital Enterprise. Business White Paper, Darmstadt
149. Steffens T (2009) Aus der Krise steuern: Differenziertes Finanz- und Liquiditätscontrolling für mittelständische Automobilzulieferer. Tectum, Marburg
150. Stenner F (Hrsg.) (2010) Handbuch Automobilbanken: Finanzdienstleistungen für Mobilität. Springer, Berlin
151. Suthikarnnarunai N (2008) Automotive supply chain and logistics management. In: Proceedings of the international multiconference of engineers and computer scientists, 2008, Hong Kong, vol II
152. Tempelmeier H, Günther H-O (2014) Produktion und Logistik: Supply Chain und Operations Management, 11. Aufl. Books on Demand, Norderstedt
153. Ulrich D (1997) Human resource champions – the next agenda for adding value and delivering results. Harvard Business Review Press, Boston
154. Vajna S (2014) Integrated Design Engineering: Ein interdisziplinäres Modell für die ganzheitliche Produktentwicklung. Springer Vieweg, Berlin
155. VDA Verband der Automobilindustrie (Hrsg.) (2011) Bd 4: Sicherung der Qualität in der Prozesslandschaft, 2. Aufl. Frankfurt am Main
156. VDA Verband der Automobilindustrie (Hrsg.) (2013) ISO/TS 16949:2013 Qualitätsmanagementsysteme. Besondere Anforderungen bei Anwendung von ISO 9001:2008 für die Serien- und Ersatzteilproduktion in der Automobilindustrie, 4. Ausgabe
157. VDI Verein Deutscher Ingenieure (Hrsg.) (1980) VDI-Richtlinie: VDI 2220 Produktplanung; Ablauf, Begriffe und Organisation. Beuth, Berlin
158. VDI Verein Deutscher Ingenieure (Hrsg.) (1986) VDI 2242 Blatt 1 Konstruieren ergonomiegerechter Erzeugnisse; Grundlagen und Vorgehen. Beuth, Berlin
159. VDI Verein Deutscher Ingenieure (Hrsg.) (1993) VDI-Richtlinie: VDI 2221 Methodik zum Entwickeln und Konstruieren technischer Systeme und Produkte. Beuth, Berlin
160. VDI Verein Deutscher Ingenieure (Hrsg.) (1997) VDI-Richtlinie: VDI 2222 Blatt 1 Konstruktionsmethodik – Methodisches Entwickeln von Lösungsprinzipien. Beuth, Berlin
161. VDI Verein Deutscher Ingenieure (Hrsg.) (2006) VDI-Richtlinie: VDI 2893 Auswahl und Bildung von Kennzahlen für die Instandhaltung. Beuth, Berlin
162. VDI Verein Deutscher Ingenieure (Hrsg.) (2008) VDI-Richtlinie: VDI 4499 Blatt 1 Digitale Fabrik – Grundlagen. Beuth, Berlin
163. VDI Verein Deutscher Ingenieure (Hrsg.) (2011) VDI-Richtlinie: VDI 3423 Verfügbarkeit von Maschinen und Anlagen – Begriffe, Definitionen, Zeiterfassung und Berechnung. Beuth, Berlin
164. VDI Verein Deutscher Ingenieure (Hrsg.) (2013) VDI-Richtlinie: VDI 5600 Blatt 3 Fertigungsmanagementsysteme (Manufacturing Execution Systems – MES) – Logische Schnittstellen zur Maschinen- und Anlagensteuerung. Beuth, Berlin
165. Wannenwetsch H (2014) Integrierte Materialwirtschaft, Logistik und Beschaffung, 5. Aufl. Springer Vieweg, Berlin
166. Weißenrieder J (Hrsg.) (2014) Nachhaltiges Leistungs- und Vergütungsmanagement: Klarheit schaffen, Führung unterstützen. Springer Gabler, Wiesbaden

167. Werdich M (Hrsg.) (2012) FMEA – Einführung und Moderation: Durch systematische Entwicklung zur übersichtlichen Risikominimierung (inkl. Methoden im Umfeld), 2. Aufl. Springer Vieweg, Wiesbaden
168. Westkämper E, Warnecke H-J (2010) Einführung in die Fertigungstechnik, 8. Aufl. Vieweg+Teubner, Wiesbaden
169. White SA (2006) Process modeling notations and workflow patterns. IBM Corp., USA. http://www.omg.org/bpmn/Documents/Notations_and_Workflow_Patterns.pdf. Accessed 23 Dec 2014
170. Wieland J (Hrsg.) (2004) Handbuch Wertemanagement. Murmann, Hamburg
171. Wiendahl H-P, Reichardt J, Nyhuis P (2014) Handbuch Fabrikplanung: Konzept, Gestaltung und Umsetzung wandlungsfähiger Produktionsstätten, 2. Aufl. Carl Hanser, München
172. Wildemann H (2012) Qualitätscontrolling: Leitfaden zur qualitätsgerechten Planung und Steuerung von Geschäftsprozessen, 18. Aufl. München
173. Wolff E (2015) Continuous Delivery: Der pragmatische Einstieg. dpunkt.verlag, Heidelberg
174. Wolke T (2008) Risikomanagement, 2. Aufl. Oldenbourg, München
175. Zentes J, Steinhauer R, Lonnes V (2013) Geschäftsmodell-Evolution: Unternehmensentwicklung als Dynamisierung von Kernkompetenzen. Institut für Handel & Internationales Marketing (H.I.MA.) der Universität des Saarlandes
176. Zerfaß A, Piwinger M (Hrsg.) (2014) Handbuch Unternehmenskommunikation: Strategie – Management – Wertschöpfung, 2. Aufl. Springer Gabler, Wiesbaden

Digitalisation of the Industry from the AUTOmobile to the autoMOBILE

4

In the United States, trams disappeared from local public transport in 45 cities from the 1930s onwards, until the practice of closing down tram networks was banned by the Supreme Court in 1956. In 1974, US government attorney Bradford Snell [26] revealed to the public that a powerful lobby made up of vehicle manufacturers, led by General Motors, oil companies, the tyre industry and supplier companies disguised as a holding company, had systematically destroyed the public tram networks. Their companies had been sold off and closed down. Bus lines and individual transport were what replaced them. This had nothing to do with the logic of market economics. It was the power and influence of monopolies which made this destructive action possible – not a conviction that they would be able to do a better job.

The times during which vehicle manufacturers saw public tram networks as direct competition they had to fight, are long since over. However, in a reality in which differentiation of core business in the markets leads to ever more complex AUTOmobiles, while – as a result of digitalisation and connectedness, improved transport planning is brought about thanks to intelligent links between different transport modes such as your own vehicle, bicycle and – yes – the tram, mobility behaviour is bound to change if the alternatives to one's own vehicle have been improved.

The crucial factor behind the shift of focus from the AUTOmobile to the autoMOBILE is the following:

Travelling in order to reach a destination is part of human nature.

And humans can do this using the AUTOmobile, which has developed in a unique way over recent decades thanks to the individual and diverse ways in which it can

S. Wedeniwski, *The Mobility Revolution in the Automotive Industry*,
DOI 10.1007/978-3-662-47788-5_4

be used. The fundamental question is, however:

In future, will the extremely versatile AUTOmobile be the only efficient and individual transport mode?

It must be recognised that there are new, flexible mobility concepts being developed on the market which create demand without putting the AUTOmobile in the spotlight [20]. It will therefore be even more significant to take a holistic view of spatial mobility via the interplay between different concepts and transport modes. The focus of this chapter will be on whether and to what extent the business architecture elaborated in Sect. 3.7 is changing the automotive industry.

It is quite clear that the mobility market which is developing today is not going to wait for the automotive industry, and can also redefine itself independently from the automotive industry. Markets which were once separate are now becoming intertwined and are growing together. The market forces include not only the current competitors of the automotive industry, but also their suppliers and customers, new market players, or possible replacement products or services.

Before we elaborate on a possible business architecture of the mobility industry for the changing autoMOBILE, we will put together a summarised market analysis. In addition to vehicle manufacturers, we will also take a particularly close look at public transport companies [8], technology and electronics companies [13] and mobility service providers [20] with their new concepts. All four come from different directions to develop market forces for a mobility industry. Inevitably, competence areas from all four impact directions will grow together to form new business competences.

As the four market forces mentioned are still only at the beginning of their development, it still remains to be seen who will play which roles in the mobility market of the future. In certain situations, further company groups may be added to these – such as energy suppliers, which can give more to the electric mobility market than just energy for charging – for example by providing infrastructure components such as charging stations. The main focus of our analysis [5] will be on the four different competition forces which we presented in Fig. 4.1. Market forces cannot be considered as either right or wrong. The combination of services with the appropriate qualified products will fashion a new path towards an attractive, individual form of mobility. Things will become exciting if the mobility industry develops as an industry branch in its own right – which makes it possible for spatial mobility to fulfil individual requirements. But what characterises the core competences of the four market forces in the context of spatial mobility?

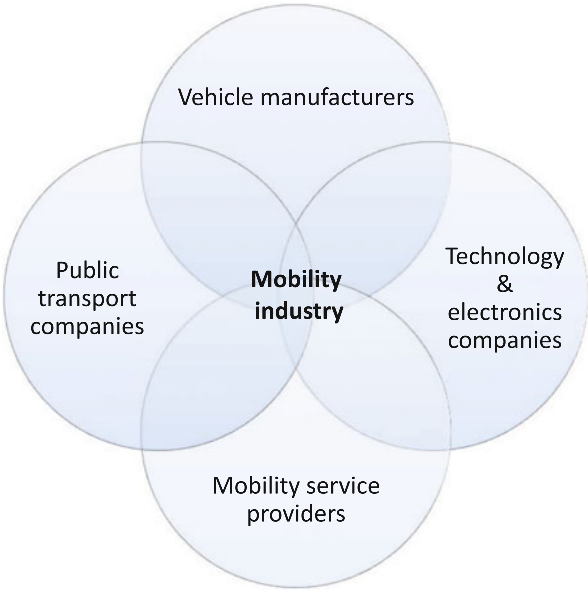

Fig. 4.1 The four market forces of vehicle manufacturers, public transport companies, technology and electronics companies and mobility service providers can also come together from different directions with their different business competences to form a mobility industry

Vehicle Manufacturers

Vehicle manufacturers have very strongly developed business competences in the global and complex process which is product development, in cost-optimised procurement, and in the international standardisation of production techniques. It is only with the help of these far-reaching competences in the three heavyweight business domains

1. "Research and development" (see Sect. 3.6.2),
2. "Procurement and inbound logistics" (see Sect. 3.6.3) and
3. "Production" (see Sect. 3.6.4)

that complex vehicles can be manufactured in accordance with today's standards. The AUTOmobile will remain a central product – even if individual requirements in terms of spatial mobility are the focus of services. On the basis of this expertise, vehicle manufacturers have excellent conditions for being able to also offer individual added value services in the broader context of mobility – the autoMOBILE. However, the strongly focused product orientation of the three business domains listed requires a change in the value creation chain within the overall framework of the automotive industry – towards a stronger orientation towards revenue on the markets from the perspective of a service provider, without a direct link to a product.

Of course, the weighting of the three most significant business domains is not the same for all vehicle manufacturers. For example,

- Honda has particular strengths in "research and development" [22],
- BMW has particular strengths in "procurement and inbound logistics" [21], and
- Toyota is particularly strong in "production" [12]

Furthermore, vehicle engineering as it has been up until now in an urban context must also surrender to other concepts and challenges if a manufacturer is also to become a fleet operator.

Public Transport Companies

In large conglomerations, public transport companies have until now been the top dogs, with almost no competition at all. The underground network in Tokyo, for example, consists of 13 lines and 274 stations, and keeps an average of 8.7 million passengers on the move every day (see Table 4.1).[1] However, this only represents 22 % of the 40 million people who travel in the Japanese capital each day. Just within 1 day, an average of 3.5 million people pass through the Shinjuku train station in Tokyo – making it the busiest train station in the world in terms of passenger numbers.[2]

In short, therefore, the public transport companies have excellent competences in terms of transporting large numbers of people in a safe and environmentally-friendly

Table 4.1 The ten busiest metros in the world

City	Country	Passengers per year	Passengers per day
Tokyo	Japan	3.17 billion	8.7 million
Moscow	Russia	2.392 billion	6.6 million
Seoul	South Korea	2.05 billion	5.6 million
Shanghai	People's Republic of China	2 billion	5.5 million
New York	United States	1.84 billion	5.042 million
Peking (Beijing)	People's Republic of China	1.83 billion	5.02 million
Paris	France	1.473 billion	4.035 million
Mexico City	Mexico	1.41 billion	3.882 million
Hong Kong	People's Republic of China	1.32 billion	3.76 million
Guangzhou	People's Republic of China	1.18 billion	4.392 million

[1] "The largest METRO in the world" http://de.globometer.com/zug-metro-tokio.php. Accessed: 12 January 2015.

[2] "Shinjuku Railway Station, Tokyo, Japan" http://www.railway-technology.com/projects/shinjuku-railway. Accessed: 12 January 2015.

way, without needing much infrastructure or space. It is possible to travel quickly and efficiently using public transport if

1. there is a sufficient number of stations,
2. there is a high number of transport modes in operation, and
3. a personal route planner puts together the different transport options in a way which is attractive in terms of both time and costs.

At the same time, urbanisation demands new mobility concepts which go beyond local public transport – as a consequence of which it is not only the vehicle manufacturers who are under pressure, but also regional transport authorities, who must seek new solutions. Users want to make the most of all system advantages of all transport modes as best as they can. In this way, a multimodal mobility concept would be very advantageous in many situations – for example, when electric vehicles not related to the station are cleverly combined with public transport, which is less limited in terms of the distances it can travel. However, the information and ticket systems used up until now are not flexible enough to the individual needs of passengers.

Technology and Electronics Companies

Technology and electronics companies have built up modern information technology which makes many comfortable, intuitive interactions possible in terms of the networking of services and linking people. It is the technological possibilities which make many services attractive in the first place, thanks to the fact that they can be used on the move. Companies such as Apple or Google, for example, create platforms on which it is possible not only to book everything from a mobile device, but also to use and be invoiced for the services of different companies in a standardised way. It should also not be forgotten that due to digitalisation, the need for people and objects to change their spatial location becomes unnecessary in many situations. For example, data transfer via the internet is replacing the post office more and more often – mainly because over the past 25 years, Microsoft has digitalised many tasks in today's office environments in private and industrial contexts. Video conferences can also reduce the need for travel by satisfying the need for simultaneous transfer of information between people in several locations.

During the past 10 years, technical possibilities have placed the focus on mobility in our society from the AUTOmobile to the autoMOBILE. It is worth reflecting on the past 50 years, which have seen just a handful of technology companies dominate the market: IBM with hardware, Microsoft with software and Google with the internet search which leads to other functions. Why shouldn't Apple reshape a personal, intuitive form of mobility? And why shouldn't Japanese electronics companies such as Hitachi, Panasonic or Sony follow closely behind them, from their different perspectives from sectors such as mechanical engineering, household appliances or entertainment electronics?

Chair of the Board of Directors of Daimler Dieter Zetsche has the following to say on the issue: "We currently have the whole value creation chain in our hands".[3] It is very unlikely, however, that he means the continually rising value creation share of the suppliers, which is already over 71 % (see Sect. 1.3), and just as unlikely that he means the infotainment systems [15] which have been bought in addition, which will be crucial in the activities inside the *travel capsules* of the future. And even though moovel is starting new, ambitious mobility concepts aimed at broadening vehicle manufacturers' value creation chains, Google is casting a long shadow as it presses ahead with new ticket concepts and exchange formats for data on local public transport such as "General Transit Feed Specification" (GTFS).[4]

Mobility Service Providers

Mobility service providers have only been on the market for a few years, and are very young in comparison to the other three market forces. They are only at the beginning of the maturing process and usually only have minimal options for investment – but they develop many radical innovations in mobility. There are some pioneering companies which have stronger finances, but it is nonetheless also possible to build up business with only very low assets. Despite all the criticism levelled against it, and despite legal wrangling with the authorities in many countries and cities, the travel service agency Uber has managed to achieve a market capitalisation of 40 billion USD.[5] While some concepts are not yet fully formed, digitalisation means that they are able to break into established business monopolies and reshape them, as a result of which they gain more acceptance from young people.

One of the fundamental competences offered by mobility service providers is the ability to seamlessly connect many heterogeneously distributed systems with each other, with transport infrastructures and other mobility providers in order to make individually tailored mobility solutions available based on these. Many of the solutions which have been around up until now can be seen rather as research projects which will disappear again after learning curves and experiences have been had. Many ideas also lack an economically viable concept which will allow them to exist in the long term. In business models which reflect the mobility behaviour of customers in new life models, the *virtual* keys between the customer and the service are always apps and smartphones. This results in the development of the crucial core

---

[3] "Zetsche views competition from Apple as something positive". http://www.automobilwoche.de/article/20150303/AGENTURMELDUNGEN/303039957/zetsche-sieht-konkurrenz-durch-apple-poitiv. Accessed: 4 March 2015.

[4] "Transit – Google Developers" http://developers.google.com/transit. Accessed: 12 January 2015.

[5] "Travel service agency Uber: Value estimated at 40 billion dollars" http://www.handelsblatt.com/unternehmen/handel-konsumgueter/fahrdienst-vermittler-uber-bewertung-auf-40-milliarden-dollar-geschaetzt/11036120.html. Accessed: 12 January 2015.

competence of customer loyalty, and closeness to the mobility service provider. It is still not known how brand identity can develop in a similar way to that of a vehicle manufacturer.

4.1 The Automotive Industry in Times of Change

In Sect. 3.1, in the context of competition, we introduced the strategy as part of where a company is placed in relation to its surroundings. We will start by bringing together the external surroundings, the market forces and their effect on the automotive industry. While this will not be a comprehensive analysis, it will nonetheless give a sufficient insight into the changes being experienced by the business environment. Building on this, possible transformations of the business competences into a business architecture of the mobility industry for the autoMOBILE are to be derived.

4.1.1 Analysis of the Environment of the Automotive Sector

We will start with the PESTLE business analysis model[6] [7] as an orientation, in order to get an overall picture of the external environment of the automotive sector and the driving forces at work within it. The analysis concentrates exclusively on identifying external influencing factors which cannot be directly influenced by individual automotive companies, and which do not make it possible for them to use any simple solutions or short-term actions. It helps to classify the environment, and to understand long-term trends. Specifically, the abbreviation PESTLE stands for the

- political,
- economic,
- socio-cultural,
- technological,
- legal and
- environmental/ecological

influencing factors of an environment analysis.

There are mutual dependencies between the six factors, which mean that the discussion topics cannot always be allocated clearly to just one category. The fundamental aim of the model is to summarise the market risks and opportunities according to different factors. This means that changes can be connected in a more

[6]Sometimes referred to as PESTEL or just PEST analysis. All of these are the same type of external environment analysis, however.

targeted way with business competences which are responsible for the growth or decline of business within the company.

It is important to recognise that digitalisation no longer influences the automotive sector as a technological factor alone – instead, it influences the business environment in terms of all six factors of PESTLE – something which we will now discuss. Table 4.2 summarises the main influences.

Table 4.2 PESTLE analysis of the external influences of the automotive sector in the digital age

Politically	• Stability and reliability of political systems
	• Role of governmental organisations in shaping the economy
	• Politically supported changes and networks at a global level
	• Freedom, privacy and security in the digital age
Economically	• Stability of the currency
	• The automotive industry as a supporting pillar of the economy, with a high degree of influence
	• Shift of growth from industrial countries to emerging economies
	• Continually increasing dependence on numerous raw materials
	• Economic competition for raw materials in the global context
	• Vehicle data create economic advantages
Socially	• High employment levels in the value creation chain of the automotive industry
	• Brand identity is valuable in society
	• Growing demand for personalisation
	• Increasing urbanisation changes mobility needs
	• Residential areas are becoming less car-friendly due to more sustainable town planning
	• Ageing population in industrial countries
	• Decreasing enthusiasm for car ownership among young people
Technologically	• Sites with a strong presence of certain technologies
	• Alternative drive technologies
	• Vehicles as part of personalised networks
	• Networked factories and digitalised value creation chains
	• Staff workplaces which are shaped by technology
Legally	• Harmonisation of technical regulations at an international level
	• Standardised connected vehicle services in several countries
	• High liability provisions
	• Emissions standards for exhaust fumes CO_2-efficiency of new vehicles
	• First attempts at regulations for autonomous vehicles
	• Increasing demand for intangible information such as vehicle data
Ecologically	• Increasing awareness of environment and health
	• Alternative drive concepts with new environmental risks
	• Taking into account recycling in vehicle engineering as well
	• Mobility services from “stationary” vehicles to moving ones

The table should not, however, be seen as a general checklist. For a strategic evaluation of the external environment, one must concentrate on the most important factors for the company in question – which also have real relevance in the specific company context. The relevant influencing factors require prioritisation with a more in-depth analysis of possible future consequences for the specific company than we can provide generally here. For example, in this section we will show how currency risks or raw materials can have a considerable external influence on the automotive industry. In Sect. 3.1.1 we used the example of the BMW company strategy to show that there can also be specific measures to minimise the influences.

Political Aspects

The automotive industry is involved in politics in regional, national, transnational and global contexts. For automotive companies, the most important factor of the political environment is the stability and reliability of the political systems in those countries served by the sales markets. In countries such as Brazil, Russia, India and China in particular, political instability can have negative effects on the consumer behaviour of the locals, which also leads to investment risks for the automotive industry. An example of this is the conflict in Ukraine, which was one of the factors which led to a drastic fall in the value of the Russian currency from mid-2014 onwards. One of the consequences of this was that the Russian car market collapsed. Until now, the western sanctions against Russia and the sanctions imposed by Russia in response to these have only affected passenger vehicle manufacturers indirectly. If the situation were to escalate, however, it would not be possible to rule out a total import ban directed against Western vehicle manufacturers. Such a political situation can indeed have effects on a mobility service provider, but if there are no assets associated with the country affected, then these effects will be less significant than those on a vehicle manufacturer.

This brings us to another very important political factor – the role of governmental organisations in shaping economic life – for example through trade restrictions, subsidies, competition regulators, security regulations and market entries where a licence must be obtained, or by limiting or even preventing access to raw materials. Many political interventions result in regulations and legislation which, for the sake of clarity, we will list under legal factors.

One special political event which had a huge, one-off effect on the automotive industry was the reunification of Germany. In 1991 and 1992, this event caused a huge rise in demand for new vehicles in the former East, which resulted in record numbers of new vehicles being registered.

In 2009, Germany saw almost as many newly registered vehicles as it had done in 1991, after the Federal Cabinet passed the Directive to Encourage the Sale of Passenger Vehicles on 14 January 2009, which is also known colloquially as the "scrappage premium". In the USA, following the collapse of the US bank Lehman Brothers in September 2008, the crisis also affected vehicle manufacturer General Motors. On 1 June 2009 it had to bring in the administrators, thus bringing about the largest insolvency proceedings in the history of the United States.[7] Due to its bailout from the state, General Motors had to endure the insult of being nicknamed "Government Motors" for a few years.[8] The success of the German scrappage premium led to other countries using this method to alleviate the effects of the crisis as well. At the same time, records such as these are just one-off effects which do not reflect long-term market developments – especially as records are always followed by a slump.

More crucial in the long-term are global changes and networks which are supported by policy and types of political influence change as well. The development of the European Union can be cited as an example, as can the increase in more global trade agreements and international organisations, which are gaining ever more political influence. A recent example is the CETA (Comprehensive Economic and Trade Agreement), which was made public at the end of negotiations on 26 September 2014, but which is yet to enter into force.[9] The interest of the European automotive industry is substantial, because the broadening of trade – via tariff cuts and the minimisation of the numerous export restrictions which are still in place – results in many advantages for the export and sale of vehicles.

Overall, politics has a great supporting influence on the growth of the automotive industry. But how does it deal with digitalisation, which is becoming ever more relevant?

The role of politics in issues of freedom, privacy and security in the digital age is yet to be clarified. Hardly anybody is prepared to pay extra for prescribed IT security in their vehicle, but the question of whether a liberal state may/should force citizens to protect their lives in a better way remains controversial. The situation can be compared with that in the 1970s, when many car drivers vehemently opposed the introduction of seatbelts. Behind this is the basic fear of becoming trapped and not being able to run away from a situation of danger. After several years of wearing a seatbelt being an obligation but failure to do so not being punishable, fines were introduced – resulting in a steep rise of those wearing them from 60 to over 90 % ; the discussions about the sense of seatbelt regulations have since died down. Nowadays, similarly emotional language is used in the context of the emergency call system eCall to refer to "motorists in glass houses" and comprehensive monitoring structures.[10] In contrast to the issue of the seatbelt,

---

[7] "Obama promises a better future for GM" http://www.zeit.de/online/2009/23/gm-insolvenz. Accessed: 19 December 2014.

[8] "U.S. Remaining Stake in General Motors: Detroit Auto Maker's Bailout Cost Taxpayers $ 10.5 Billion" http://online.wsj.com/articles/SB10001424052702304744304579248001805812732. Accessed: 19 December 2014.

[9] "Canada-EU free trade deal could change auto industry" http://www.cbc.ca/news/canada/windsor/canada-eu-free-trade-deal-could-change-auto-industry-1.2125174. Accessed: 19 December 2014.

[10] "The danger lurking in the eCall emergency call system" http://www.welt.de/motor/article125249980/Welche-Gefahr-hinter-dem-Notrufsystem-eCall-lauert.html. Accessed: 19 December 2014.

however, the usefulness of possible IT protection measures is yet to be clarified. In the case of many new technologies, it takes time for it to become apparent whether its usefulness outweighs any disadvantages.

Economic Conditions

Of course, currency and its stability are at the centre of economic factors. As the automotive industry develops, produces, sells and services its products internationally, factors such as exchange rates, inflation rates, economic growth and economic cycles have a central influence on business and the resulting revenue – especially for those companies which export high numbers of vehicles and replacement parts. Further factors such as taxation, interest, availability of resources and unemployment, for example, are relevant to decisions on locations for production or administration.

According to the annual figures published by the German Association of the Automotive Industry, the turnover of the entire automotive industry in Germany in 2013 was €361,767 million.[11] This means that this industry branch contributes around 20 % of the turnover of the manufacturing industries in Germany, making it a supporting pillar of the German economy with a correspondingly high level of influence.

Over the past few years, worldwide economic growth has shifted from traditionally stronger industrial nations such as the United States, Japan, Western Europe and Canada to move towards the so-called emerging economies such as Brazil, Russia, India and China, but also to countries which have until now been referred to as developing economies, such as those in Africa. In the case of the automotive industry, this is due to the very low or even negative population growth rate in the traditionally stronger countries – but also because they are to a large extent saturated with cars, and vehicle numbers are limited by the number of parking spaces each household has. There are many statistics which indicate the number of vehicles per 1000 inhabitants.[12] While their ways of counting are not standardised – in terms of commercial vehicles, for example – it is possible to agree on the fact that in Germany or Japan there is an average of one vehicle per two inhabitants; while the number of vehicles per inhabitant is even higher in the United States. More important than exact figures, however, are comparisons with countries in which the number of vehicles per inhabitant is much lower than it is in industrial countries. The resulting economic potentials cannot, however, always necessarily be expected to be the same as actual consumer behaviour. Political instability has already been mentioned as a possible influencing factor. This is also accompanied by the problem of environmental degradation – in addition to the question in which situations public transport makes more economic sense [10].

[11] "German Association of the Automotive Industry – Figures and data" http://www.vda.de/de/zahlen/jahreszahlen/allgemeines. Accessed: 19 December 2014.

[12] "Ranking: The ten countries with the highest density of passenger vehicles, Spiegel Online" http://www.spiegel.de/auto/aktuell/ranking-die-zehn-laender-mit-der-hoechsten-pkw-dichte-a-684947.html. Accessed: 19 December 2014.

Neither should we neglect to mention the dominance of oil products and the influence of the price of crude oil – which continue to have a formative influence on the automotive industry. While work has been going on for some time, there is still a long way to go until the vehicle manufacturers will be able to reduce this dependence significantly by using alternative drive types. Only very few companies, such as Tesla Motors and their clients, are slightly less dependent on oil than the average vehicle manufacturer.

And oil is far from being the only raw material which vehicle manufacturers – along with a far-reaching chain of suppliers – are dependent on. If we take a closer look, we see that there is a continually increasing dependence on numerous raw materials which is linked not only to increasing production figures, but also to the ever growing quantities of raw materials which are needed in order to produce a single vehicle. Over the past decades, all vehicles have significantly increased in weight. The weight of the first Golf I by Volkswagen in 1974, for example, varied between 750 and 970 kg depending on the version and equipment in question; the seventh model – the Golf VII, which came onto the German market in autumn 2012, weighs between 1205 and 1395 kg. While the larger dimensions of the models contribute to this increase in weight, the main factor is the multitude of technical parts which have been added during the past decades, and which fulfil a broad range of tasks in the areas of performance, safety, reliability, economic viability, comfort and entertainment etc. A more precise presentation can be found in Sect. 2.3. While the lightweight technology used by BMW helps to reduce the vehicle's weight, it does not do anything to get rid of the continually growing dependence on many raw materials. Nowadays, the automotive industry is one of the largest users of microchips, steel, iron, aluminium, copper, lead, textiles, plastics, vinyl, rubber, and also has an increasing need for rare earth elements.

During the past few years, especially thanks to its automotive industry, China is no longer present on the market just as a supplier of raw materials – but has also become a large source of additional demand. This has also resulted in a clear rise in economic competition for raw materials in a global context – something which has been heightened due to export restrictions on raw materials in China.

The question of how vehicle user data will develop as an economic factor still remains largely unanswered – or, to be more precise, whether similar dependencies will develop in new value creation chains in this context in the future. It should no longer be ruled out that, in future, data – in particular vehicle data – will be traded on the stock market as is the case with raw materials at the moment. Simply possessing data in the context of vehicles, users and use profiles can become an economic advantage. The main risk is still to be found in the learning curve with data and investments in the "right" mobility services, which can also remain profitable in the long term.

Societal Forces and Trends

Societal factors can be divided into structural characteristics and their corresponding trends. The structural characteristics include, for example, population structure, education, moral concepts and income distribution. The corresponding trends are influenced by demographic change, for example.

The automotive industry is of high importance to the German population. According to annual figures from the German Association of the Automotive Industry, there were an annual average of 756,021 employees in the automotive industry in 2013 – something which has a direct influence on their societal significance. This figure is even higher if one counts the companies which exist along the value creation chain independently from the automotive industry – such as suppliers of raw materials to the automotive trade and recyclers of old vehicles. By including these people as well, one comes to a total figure of 1.8 million employees [23].

How visible are companies in our society? In fact, it is rather rare for companies to be in the spotlight – for example in the case of staff strikes, or when companies become embroiled in scandals. Usually, at a consumer level, it tends to be the product brands of a company which are perceived more strongly. In the case of cars, this is particularly the case in those countries where vehicles are considered status symbols and are not only used for the specific purpose of travel. This is why brand identity continues to have very high importance for automotive companies, as we demonstrated in the context of the business competence "corporate and brand identity" in the domain of "marketing and communication" in Chap. 3.

With a focus on premium vehicles, companies invest considerably in associations such as safety, comfort, performance or reliability. If we look at our purchasing behaviour critically, we will often see that in order to be able to distinguish one vehicle from another in a "blind test", it is increasingly necessary to be an expert who is constantly updating their knowledge. Decisions tend to be made very quickly on the basis of the brand name – even if this can result in higher prices being paid.

Depending on the brand's orientation, different sectors of society are addressed in accordance with their lifestyle: Single, independent individualists have different mobility needs to those of families. Customer segments are, however, by no means static – as our society with its needs and lifestyles is in constant flux. How, for example, would we define the 'family' customer segment nowadays? Would separated parents also be included, or the rising numbers of same sex married couples? Nowadays, there are many families whose members have been brought together as a result of separations and divorces, and are sometimes referred to as "step families". The trend of bringing children from a previous relationship into a partnership is becoming increasingly common. It is no longer rare for people to have family around them during the week and then to be on their own at weekends – or vice versa. Does this mean that there are other demands on a family vehicle which need to be taken into account by the manufacturer? One thing is certain: the more diverse family circumstances there are, the more demand for individualisation increases.

The causes of changing values in society are not just a result of growing wealth and modernisation, but also of increasing urbanisation. This has direct effects on the business models of the automotive industry, and requires new mobility solutions.

As part of transport in urban or rural areas, over short or long distances, different needs arise which can only be satisfied by a range of mobility concepts. In this way, increasing urbanisation – especially in emerging economies with low purchasing power – requires the establishment of small, lightweight and manoeuvrable city vehicles alongside a solid public transport network.

Cities are not only being rebuilt due to increasing urbanisation, but also in ageing industrial societies where continuing population decline requires more sustainable urban planning [25] and urban transport planning [27]. The process of rethinking new concepts in urban development involves, for example, a more socially acceptable form of mobility by banishing cars from important parts of city centres in order to avoid car traffic as much as possible. There has been a congestion charge zone in the centre of London since 2003, while New York City is home to the best known park in the world – the “High Line Park” – which has been built over the past few years on a disused elevated railroad spur. In urban and transport development departments, there is a desire to encourage residents to start walking more again. In modern urban planning, the car – which has been considered an essential element of what residents need and want ever since the post-war era – is now included as an unwanted, necessary evil at best, and is kept out of sight or banished to the sidelines if possible. If it were possible, it would be preferable to not have to plan for them at all. Free public transport, electric bikes and other elements will make it possible to build areas of cities with reduced car numbers – something which is now being discussed more and more seriously.

Demographic change in our society also includes the ageing population in industrial countries and increasing life expectancy in emerging economies. In view of this, the automotive industry will have to adopt a more sensitive approach towards issues such as fitness to drive and drivers’ health in order to make it possible to change to travel services or even public transport. Fully automated, autonomously driving vehicles [14] cannot be the only answer. Despite all the criticism levelled against it in relation to data protection, the connectivity between a vehicle and a mini computer to be worn directly on the body – so-called “fitness wearables” – can provide health protection, for example by working out a personalised, stress-free navigation route through a city, or by recommending a break in driving.

In short, there are definitely many personal preferences in our society which can be connected with a vehicle and its use. As such, it can no longer be sold as “a” fully-integrated package. Even a diverse range of models, as is the aim of customer segmenting, cannot integrate all needs.

Using a range of statistics, it can be recognised that young people’s love of cars is diminishing in our society. Between 1995 and 2012, for example, the average age of German car buyers rose continuously from 46.1 to 51.9 years.[13] A fundamental reason for this is that many young people no longer consider it a priority to hold

[13]“Young people don’t care about new cars” http://www.zeit.de/auto/2013-04/neuwagen-kunden-alter. Accessed: 19 December 2014.

Table 4.3 Driver's licence ownership rates among young people in the United States (*Source*: "Percentage of teen drivers continues to drop" http://ns.umich.edu/new/releases/20646-percentage-of-teen-drivers-continues-to-drop. Accessed: 19 December 2014)

Year	17 years (%)	18 years (%)	19 years (%)
1983	69	80	87
2008	50	65	75
2010	46	61	70

a driver's licence.[14] It is not only the sales of cars which are affected by this, but also their use. For example, Table 4.3 shows the continual decline in driver's licence ownership among 17–19 year olds.

Technological Developments

Technological developments affect the automotive industries in a wide variety of ways. The influencing factors include research – from public and state-financed institutions too – and the resulting new products and processes. Technological possibilities and their ease of use are also gaining more and more importance and influence in almost all industries. Here we are simply summarising just a few of the main influencing factors, as the principle permeation of digitalisation along with new technologies was introduced as part of the individual business competences in the automotive industry in Sect. 3.6.

Almost one third of all expenditure for research and development in Germany is spent in the context of the automotive industry. This means that locations in a region where certain technologies are particularly present become an influencing factor. Germany is an important location for many – but not necessarily all – vehicle technologies. Recently, for example, many automotive companies and suppliers have invested in new research and development locations for infotainment systems [15] and connected vehicle services in Silicon Valley [11] – which is not a place in the usual sense of the world, but more an attitude held by creative people who change the world. It is shaped by anti-cyclical business cultures, and has established itself as the home of Apple, Google, Facebook, Oracle, Intel and Stanford – among others. Spatial proximity to the developments of digital technologies and of large and small creative young companies makes it possible for the automotive industry to keep up with and collaborate closely with entertainment technologies. Proximity to the IT companies helps to place the precision of engineers in the foreground, in addition to shaping values such as safety and comfort, as well as social and digital networking.

[14] "Driver's licence no longer a status symbol: Driving is out, smartphones are increasingly important" http://www.faz.net/aktuell/technik-motor/auto-verkehr/fuehrerschein-kein-statussymbol-autofahren-ist-out-smartphones-werden-wichtiger-13346242.html. Accessed: 19 December 2014.

The alternative drive technologies which are different to the common combustion engine in terms of their energy source or engineering concept are being given increasing levels of attention. There is still hope that it will be possible to solve the problems of environmental pollution and the depletion of fossil fuel sources. It is still uncertain, however, which alternative drive technology will catch on in future – something which could lead to costly misinvestments. Neither is it clear how significant the actual improvement to environmental degradation may be, or the reduction in dependence on finite resources. The electric drive is an alternative drive concept which is still in the early stages of development, but which is believed to have great potential. Hydrogen and biogas are two examples of alternative fuels which do, however, present numerous challenges for passengers and the environment in terms of sustainability, acceptable refuelling procedures and safety. Toyota is making progress in a new direction all of its own, and is presenting the series version of a hydrogen-powered fuel cell car in Japan.[15] Both manufacturers and suppliers still need to build up a lot of knowledge about key technologies for alternative drive concepts in a broad range of countries, as a result of which the market and manufacturer positions which have existed until now could change. The countries' governments also play a significant role in supporting infrastructures for alternative drive technologies such as charging stations.

Constantly increasing network speeds and bandwidths combined with falling costs for data transfer influence mobility services and possibilities within the vehicle. The current LTE (Long Term Evolution) mobile technology, for example, makes it possible to transmit about ten times as much data in practice as the third generation UMTS (Universal Mobile Telecommunications System). Growing networks and customer needs integrate vehicles into personalised networks with technical framework conditions which are unknown during vehicle development.

Many production procedures have a long history in the automotive industry. Thanks to the government support programme Industry 4.0 in Germany the network of factories and digitalisations in manufacturing processes and techniques are seeing long-term, far-reaching changes [2].

It must also be mentioned that there is great potential for technical knowledge and experience gained by staff in a private capacity to be used in the workplace too – by creating free spaces for technology. While our main focus here is not on how companies are being challenged by demographic development, it must nonetheless be taken into account that this phenomenon is changing the extent of the knowledge gained in a private capacity by staff who are older on average, and the expectations of the young so-called "Generation Y", who attach importance not only to work-life balance, but also to the appreciation of their competences, and who are shaped by their interacting with a broad range of technologies every day.

---

[15] "Toyota's series car with fuel cell: The advance of hydrogen" http://www.spiegel.de/auto/aktuell/toyota-mit-wasserstoff-antrieb-fcv-faehrt-mit-brennstoffzelle-a-977331.html. Accessed: 19 December 2014.

Legal Framework Conditions

There are legal framework conditions on many levels, which tend to be perceived by industry as restrictions and sources of extra work alone. In particular, the automotive industry has to take into account national and international legal provisions and regulations throughout the life cycles of its products. In some situations, legal framework conditions are standardised at the level of a union of states such as the European Union. Local interest associations, on the other hand, are often active on the community and regional levels in automotive companies, but they can have significant effects on the ability of a company to perform.

The central task of international organisations remains continuing to harmonise technical provisions for vehicles at an international level. The UN Convention on the United Nations Economic Commission for Europe (UN/ECE) was signed in the 1950s, and currently has 49 signatories.[16] Since 1998, there has been work towards a global agreement,[17] which as yet includes no approvals or certification processes, however. For legal reasons, it will not be possible for there to be a vehicle which is standardised at a global level – even for several decades. Legal framework conditions are not, however, the sole reasons for the high level of variability between vehicle parts. Volkswagen, for example, cannot simply reduce its 350 types of exterior rear-view mirrors and 700 different bumpers to the technical basics of just a few basic models.[18] We do not necessarily have to look as far as old historical burdens in order to recognise the problems which occur when harmonising regulations. Currently, for example, the emergency call system eCall shows us that numerous legal hurdles still need to be overcome in order to make it possible to provide connected vehicle services which are standardised in more than one country.

The automotive industry is not fundamentally different from other global industries when it comes to general legal factors such as legislation, tax directives, the awarding of patents, or competition regulations. There are, however, significant differences in terms of strict liability provisions for the car industry, and the special regulations which go hand in hand with them.

At the moment, the development of three legal provisions is particularly in the focus of the public eye. These are: the taxes and emissions standards for exhaust gases and the CO_2 efficiency of new vehicles in order to reduce global warming; changing regulations such as congestion charges or road tolls; and, finally, the first attempts to regulate the development and support of autonomous vehicles [14].

Another topic related to legal framework conditions which is still in its infancy is the increasing amount of information which can be gained from electronic systems,

[16] "Vehicle Regulations" http://www.unece.org/trans/main/welcwp29.html. Accessed: 19 December 2014.

[17] "GAR – Global Technical Regulations" http://www.globalautoregs.com/gtr. Accessed: 19 December 2014.

[18] "To what extent is Volkswagen still the 'car of the people'? More types of exterior mirrors than car models" http://www.zeit.de/mobilitaet/2014-08/volkswagen-vw-probleme/seite-3. Accessed: 19 December 2014.

such as vehicle data. In this context, there are many questions which are related to the classification of data, claims to this data and liability for incorrect processing of data. We introduced this issue in Sect. 3.6.8 in the business competence "Customer and vehicle data".

Ecological Issues

Ecological factors include the increasing awareness of the importance of the environment and health in our society, which is reflected in values such as environmentally aware waste disposal – from production to the recycling of vehicles [24] and the reduction of emissions. There are still numerous challenges which need to be overcome in these areas.

It has now already been proved that the ambitious goal of reducing emissions cannot be realised by increasing the efficiency of classic combustion engines alone. Alternative drive technologies are becoming necessary – but they are dependent on numerous raw materials, and cause other environmental problems. In this way, electric vehicles are controversial from an environmental point of view, because their value for the environment is especially dependent on the way in which their electricity is generated.[19] Furthermore, the high-performance permanent magnet in the electric car cannot function without lithium and several rare earth metals, while hydrogen-powered vehicles require platinum for their fuel cells. This means that the availability of raw materials and ecological access to them is a pre-condition for the production of electric cars.

Rare earth metals only occur in low concentrations in minerals which are few and far between, and can only be extracted using costly processes. China has a global monopoly in terms of the occurrence of these raw materials and their extraction. The extraction of rare earth metals is associated with considerable environmental risks. Radioactive substances are released, while large amounts of poisonous waste are left as residue, which damage humans and the environment in the form of particles and via groundwater. Moreover, there are many small-scale mines in which no environmental protection is practised at all.

At the end of a vehicle's life cycle, it becomes more and more costly – but also more necessary – to deconstruct it into its constituent parts. The planning of vehicle engineering must take into account the options for recycling components and materials so that, in future, individual components can be dismantled easily and their raw materials can be reused [4]. Recycling is, however, a process which uses quantities of energy which should not be underestimated in terms of the separation and retrieval of various metals.

A basic requirement of vehicles is that they should be environmentally friendly. In terms of environmental and health consciousness, there is also a basic issue of how to maintain a vehicle. Why should the numerical ratio of vehicles to inhabitants

[19] "Electric cars may do more harm than good" http://www.welt.de/wissenschaft/umwelt/article135412530/Elektroautos-koennen-mehr-schaden-als-nutzen.html. Accessed: 19 December 2014.

continue to move in the direction of increasing vehicle numbers? Another no less fundamental question is the following: How long, on average, do we spend travelling each day?

Actual use times can only be estimated, as it is not yet possible to carry out a precise quantitative arrangement of all vehicles which are currently in use. We can get a rough idea by calculating parking durations as times of non-use, or by calculating the average distances which are travelled on a daily basis by certain population groups. There are many analyses and statistics on these topics, particularly on the use of parking spaces near residences and workplaces, and on the average duration of travel (see [1,9,16,29]). While these values certainly cannot be generalised, they reflect what most vehicle owners already know from their own use habits. All evaluations show an average use of between 1 and 2 h per day – which corresponds to vehicle use of between 3 and 8 %.

In the light of these figures, we can say that vehicles spend more time "stationary" than they do in motion – so, ecologically speaking, they cause a high level of pollution while only being used to a minimal extent.

4.1.2 Competitive Forces and Imminent Market Developments

Market changes have an effect on the competitive advantages of individual companies – which means that a business model which is currently successful will not necessarily survive in the long term without being modified. In this section we will deal with influencing factors which are in the direct competitive environment of the automotive industry, and of which two – digitalisation and connectedness – have a direct influence on the company. In terms of the structural analysis of sectors in the context of market and competitive forces, the "Five Forces Model" by Michael E. Porter [18] has gained credence. It helps to recognise and analyse the greatest challenges and risks which are to be found in the direct business environment. It was developed and established as an aid for strategic analysis in business planning. When using it, it should be remembered that external forces tend to affect all automotive companies. By doing so, market forces can be discussed in a way which is independent of a specific company. The success of the response to the five forces as a competitive strategy depends, however, on the different skills of the company in question. This is illustrated by the examples from Sect. 3.1.

The focus is on the rivalry between existing competitors in the sector. Current competitors are far from being the only dangers facing companies, however. In addition to the factors of the external business environment, the negotiating power of suppliers and purchasers as well as potential new market players and the threat of replacement products or services can influence the attractiveness of a business model, and can spark great changes. In total, there are five basic competitive forces

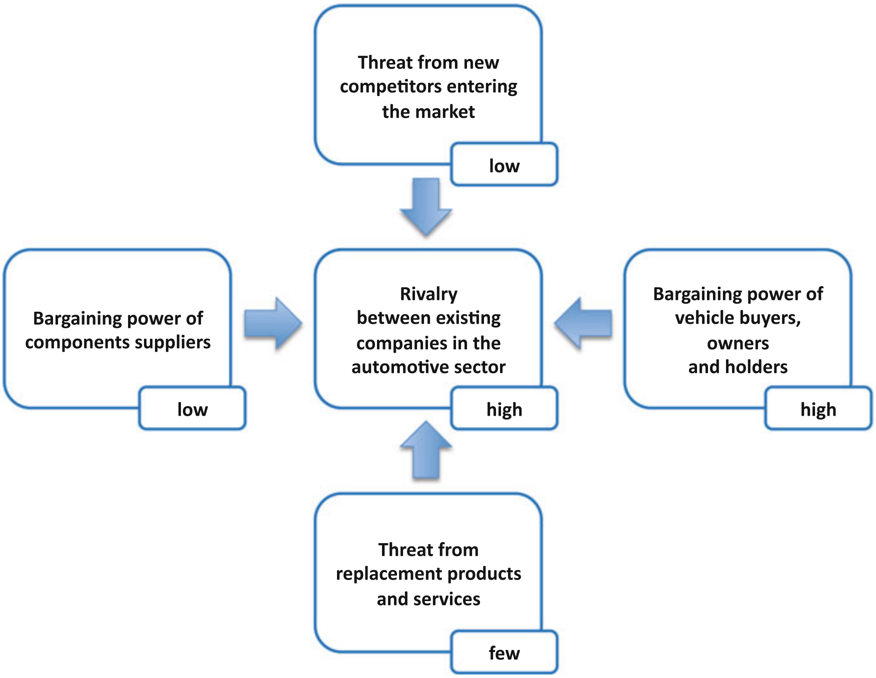

Fig. 4.2 The five market forces and their risks to sector competition, according to Michael E. Porter [19] for the automotive industry of the twentieth century

which, taken together, define the competitive intensity and economic viability of the sector. All five come from different directions to have an effect on a company. In terms of formulating a strategy, the strongest forces are what is crucial – with their characteristics which create business pressure. In Fig. 4.2 we have presented the model for the automotive industry which was valid in the twentieth century. In this diagram, the automotive industry is in a good position, because the competitive strategy basically only had to concentrate on the customer as a buyer, and on the rivalry between the existing companies. For many decades, this remained valid for as long as these two forces were the only dangers threatening to cause losses of business or prospects of gains in terms of competition.

In the twenty-first century, digitalisation and connectedness has made many value added services possible for individual mobility, meaning that the number of replacement products and services has increased very rapidly. As a result, threats throughout all of the competitive environment have increased. We clarify this in a model (see Fig. 4.3) using the extreme scenario of the existing automotive industry developing to become a supplier of the mobility industry with relatively little negotiating power.

All of the four other market forces (except for the supplier) create a great amount of pressure on business, which means that it is not attractive – at least economically

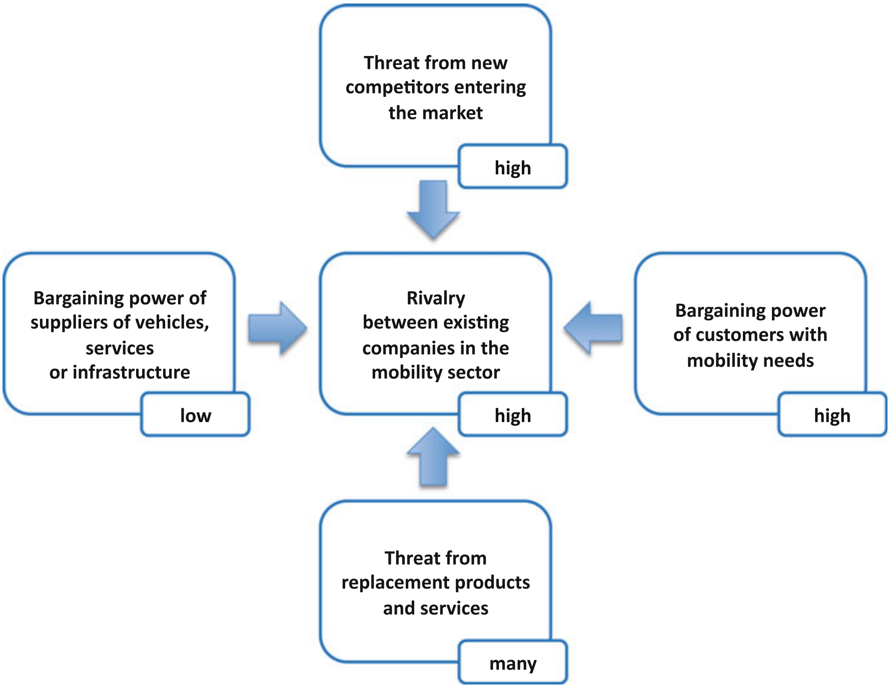

Fig. 4.3 The five market forces in the competitive model of the mobility sector

– particularly at the current time, and that it needs more sustained investment. This diagram shows which imminent challenges a vehicle manufacturer should prepare to have to deal with. The aim is to broaden the business model to include value added services for individual mobility, but at the same time to use the creation of vehicle products in order to set the business apart in the market. The mobility sector is still very young, and is yet to establish an attractive sector structure in the competitive environment. It is important for strategically well-placed companies to develop a strong position. Even though it is still difficult to create competitive advantages: Thanks to their vehicle competence, vehicle manufacturers have good prerequisites for exploiting the mobility sector. They should merely take care not to underestimate other sectors, such as parking space providers – who can use their advantages in strictly regulated countries such as Japan. After all, nowadays, parking spaces are just as essential to mobility as vehicles are – at least for as long as it is not possible to achieve 100

In the next section, we will analyse the five forces and how they can be developed.

Rivalry Within the Industry

Rivalry within the industry is becoming increasingly intensive – if not more aggressive – as chances for growth can now only be realised by taking clients from competitors. In the industrial nations, the number of vehicles sold per year has been falling for several years. Precise figures are published, for example, by the "International Organization of Motor Vehicle Manufacturers".[20] According to them, 87,507,027 were sold in 2013. Globally speaking, sales figures have risen continually over the past 5 years – mainly because of rapid growth in China and India. There is only a finite number of new markets which can be broken into. Over a period of 9 years it has become very clear that in both Europe and North America, sales figures of new vehicles have declined. Obviously, the market is becoming saturated. Even though the world's population is continuing to grow, the end of market capacity for vehicles will be reached in the foreseeable future. Interplanetary business between markets which we cannot yet even imagine will remain a fiction for a long time to come. This is why sales and distribution in the industrial nations will mainly concentrate on existing customers, and on taking customers from the competition.

Competition is also becoming more stiff because the automotive sector is limited to fewer and fewer companies. If we look at the turnover figures of the world's largest companies as listed in Fortune 2014 "The Global 500",[21] we will notice that there are 21 automotive companies – which are summarised in Table 4.4.

We have not listed car suppliers or those vehicle manufacturers which do not produce any passenger vehicles. It would only be possible to make a precise comparison if one could concentrate on a single business area of the companies listed – such as passenger vehicles, for example. There are, however, no standardised company reports about business figures which are categorised according to a comparable product portfolio, observation period and separate subsidiary companies or joint ventures. This is not particularly relevant to our discussion of rivalry within the industry.

Table 4.4 presents the two following main insights:

- The nine largest vehicle manufacturers in terms of vehicles sold account for almost 70 % of worldwide competition in terms of new vehicles.
- The five main Chinese automobile manufacturers already account for around 16 % of total competition, even though their production concentrates almost exclusively on the Chinese market. Until 2004, Fortune's "The Global 500" did not list a single Chinese automobile manufacturer.

In short, this results in a higher level of competition within the sector, as shown in Fig. 4.2. Loyal customers with a real connection to the brand therefore become increasingly important, as described as a societal factor in Sect. 4.1.1.

While rivalry on a global level drives the globalisation of companies and their brand identities forward, this does not mean that the vehicles are necessarily standardised on a global level. They must fit in with regional requirements and

[20] "Production Statistics – OICA" http://www.oica.net/category/production-statistics. Accessed: 19 December 2014.

[21] http://fortune.com/global500. Accessed: 19 December 2014.

Table 4.4 The world's largest manufacturers of passenger vehicles, which are listed according to turnover in Fortune 2014 "The Global 500"

Company	Employees	Turnover in million	Sold vehicles
Volkswagen (Wolfsburg, Germany)	572,800	$ 261,539	9,728,250
Toyota Motor (Toyota City, Japan)	333,498	$ 256,454	9,692,000
Daimler (Stuttgart, Germany)	274,616	$ 156,628	2,353,600
General Motors (Detroit, USA)	219,000	$ 155,427	9,714,652
Ford Motor (Dearborn, USA)	181,000	$ 146,917	6,330,000
Honda Motor (Tokyo, Japan)	198,561	$ 118,210	4,323,000
Fiat Chrysler Automobiles (London, United Kingdom)	225,587	86,816 €	4,352,000
Nissan Motor (Yokohama, Japan)	160,530	$ 104,635	4,914,000
BMW Group (Munich, Germany)	110,351	$ 100,971	1,963,798
SAIC Motor (Shanghai, China)	198,000	$ 92,024	5,106,000
Hyundai Motor (Seoul, South Korea)	104,731	$ 79,766	4,732,000
China FAW Group (Changchun, Jilin Province, China)	120,000	$ 75,005	2,908,400
Dongfeng Motor Group (Wuhan, Hubei, China)	114,365	$ 74,008	2,567,700
PSA Peugeot Citroën (Paris, France)	194,682	$ 71,807	2,818,000
Renault (Boulogne-Billancourt, France)	121,807	$ 54,339	2,628,208
Kia Motors (Seoul, South Korea)	48,089	$ 43,486	2,746,000
Beijing Automotive Group (Beijing, China)	22,000	$ 43,323	2,164,000

(continued)

Table 4.4 (continued)

Company	Employees	Turnover in million	Sold vehicles
Tata Motors (Mumbai, Maharashtra, India)	66,593	$ 38,502	1,020,546
Guangzhou Automobile Industry Group (Guangzhou, Guangdong, China)	38,500	$ 32,775	1,004,600
Suzuki Motor (Hamamatsu, Japan)	51,503	$ 29,330	2,711,000
Mazda Motor (Hiroshima, Japan)	40,892	$ 26,873	1,331,000

Fiat Chrysler Automobiles, which was founded in 2014, has also been added. The data in the columns "Employees" and "Vehicles sold" are from the business and annual reports published by the company in 2014

changing needs in order for it to be possible to sell them. Japanese firms in the United States, for example, often sell American-looking vehicles which are only produced in the USA.

In the mobility sector, however, there is still no comparable rivalry on a global level.

Suppliers' Negotiating Power

Automobile suppliers are very fragmented. Above all, there are thousands of local suppliers whose entire business is very specialised and relies on mechanical, hydraulic, electrical or electronic parts and only one or two vehicle manufacturers. In Sect. 1.7 it was mentioned that, in Germany 97 % of the country's 7457 companies employ between 20 and 1000 employees. For the many specialised suppliers, it is particularly serious if a vehicle manufacturer decides to switch to another supplier, or no longer uses a certain part in construction. As a result of this, most suppliers only have minimal market power and are closely controlled by the procurement of manufacturers – especially when sales volumes are pooled. Some exceptions include suppliers of raw materials – who have a very strong negotiating position because there are only very few companies selling the same raw materials. We presented this economic factor in Sect. 4.1.1 in the context of the automotive sector.

Table 4.5 shows the few manufacturers of passenger vehicles which are listed according to turnover in Fortune 2014 "The Global 500". This handful of suppliers currently dominates[22] the market for AUTOmobiles. Electronics companies such as Samsung, Panasonic or Sony currently also supply some areas within the automotive industry. Investments within the market do, however, indicate that electronics

[22]Further movement is expected in the market during the years to come. The figures are from the end of 2014.

Table 4.5 The world's largest automobile suppliers, which are listed according to turnover in Fortune 2014 "The Global 500"

Company	Employees	Turnover in million	Share automobile (%)
Bosch (Stuttgart, Germany)	281,381	$ 61,632	65
Continental (Hanover, Germany)	177,762	$ 44,249	96
Johnson Controls (Milwaukee, USA)	170,000	$ 42,730	51
Denso (Kariya, Japan)	139,842	$ 40,885	98
Bridgestone (Tokyo, Japan)	143,448	$ 36,573	85
Magna International (Aurora, Canada)	125,000	$ 34,835	100
Aisin Seiki (Kariya, Japan)	83,378	$ 28,171	96
Michelin (Clermont-Ferrand, France)	111,200	$ 26,879	85

The data in the columns "Employees" and "Auto share" (percentage share of turnover in the business area for the automotive industry) is from the business and annual reports published by the companies in 2014

companies are observing Apple too, and are building up a negotiating position within the competitive market of the autoMOBILE.[23] Access to vehicle data is no longer controlled by the manufacturers alone; instead, suppliers with new value added services will contact the end customers directly.

Consumer Influence

For a vehicle manufacturer with build to stock production, the influence of car buyers is only minimal, as they usually only want to buy a single vehicle for private use – on occasions which are few and far between. Depending on the market and segment in question, groups of buyers have different focuses and factors in their decisions – such as age, whether they have a driving licence, whether they have access to a parking space, taxes, insurance and environmental awareness. Company cars in particular account for a large proportion of premium vehicles in Germany. In this context, consumers have negotiating positions which are different to those which can be achieved by private buyers.

[23] "Will Samsung Enter Autonomous Vehicle Market?" http://www.businesskorea.co.kr/article/9140/practical-value-exynos-will-samsung-enter-autonomous-vehicle-market. Accessed: 24 February 2015.

Nonetheless, nowadays it is possible for private buyers to be much more focused on the product they wish to buy. Thanks to digital options and different information channels, people are very well-informed – which means that the comparison of performance or prices no longer necessarily takes place on site at the dealer's.

The negotiating power of customers with individual mobility needs will increase even more if they no longer appear just as one-off purchasers. A longer-term relationship is needed with clients which goes beyond just one purchase transaction; if this is not built up, then it is much easier for the customer to switch from one mobility range to another. Loyal customers with a real connection to the brand therefore become increasingly important, as described as a societal force in Sect. 4.1.1.

Threat Posed by New Market Players

The threat posed to the traditional AUTOmobile by new market players is low – especially for vehicles with a classic combustion engine. Investment costs for product development and manufacture in capital-intensive factories, which require comprehensive advance payments and high liability risks, are too high. This makes the market entry barrier to the automotive sector a very high hurdle for ambitious young entrepreneurs with new concepts and visions. In general, the following applies: The higher the investment which is needed for market participation, the lower the probability is that a company will be able to break into the market. In the introduction, we mentioned examples of newly founded companies such as Tesla Motors and Local Motors.

The actual threat, however, is posed by new market participants with replacement products or services which also make individual mobility possible. They are acting in a mobility industry which is less and less concerned with vehicle manufacture, and also need time to build up a reputation with consumers. Companies such as Uber are already on the market with their own distribution networks.

Threats Posed by Replacement Products or Services

In the traditional automotive industry, there were only very few replacement products – such as public transport, for example. One possible approach is to strategically eliminate replacement products, as described at the beginning of the chapter using the example of the United States. Another approach is to incorporate the unavoidable factor of competition into strategy – which is occurring at Daimler, for example (see Sect. 3.1.3), with its company strategy as part of "driving forward connected vehicles and new mobility concepts".

4.1.3 Evolution, Transformation and Creation

In the two previous sections, we concluded that there is a long list of problematic developments surrounding the AUTOmobile, including

- digitalisation,
- connected vehicles,

- emissions reductions,
- too many alternative drive concepts and
- decreasing enthusiasm for car ownership among young people,

and that there are strong market forces for the creation of a mobility industry.

How is it possible to change an existing business model in the automotive industry?

By themselves, having a specific company goal or a strategically planned "right" way of getting there are not enough. It's just like with a GPS system: It can only tell the vehicle which direction to go in if a specific destination is provided, but this does not mean that it is the right route for the driver. This can only be defined by taking into account the framework provisions and priorities of the driver and the vehicle. Otherwise, the available fuel might not be enough – or the driver may arrive late for his appointment and might as well forget the entire journey. The same applies to the company-specific alteration of existing business models. Companies change in different ways in order to react to the evolving market requirements which affect them.

We will take a look at three degrees of possible changes in the automotive industry, which we define as follows in our context:

Evolution	concentrates on the development of core business, the product portfolio or exploiting and penetrating new markets by selling products. It is protected by its established company processes, and it has very high chances of success in a closed context which already functions. At the same time, however, it is only possible to a limited extent for innovations and alterations outside of the product context and the existing value creation chain – for example the rise of digitalisation within the vehicle as a result of the change of vehicle drive from a combustion engine to an electric one. The effects on the business orientation of product sales would hardly change, however.
Transformation	investigates and tests new business models step by step – outside of the company as well. It benefits from the creativity and business innovations of areas within the company which have different types of experience, researches new strategic orientations and brings about change. Often, it is protected by the company's solid financial basis – but also restricted by the goals of the existing business model. Daimler, for example, develops new digital products which make it easier for customers to do without a vehicle.[24] In terms of the transformation of its business model, Daimler sees IBM as a successful example to aspire to, as IBM

[24] "Why Daimler is its own competition" http://www.wsj.de/nachrichten/SB10001424127887323372504578468933801351120. Accessed: 19 December 2014.

developed from a business which used to be dominated by mainframes into a business model based on software, consultation and services. This is why, today, the company "is seen as being just as successful as it used to be – but with very different content".

Creation brings about new business models – even when there is only a very vague vision. It is often shaped by the establishment of new companies with very short processes, has hardly any historical burdens, and can develop very quickly thanks to its iterative trial and error methods and constant striving towards optimisation. For companies which are already established, however, it is a balancing act – because the brand identity may change, which may result in irreversible irritation among existing clients. One example is the entry of Google, which is known for its internet services, into the automotive industry – with a product which does not put the vehicle itself in the primary focus of the value creation chain – instead, the focus is on the client, who is influenced and directed using the data from his/her movement and behaviour patterns. For Google, a step like this is crucial – because its core competence of the internet search is only a "temporary strength" which is based on consumers' comfort. A vehicle involves more ways in which to check and influence a person's behaviour.

Figure 4.4 shows the different degree of change to the business model using a general example in the automotive industry.

4.2 Business Architecture of the Mobility Industry for the autoMOBILE

Figure 3.5 shows an established business model in the automotive industry. Of course, changes to the model have fundamental effects on all of the company's business. Things become risky, however, if the brand identity changes, and regular customers see no value in the new promise of benefit. In this regard, the task of developing new models is very difficult, because the automotive industry has become very mature over several decades. The same applies to dealing with several business models if new models are competing with ones which have existed for a long time, or even throwing them into question entirely. However, new business models are always developing in the competitive market [3], and automotive companies are required to implement the first steps towards a mobility industry.

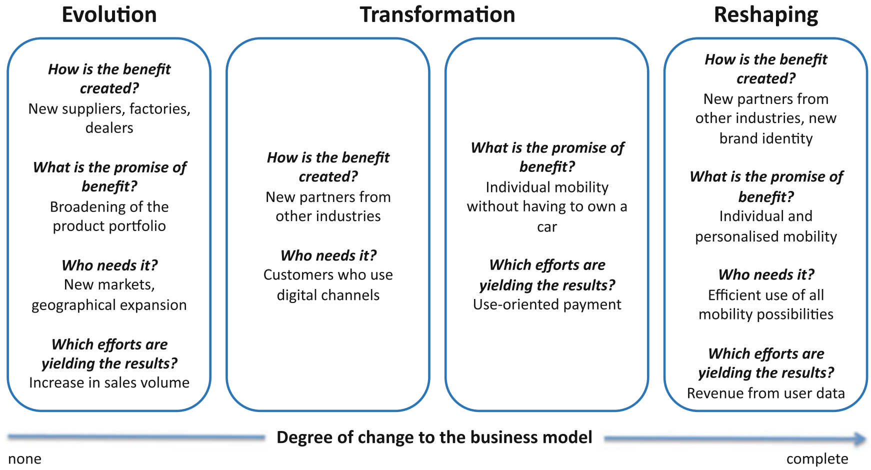

Fig. 4.4 In terms of the evolution of the existing business model in the automotive industry, the extent of the changes is only very minimal. Transformation allows established companies to develop new business models with a manageable level of risk. Creation, on the other hand, makes it necessary for there to be a change of strategy to a completely new entrepreneurial impact direction

4.2.1 Business Model of a Mobility Service Provider

Of course, automotive companies need to examine the business models of mobility service providers more precisely in order to be able to move away from the vehicle-centric model of thought when they develop towards the mobility industry. Mobility service providers build on two basic principles which distinguish them fundamentally from traditional automotive companies.

Collaborative consumption:	Goods for a specific purpose are used jointly.
Need orientation:	Clients' needs are fulfilled by services without any product loyalty or assets.

For example, a rental car company makes a car-sharing car available as part of its business model – which means it has already been adhering to the first principle of "collaborative consumption" for several years. By contrast, the driving service agencies Uber and myTaxi are not bound to assets or to a fleet of vehicles, and adhere to both principles. The route planner moovel is not even bound to transport itself. There are so many varieties of mobility services that vehicle manufacturers cannot concentrate on all of them – especially given the fact that there are also mobility services which have nothing to do with vehicles – such as travel agencies, for example.

We will concentrate on the "car-sharing" business model, because it is a vehicle-related service similar to a rental car, and is located right at the centre of the intersection between mobility services, where the transition between an owned

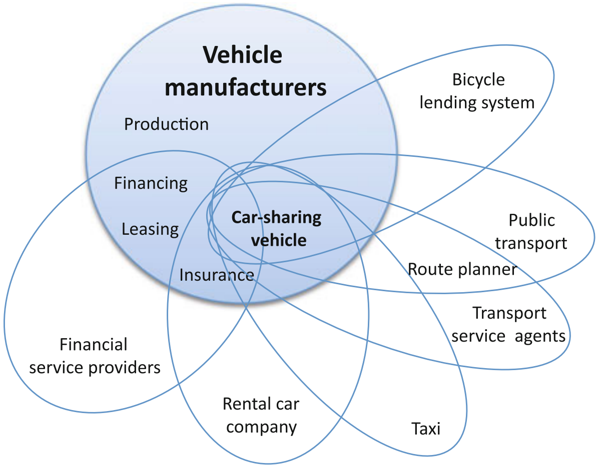

Fig. 4.5 Car-sharing vehicles are at the centre of the intersection between mobility services, at the transition between an owned AUTOmobile and a used autoMOBILE

AUTOmobile and a used autoMOBILE (see Fig. 4.5) is found. To be precise, there are three different variants:

1. *Station-dependent car-sharing vehicles* are often rented for a certain period of time – usually a few hours or days – in conglomerations or for journeys between cities. The vehicles are collected at defined parking spaces, where they are also left afterwards. The difference between this and a traditional rental car is that in this case, there is no need to conclude a contract for every rental. Some examples of this are Flinkster and car2go black.
2. *Station-independent car-sharing vehicles* are located in a defined area of use, and are paid for the driving time or distance they are used for. Users enjoy full flexibility in the sense that they can leave the vehicles in any free parking space as long as it is not outside the area of use. Some examples of this are car2go and DriveNow.
3. *Private car-sharing vehicles* are rented or rented out in a private capacity for defined periods of time. One example of this is Autonetzer.

But we should always keep in mind that also “car-sharing” is just a temporary business model which will further evolve in the next years.

The brand car2go, for example, is a completely new business model for Daimler. See Figs. 4.6 and 3.5. The way in which benefit is created is very different in each of the two business models. But even though this is a new business model, it still involves building a bridge to the existing core business – as part of which it is only Daimler vehicles which are used in the fleet. This creates a competitive advantage in comparison to other providers – who have to purchase vehicles on the open market. The model used by car2go is still at the beginning of its development, but with

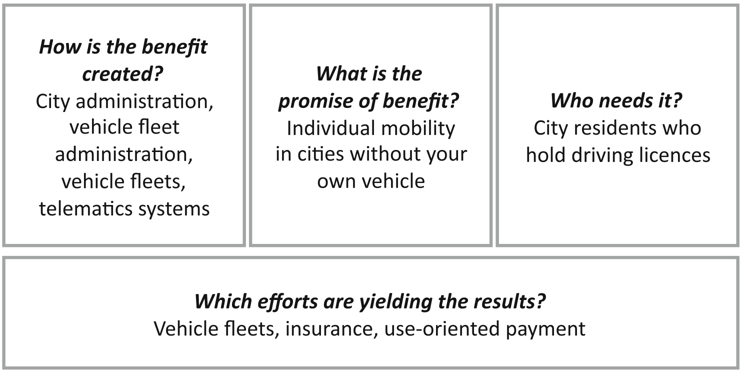

Fig. 4.6 Simplified business model of the brand car2go as a provider in the segment of station-independent car-sharing

moovel, it has already managed to establish its own independent, strategic business unit within Daimler. In this situation, the existing business model is not replaced as a result of the transformation – instead, it is complemented in a way which makes sense, and the company learns how to deal with several business models. Nonetheless, Daimler must make decisions on the organisational structure of the new business model – i.e. whether it will continue to be developed in a way which is integrated into the established core business, or separate from it.

The start-up moovel, however, does not consist of brands such as car2go alone, which were developed from Daimler's internal competences and resources. Other brands such as myTaxi and RideScout were acquired by moovel so that it could speed up the development of the business model on the international mobility service market.[25]

An important factor in the success of such transformations is the flexibility of the enterprise architecture at the level of the business architecture. This also means a change in the business competences.

4.2.2 Business Domains

The paradigm shift from the AUTOmobile to the autoMOBILE means that the business model is not the only thing to change. Via the implementation of the model, this change has direct effects on most business domains. According to the definition of different extents of changes to the business model (see Sect. 4.1.3), we will concentrate on transformation as regards the established automotive industry. Using this form of innovation, established large companies can, to a great extent, plan

[25]"moovel acquires mytaxi and RideScout" http://media.daimler.com/dcmedia/0-921-657772-49-1735230-1-0-1-0-0-0-0-0-0-1-0-0-0-0-0.html. Accessed: 19 December 2014.

their business success with manageable risks. The targeted, iterative development of existing business competences and resources makes it possible to build up new business areas in the area of spatial mobility which are outside of vehicle ownership, and which address other needs. The transformation is characterised by the fact that a connection to the existing core business remains intact – even if the development of new areas of growth is outside of this.

Our starting situation is made up of the business domains of the automotive industry, which we have put together in Fig. 3.7. Depending on the goals and strategic orientation of the mobility services, however, the transformed model of business domains may vary from one automotive company to another.

For the transformation of business competences, we use the two following basic principles:

1. Primary focus on building up digital competency
2. Modernisation of the three heavyweights in secondary focus

Behind the conclusions presented in this section and the next, there is an interactive process as part of which many levels must be taken into account simultaneously: The business domains, along with the respective business competences of the reference model shown in Fig. 3.44 with the corresponding characterisations which we summarised and discussed in the subsections of Sect. 3.6 along with aspects of digitalisation. We will not, however, go into more detail about the approach – instead, we will explain the results of a possible transformation.

We will begin this section by giving a rough outline of the positions of the new business domains (see Fig. 4.7), which come about as the result of the business model of the mobility industry being applied to the business domains of the automotive industry. In the next section, we will address the new or changed business competences of each of the domains.

Primary Focus on Building Up Digital Competency

The primary focus is on those business domains which orient themselves towards the market. Thanks to the possibilities provided by connectedness and digitalisation in particular, we design the two business domains with a primary focus on

1. "Sales and digital access" and
2. "Digital product integration and value added service"

and a secondary focus on the existing business domain of "financial service" within the framework of the prioritised basic principle.

Sales and Digital Access

The business domain of "sales and digital access" is derived from the original business domain of "sales and outbound logistics" (see Sect. 3.6.6). All business competences with a link to outbound logistics are shifted to physical production. This can be similar to the sale of a factory – with the difference, however, that this

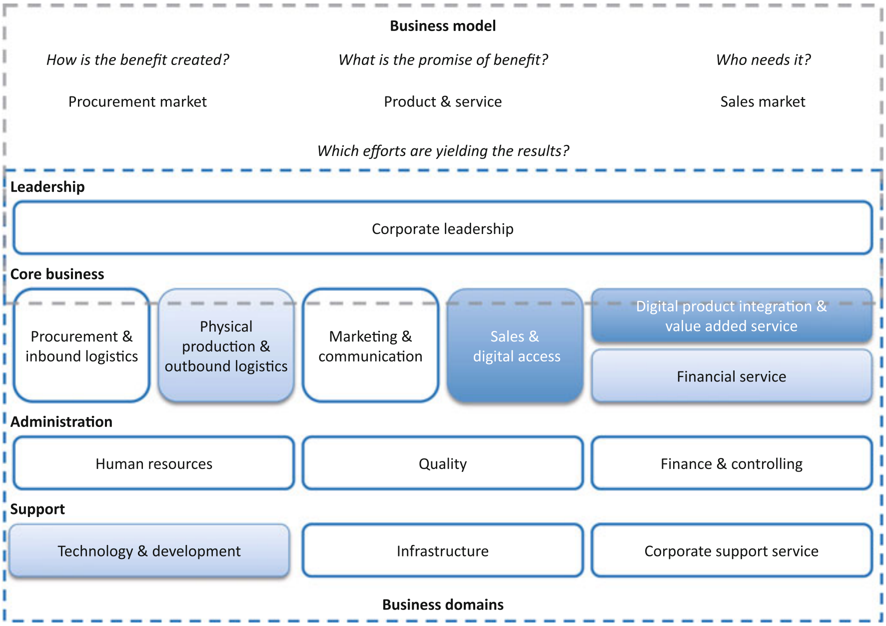

Fig. 4.7 Transition of the business model of a mobility industry to the business domains of the automotive industry, based on Fig. 3.7. The *dark blue* domains have a primary focus on transformation, while this is the secondary focus of those domains coloured *light blue*

is not where sales are managed, but where handover takes place either to private customers or to fleets for various mobility services.

In addition, there are models for individually tuned customer relations with stronger digital access. Thanks to modern technologies and the bringing together of several sales channels – such as the internet – direct sales take on a whole new meaning in this domain.

Some automotive companies such as Daimler are already implementing business domains such as these.[26]

Digital Product Integration and Value Added Service

The business domain of “digital product integration and value added service” is derived from the original business domain of “after-sales support” (see Sect. 3.6.8). Alongside the continuation and further improvement of business competences in order to support traditional customer service, mobility services are built up, and the crucial direct and control business competences from the domain “research and development” are taken on. The objective is to pool products and services. In doing

[26]“Daimler expands its digital customer service” http://www.computerwoche.de/a/daimler-baut-seinen-digitalen-kundenservice-aus,3066395. Accessed: 19 December 2014.

so, this business domain must develop the *digital copy* in such a way that it becomes a new type of production in addition to the three ones which are already established in terms of product manufacturing (see Fig. 2.2). Therefore, the final integration and product validation will occur after the sales of the vehicle and not anymore before as it is today.

Financial Service

Even if the name of the "financial service" business domain (see Sect. 3.6.7) has not changed, an increasing number of mobility ranges and usage/payment models are creating new demands on financing, insurance and payment systems.

Modernisation of the Three Heavyweights in Secondary Focus

The basic requirement for successfully building up new business competences in the long term in those core business domains which are oriented to the market, is to alter those business competences in the core business domain which focus on the procurement market. We refer to the three domains of

1. "Research and development",
2. "Procurement and inbound logistics" and
3. "Production"

as heavyweights, because the traditional vehicle manufacturers view them as their value creation. Depending on the company, the focuses and differentiations in the market vary in many ways, including in terms of these three business domains:

- Honda's focus on "research and development" seems to be particularly pronounced [22].
- In the case of Toyota, one gets the impression that purchases have a lot of influence. By shifting "research and development" to suppliers such as Denso, however, the cost focus of purchases is usually only on procurement. While BMW has a dominant focus on "procurement and inbound logistics" [21], it is structured in a different way to Toyota.
- The Toyota production system [17] enjoys a very good reputation, and is often copied due to its uniqueness in the "production" business domain [12].

Our secondary focus in this area is on the following two business domains:

1. "Physical production and outbound logistics" and
2. "Technology and development"

The business domain "procurement and inbound logistics" remains unchanged to begin with, as suppliers will continue to be central to a mobility industry. Cooperation models may be given new orientations – which does not tend to be something completely new. The situation can be different if a vehicle manufacturer in procurement does not have a global positioning, but it needs this to be part of a mobility industry. At the end of the day, however, it is less about redesigning the whole domain, and more about changes on the level of business competences.

Physical Production and Outbound Logistics

The business domain of "physical production and outbound logistics" is derived from the original business domain of "production" (see Sect. 3.6.4). These are accompanied by business competences in the context of outbound logistics, engineering and production launches. The overall framework concentrates on creating a *minimalistic travel capsule*, for which, once again, the bill of materials of the AUTOmobile only concentrates on the fundamental parts of the three subsystems "drive system", "chassis" and "bodywork" (see Fig. 2.7). Build to order should be considered on top of build to stock and not instead of.

Technology and Development

What is certainly one of the most difficult changes to make is to shift the original core business domain of "research and development" (see Sect. 3.6.2) into the support domain of *technology and development*, and to get rid of some business competences. Essential business competences are shifted into the business domains of "digital product integration and value added service" and "physical production and outbound logistics".

Corporate Leadership

The transformation of the business model can also have effects on the seven remaining domains – which are, however, not so much in our focus. We will only look at the business domain of "corporate leadership" (see Sect. 3.6.1) in terms of the direct influence of the changed business model. In Fig. 3.12, we have summarised a few simplified challenges posed by corporate leadership to the business domains of the automotive industry. Creating the five business domains anew also changes this orientation, as is summarised in Fig. 4.8. Here it is also the case, however, that the analysis should take place in more detail in terms of company-specific leadership on the level of the business competences.

4.2.3 Business Competences

In Fig. 3.44, we have summarised a reference model of the business architecture using the business competences for the automotive industry as it is today. The implementation of the business model is in a state of interplay between the domains and their business competences, with some special characterisations. In this section, we will summarise those of the new or fundamentally changed business competences of the business domains which we focused on in Sect. 4.2.2, and discussed from several perspectives in each of the subsections of Sect. 3.6. In Fig. 4.9, we present the reference model of the business architecture for a possible mobility industry with core competences regarding the autoMOBILE.

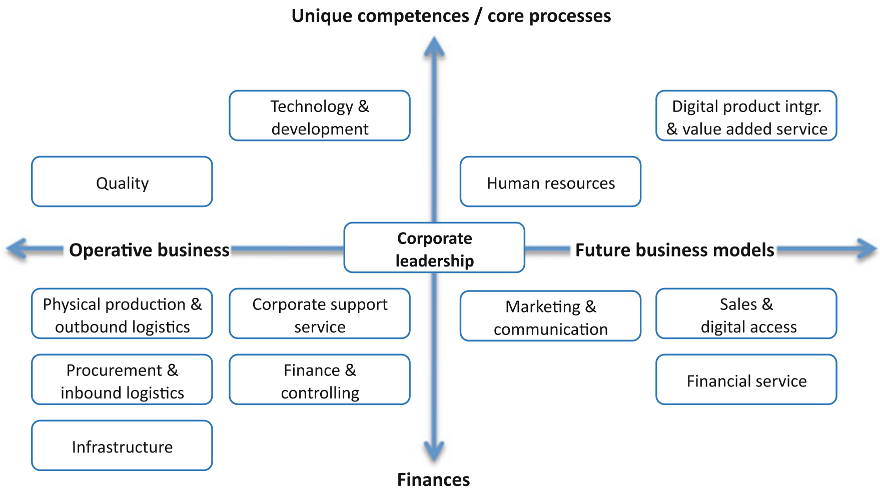

Fig. 4.8 Simplified representation of the business domains in terms of challenges faced by corporate leadership in a mobility industry

Sales and Digital Access

In the domain "sales and digital access", our primary focus is on two business competences:

1. The business competence "customer voice and contact" is a shift in and broadening of the business competence "customer voice" of the business domain "after-sales support". Not only does it deal with the technical demands of the vehicle to be operated – it also complements the business competences "corporate communication" and "marketing and communication" from the domain "corporate and brand identity", in order to ensure a long-term, direct and individual customer relationship. CRM systems taken on a central role here in terms of making customer experiences more targeted, and managing them in a more consistent way.
2. In the original business competence "order and distribution", the focus shifts more towards the individualisation of the commission, with the business competence "order and individualisation". In this context, the new competences of the business domain "digital product integration and value added service" should be used intensively.

and two business competences in secondary focus:

1. Neither the business competence "qualification, quote, contract"
2. nor "acceptance and documentation" deviates fundamentally from the task areas given up until now. Through direct sales, there are different processes, approaches to work and types of sales training which become necessary as a

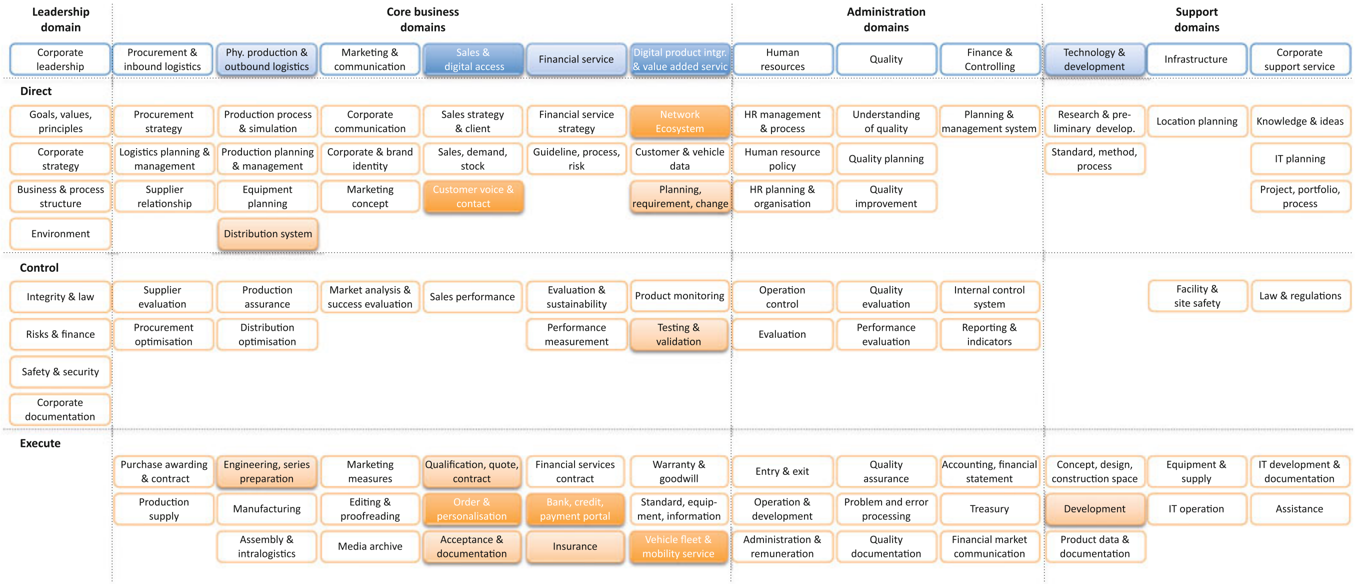

Fig. 4.9 Reference model of the business architecture for a possible mobility industry with core competences regarding the autoMOBILE. During the transformation, the *orange-coloured* business competences are in focus – the *darker ones* in primary focus, the *light ones* in secondary focus

result of the demand to individualise products, as shown by the fact that BMW has introduced the new role of "Product Geniuses" into its company strategy (see Sect. 3.1.1).

Digital Product Integration and Value Added Service

In the domain "digital product integration and value added service", our primary focus is on two business competences:

1. We are creating a new, execute business competence "vehicle fleet and mobility service" which builds up individual value added services in the broader context of mobility – the autoMOBILE – similar to what was described in Sect. 4.2.1.
2. The framework of the original direct business competence "connected vehicle" is broadened to include "network ecosystem" as shown in Fig. 3.36. A central theme is, nowadays, whether the telematics unit (see Sect. 2.5.2) must continue to remain part of the technical vehicle architecture. Even in the context of the emergency call system eCall, people always need rapid breakdown assistance – no matter how they are involved in traffic (inside or outside a vehicle). The vehicle data needed for emergencies, such as chassis number or drive system, does not necessarily have to be sent by the vehicles' integrated systems.

and two business competences in secondary focus:

1. The main focus of the original direct business competence "planning, requirement, change" from the domain "research and development" is shifted to this domain. It has the long-term task of transforming product development (see Sect. 2.2) into three main phases.
   (a) To reduce the original process to a minimalistic, roadworthy travel capsule, as part of which the AUTOmobile's bill of materials concentrates only on the main parts of the three subsystems "drive system", "chassis" and "bodywork" (see Fig. 2.7).
   (b) The subsystems "Interior/Equipment" and, to a certain extent, "Electrics/Electronics" are shifted to a second phase, *periphery*, and can, in accordance with traditional product manufacturing, be connected to the travel capsule's central unit, and replaced. It is an idea which has been developed from the BMW concept "LifeDrive Architecture",[27] in which the Drive and Life modules are separate from one another. Concepts such as Lego vehicles[28] are ideas which cannot yet be implemented. First implementations of 3D printers

[27]"BMW i : Concept" http://www.bmw.com/com/en/insights/corporation/bmwi/concept.html. Accessed: 19 December 2014.

[28]"Life-size Lego car runs on air" http://edition.cnn.com/videos/world/2013/12/29/nr-australia-lego-car.cnn. Accessed: 19 December 2014.

have been made in the automotive industry by Local Motors.[29] Soon, it will also be possible to produce personalised printed equipment components, or components for vintage vehicles. Increasingly, technology and electronics companies will drive their experiences with interfaces for the decoupling of peripheral devices in the automotive industry.

(c) The third and final phase mainly concentrates on the subsystem "Communication and Entertainment" and includes software, which must not necessarily be integrated into the first two phases. It forms a layer for virtualisation – which is referred to in IT as a "Software Defined Environment" [28]. An example which has already been implemented as part of such a virtualisation is the firmware of Tesla Motors.[30]

These three new phases form the basis for digital product integration, as we have presented in a summarised way in Fig. 4.10.

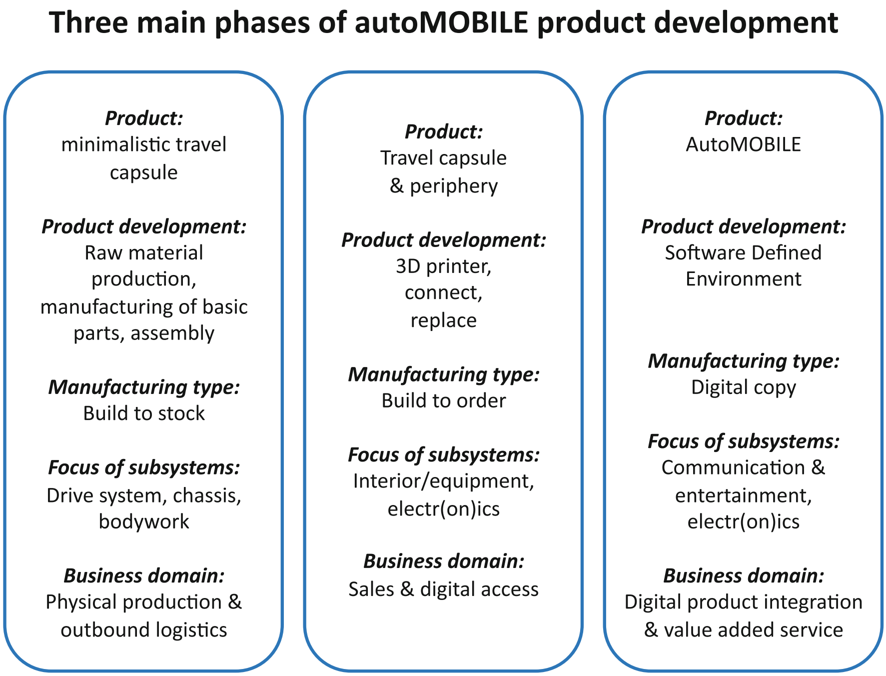

Fig. 4.10 Paradigm shift in the product development of the autoMOBILE in three main phases

[29] "Local Motors – 3d Printed Car" http://localmotors.com/3d-printed-car. Accessed: 19 December 2014.

[30] "A Silicon Valley Approach to Vehicle Software" http://my.teslamotors.com/roadster/technology/firmware. Accessed: 19 December 2014.

2. Due to the significant changes to product development, the control business competence "testing and validation" from the domain "research and development" must also be given new direction and shifted into this business domain.

Financial Service

In the domain "financial service", our primary focus is on one business competence:

1. While some automotive companies already have an execute "bank and credit" business competence, others have to build it up from scratch. Due to the increasing number of mobility ranges on offer, this business competence must be broadened to include "bank, credit, payment portal" in order to make it possible for different individual and public services to be billed for conveniently using a single payment system. The financial services of a vehicle manufacturer usually carry out large-scale transactions when promoting product sales. In the use-oriented mobility industry, on the other hand, there are many small sums of money which need to be dealt with in a different commercial way in order to remain cost-efficient in terms of a worldwide transaction system.

and one business competence in secondary focus:

1. In the executive business competence of "insurance", in addition to traditional vehicle insurance, both new insurance models for own fleets and driver-related insurance gain more relevance for the mobility industry.

Physical Production and Outbound Logistics

In the domain "physical production and outbound logistics", our secondary focus is on two business competences:

1. The direct business competence "distribution system" from the domain "sales and outbound logistics" is more closely linked to the production site. This is less about factory outlets than it is about having a stronger focus on build to stock production, at least for the minimalistic travel capsule which is, in general, only manufactured using physical production.
2. Vehicle engineering of the business competence "development and engineering" from the domain "research and development" is brought together with the execute business competence "series preparation" into one competence: "engineering, series preparation".

Technology and Development

In addition to the outsourcing of the business competences "planning, requirement, change" and "testing and validation", in the domain of "technology and development" our primary focus is on one business competence:

1. The original execute business competence of "development and engineering" is reduced to "development" alone.

It can also make perfect sense to shift the business competences “knowledge and ideas” or “project, portfolio, process” from the domain “corporate support service” to this business domain. For the moment, however, we have only looked at reducing the business competences in this domain.

4.3 Outlook

Where will digitalisation and connectedness take us in terms of spatial mobility?

The automotive industry is currently facing the prospect of its greatest transformation in the history of the AUTOmobile, and companies appear to have no idea of how to orient themselves in regard to this. The enterprise architecture described in this book was designed in such a way that a mobility industry cannot develop in isolation from the automotive industry, if vehicle manufacturers give their business competences new direction.

The fundamental theme that we have gone into less detail about is security – in the sense of security from attack. We only touched on it as a business competence from the domain “corporate leadership” (see Sect. 3.6.1). It is important to be aware that in the digital world, there are no thick, high walls. At the end of the day, the only thing of importance will be how we behave socially in a large, connected family – and how we act towards black sheep.

The main problem is due to the fact that digitalisation is based on discrete mathematics. It simply has not been proven whether one-way mathematical functions exist – functions which can only be reversed with a lot of effort, or are not reversible at all. In practice, multiplication is a very widespread procedure in the field of digital security, because the decomposition of numbers can still involve a great amount of effort when using today’s technologies [6]. There is bound to be an inverse function – even if the Riemann Hypothesis of 1859 still has not been solved – after all, it has not been disproved either [30].

A broader discussion of this factor would be far outside the scope of this book. Further developments and thoughts are elaborated on in the blog

http://think-automobility.org

The designing of the mobility industry will remain exciting and interesting for some time to come.

References

1. Bates J, Leibling D (2012) Spaced out – perspectives on parking policy. Royal Automobile Club Foundation for Motoring, London
2. Bauernhansl T, ten Hompel M, Vogel-Heuser B (2014) Industrie 4.0 in Produktion, Automatisierung und Logistik: Anwendung – Technologien – Migration. Springer, Wiesbaden
3. Bhidé AV (2000) The origin and evolution of new businesses. Oxford University Press, New York

4. Braess H-H, Seiffert U (Hrsg.) (2013) Vieweg Handbuch Kraftfahrzeugtechnik, 7. Aufl. Springer, Wiesbaden
5. Cadle J, Paul D, Turner P (2014) Business analysis techniques, 2nd edn. BCS, Swindon
6. Crandall R, Pomerance CB (2005) Prime numbers: a computational perspective, 2nd edn. Springer, New York
7. Eva M, Hindle K, Rollason C, Tudor D (2014) Business analysis, 3rd edn. BCS, Swindon
8. ifmo Institut für Mobilitätsforschung, eine Forschungseinrichtung der BMW Group (2006) Öffentlicher Personennahverkehr: Herausforderungen und Chancen. Springer, Berlin
9. infas Institut für angewandte Sozialwissenschaft GmbH, Deutsches Zentrum für Luft- und Raumfahrt e. V. Institut für Verkehrsforschung (2010) Mobilität in Deutschland 2008 – Ergebnisbericht. Bonn und Berlin
10. Kaltheier RM (2001) Städtischer Personenverkehr und Armut in Entwicklungsländern: Ist-Analyse und Optionen einer armutsorientierten Verkehrspolitik und -planung. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Abteilung 44, Umweltmanagement, Wasser, Energie und Transport, Eichborn
11. Keese C (2014) Silicon Valley: Was aus dem mächtigsten Tal der Welt auf uns zukommt. Albrecht Knaus, München
12. Liker JK (2004) The Toyota way: 14 management principles from the world's greatest manufacturer. McGraw-Hill, New York
13. Marsh P (2012) The new industrial revolution: consumers, globalization and the end of mass production. Yale University Press, New Haven
14. Maurer M, Gerdes JC, Lenz B, Winner H (Hrsg.) (2015) Autonomes Fahren: Technische, rechtliche und gesellschaftliche Aspekte. Springer, Wiesbaden
15. Meroth A, Tolg B (2008) Infotainmentsysteme im Kraftfahrzeug. Grundlagen, Komponenten, Systeme und Anwendungen. Springer, Wiesbaden
16. Oak Ridge National Laboratory (2001) 1995 NPTS databook – based on data from the 1995 Nationwide Personal Transportation Survey (NPTS), Oak Ridge
17. Ohno T (1988) Toyota production system: beyond large-scale production. Productivity, Portland
18. Porter ME (2004) Competitive strategy: techniques for analyzing industries and competitors. Free Press, New York
19. Porter ME (2008) The five competitive forces that shape strategy. Harv Bus Rev 57:57–71
20. Proff H (Hrsg.) (2014) Radikale Innovationen in der Mobilität: Technische und betriebswirtschaftliche Aspekte. Springer, Wiesbaden
21. Rast CA (2008) Chefsache Einkauf. Campus, Frankfurt am Main
22. Rothfeder J (2014) Driving Honda: inside the world's most innovative car company. Penguin, New York
23. Schade W, Zanker C, Kühn A, Kinkel S, Jäger A, Hettesheimer T, Schmall T (2012) Zukunft der Automobilindustrie. Arbeitsbericht Nr. 152, Büro für Technikfolgen-Abschätzung beim Deutschen Bundestag. Karlsruher Institut für Technologie, Berlin
24. Schenk M (1998) Altautomobilrecycling: Technisch-ökonomische Zusammenhänge und wirtschaftspolitische Implikationen. Springer, Wiesbaden
25. Schuster W (2013) Nachhaltige Städte – Lebensräume der Zukunft: Kompendium für eine nachhaltige Entwicklung der Stadt Stuttgart. oekom, München
26. Snell BC (1974) American ground transport – a proposal for restructuring the automobile, truck, bus & rail industries. U.S. Government Report, Washington
27. Steierwald G, Künne H-D, Vogt W (Hrsg.) (2005) Stadtverkehrsplanung: Grundlagen, Methoden, Ziele, 2. Aufl. Springer, Berlin

28. van den Dam R (2013) Internet of things: the foundational infrastructure for a smarter planet. In: Balandin S, Andreev S, Koucheryavy Y (eds) Internet of things, smart spaces, and next generation networking: 13th international conference, NEW2AN 2013, and 6th conference, ruSMART 2013. Proceedings, S1–12, St. Petersburg, 28–30 August 2013
29. Vivier J (2006) Mobility in cities database – analysis and recommendations. International Association of Public Transport (UITP), Brussels
30. Wedeniwski S (2002) ZetaGrid. In: Schoder D, Fischbach K, Teichmann R (Hrsg.) Peer-to-Peer: Ökonomische, technologische und juristische Perspektiven, S 173–188. Springer, Berlin

Index

ABS. *See* Anti-lock braking system (ABS)
Advanced planning and scheduling (APS), 149
Aisin Seiki, 263
Akao, Y., 206
American Productivity & Quality Center (APQC), 98, 100
Anti-lock braking system, 38, 126
Apple, 30, 69, 77, 218, 243, 253, 263
APQC. *See* American Productivity & Quality Center (APQC)
APS. *See* Advanced planning and scheduling (APS)
Architecture
  application, 22
  business, 22, 103, 228, 229, 266
  data, 22
  enterprise, 5, 6, 21, 23, 29, 71, 89, 103, 226, 228, 230
  IT, 21, 38
  network, 54, 67
  technology, 22
  vehicle, 30, 36, 38, 60
Association of German Engineers, 61
Audi, 51, 79, 82–87, 104, 106, 116, 162, 175, 215
AUTomotive Open System ARchitecture (AUTOSAR), 47, 48, 190

Beer, M., 193
Beijing Automotive Group, 261
Benz, C.F., 31
Bill of materials (BOM), 22, 38, 39, 149
  building block, 40
  engineering, 53
  manufacturing, 53
  materials index, 39
  sales, 53
  service, 53
  variant, 49, 121
BMW Group, 1, 10, 30, 49, 51, 57, 69, 79–84, 86, 87, 106, 111, 116, 131, 145, 162, 170, 173, 178, 185, 187, 211, 215, 242, 247, 250, 261, 272, 276
Bodywork, 41, 67, 273, 276
BOM. *See* Bill of materials (BOM)
Bosch, 12, 54, 111, 263
BPMN. *See* Business Process Model Notation (BPMN)
Brand identity, 91, 108, 119, 127, 161, 245, 246, 251, 266
Bridgestone, 263
Bus system
  CAN (*see* Controller area network (CAN))
  FlexRay, 56
  LIN (*see* Local interconnect network (LIN))
  MOST (*see* Media oriented systems transport (MOST))
Business
  architecture, 273, 275
  competences, 75, 95
  components, 96
  domain, 23, 92
  model, 5, 88
  service, 100
Business Process Modeling Notation, 100

CAD. *See* Computer-aided design (CAD)
CAE. *See* Computer-aided engineering (CAE)
CAM. *See* Computer-aided manufacturing (CAM)
CAN. *See* Controller area network (CAN)
CAO. *See* Chief analytics officer (CAO)
Car-sharing, 90, 177, 267
CAS. *See* Computer-aided styling (CAS)

S. Wedeniwski, *The Mobility Revolution in the Automotive Industry*,
DOI 10.1007/978-3-662-47788-5

CDO. *See* Chief data officer (CDO)
CEO. *See* Chief executive officer (CEO)
CETA. *See* Comprehensive Economic and Trade Agreement (CETA)
CFO. *See* Chief financial officer (CFO)
Chassis, 41, 67, 273, 276
Chief analytics officer (CAO), 18
Chief data officer (CDO), 18
Chief executive officer (CEO), 103
Chief financial officer (CFO), 103
Chief information officer (CIO), 17, 18, 190, 224
Chief technology officer (CTO), 17
China FAW Group, 261
Chrysler, 78, 109, 111, 112, 215
CIO. *See* Chief information officer (CIO)
CMS. *See* Content management system (CMS)
CNC. *See* Computer numerical control (CNC)
Comité Européen de Normalisation, 123
Component business model, 96
Comprehensive Economic and Trade Agreement (CETA), 248
Computer numerical control, 63, 64, 133, 153, 157
Computer-aided design (CAD), 63, 65, 126, 129, 133, 151, 167
Computer-aided engineering (CAE), 22, 64, 65, 125, 126
Computer-aided manufacturing (CAM), 64, 65
Computer-aided styling (CAS), 126
Concept booklet, 129
Connected vehicle, 44, 66, 68, 77, 113, 124, 131, 135, 170, 184, 185, 187–189, 207, 246, 253, 255
Construction space, 54, 127, 129, 133
Content management system, 65, 132, 134
Continental, 12, 263
Controller area network (CAN), 54, 56, 57, 190
Corporate communication, 159, 219
Corporate documentation, 109
Corporate identity, 109, 127, 161
Country
- Australia, 172
- Brazil, 81, 86, 111, 247, 249
- Canada, 249
- China, 81, 86, 111, 242, 247, 249, 250
- France, 165, 242
- Germany, 20, 81, 86, 106, 111, 165, 189, 249, 254, 262, 263
- India, 86, 247, 249
- Japan, 86, 106, 165, 242, 249, 259
- Mexico, 242
- Russia, 86, 242, 247, 249
- South Korea, 242
- Switzerland, 165
- United States, 81, 106, 111, 165, 239, 242, 247–249, 262, 264

Creation, 266
CRM. *See* Customer relationship management (CRM)
Crosby, P.B., 203
CTO. *See* Chief technical officer (CTO)
Customer loyalty, 170
Customer relationship management (CRM), 170, 176, 177
Customer retention, 170
Customer voice, 187

Daimler, 10, 30, 32, 46, 49, 51, 53, 78, 79, 85–87, 95, 106, 107, 109–111, 114, 116, 117, 120, 125, 127, 137, 140, 142, 150, 160–162, 172, 178, 179, 185, 190, 211, 215, 222, 226, 230, 243, 261, 264, 265, 268, 269, 271
Data protection law, 189
Deming, W.E., 203
Denso, 263, 272
Desktop publishing (DTP), 165
Deutsches Institut für Normung – German Institute for Standardization (DIN), 124
Digital factory, 151
Digital Mock-Up (DMU), 65
Dimension concept, 129
DIN. *See* Deutsches Institut für Normung – German Institute for Standardization (DIN)
Distribution system, 171
DMS. *See* Document management system (DMS)
DMU. *See* Digital Mock-Up (DMU)
Document management system, 65, 132, 144, 177
Document management systems, 167
Dongfeng Motor Group, 261
Drive system, 41, 67, 273, 276
Driver assistance systems, 38, 113, 185
DTP. *See* Desktop publishing (DTP)

Earnings before interest and taxes (EBIT), 215
eCall, 248, 255, 276
ECU. *See* Electronic control unit (ECU)
Electr(on)ics, 7, 37–39, 43–47, 52, 54, 55, 57–60, 65, 69, 116, 123, 124, 126, 127, 131, 137, 166, 192, 262, 276

Electronic control unit (ECU), 46, 48, 54, 57, 137
Electronic stability programme, 126
Engineering, 35, 116, 129
Enterprise resource planning (ERP), 7, 62, 65, 72, 135, 137, 145, 149, 153, 156, 177, 192, 210, 216
Environment, 115, 246, 256
Ericsson, 69
ERP. *See* Enterprise resource planning (ERP)
European Telecommunications Standards Institute, 123
Evolution, 265

Facebook, 253
Factory concept, 150
Failure mode and effects analysis (FMEA), 208
Ferrari-Maserati, 215
Fiat Chrysler Automobiles, 261
Five forces model, 257
FMEA. *See* Failure mode and effects analysis (FMEA)
Ford Motor, 30, 31, 34, 66, 112, 173, 178, 215, 261
Ford, H., 31
4-wheel-drive, 51
Functional structure, 39, 60

Gateway, 57
General Motors, 30, 103, 112, 173, 215, 239, 247, 261
General transit feed specification (GTFS), 244
German Association of the Automotive Industry, 208
German Automotive Industry Association, 124
German Commercial Code, 214
German Commission for Electrical, Electronic & Information Technologies, 124
German Engineering Association, 37
German Institute for Standardisation, 39
Global positioning system (GPS), 69
Goods receipt, 144
Google, 2, 12, 30, 44, 69, 77, 114, 166, 174, 218, 243, 244, 253, 266
Gorriz, M., 190
GPS. *See* Global positioning system (GPS)
GTFS. *See* General transit feed specification (GTFS)
Guangzhou Automobile Industry Group, 262

Handelsgesetzbuch – German Commercial Code (HGB), 214
Hitachi, 243
Honda Motor, 162, 215, 242, 261, 272
Human resource policy, 195
Hyundai Motor, 215, 261

IBM, 30, 96, 100, 112, 191, 210, 243, 265
Idea, 225
IEC. *See* International Electrotechnical Commission (IEC)
IFRS. *See* International financial reporting standards (IFRS)
Imai, M., 88
Industry 4.0, 19, 254
Information technology (IT), 7, 17, 20, 59, 63, 72, 124, 223, 224, 226, 227, 230
Innovation, 83, 123, 225, 265
Insurance, 90, 180–182, 184, 185
Integrity, 110
Intel, 30, 253
Interface model, 38
Intermodal, 14
International Electrotechnical Commission (IEC), 123
International financial reporting standards (IFRS), 214
International Standard Organisation (ISO), 54, 123
International Telecommunication Union (ITU), 123
Invention, 225
ISO. *See* International Standard Organisation (ISO)
IT. *See* Information technology (IT)
ITU. *See* International Telecommunication Union (ITU)

Japan Automotive Software Platform and Architecture (JasPar), 48
Johnson Controls, 263

Kaizen, 87, 88, 113, 148, 187, 195, 198, 203, 225
Kanban, 139, 144
Kia Motors, 215, 261

Lifelong vehicle documentation, 91
Local interconnect network (LIN), 56, 57, 59
Local Motors, 4, 34, 264, 277

Location planning, 221
Logistics concept, 138
Logistics planning, 138
Logistics requirements documentation, 139

Magna International, 263
Manufacturing execution system (MES), 156
Market analysis, 164, 240, 245–266
Marketing concept, 162, 167
Marketing mix, 163, 165, 169
Material flow, 138, 153
Mazda Motor, 262
Mechanics, 36–38, 41–43, 45, 54, 59, 60, 65, 126, 127, 130, 262
Mechatronics, 37
Media oriented systems transport (MOST), 56, 57
MES. *See* Manufacturing execution system (MES)
Michelin, 263
Microsoft, 30, 243
Mobility industry, 3, 15, 240, 265
Mobility service
  Autonetzer, 268
  car2go, 87, 161, 180, 184, 227, 268, 269
  car2go black, 268
  ChargeNow, 81
  DriveNow, 81, 268
  Flinkster, 268
  moovel, 87, 95, 161, 180, 244, 267, 269
  myTaxi, 180, 267, 269
  OnStar, 69
  ParkNow, 81
  RideScout, 269
  Uber, 244, 264, 267
Model range, 80, 119, 129
MOST. *See* Media oriented systems transport (MOST)
Multimodal, 14

Next generation telematics patterns (NGTP), 69, 71, 190
Nissan Motor, 30, 109, 215, 261

OBD. *See* On-board diagnostics (OBD)
Object Management Group (OMG), 100
OEM. *See* Original equipment manufacturer (OEM)
OMG. *See* Object Management Group (OMG)
On-board diagnostics (OBD), 59, 188, 190
Operating equipment, 130, 150, 152
  planning, 150
Operating resource, 94, 153
Oracle, 195, 253
Original equipment manufacturer (OEM), 12, 25

Panasonic, 243, 262
Pay-as-you-drive (PAYD), 184
Pay-how-you-drive (PHYD), 184
PAYD. *See* Pay-as-you-drive (PAYD)
PCF. *See* Process classification framework (PCF)
PDM. *See* Product data management (PDM)
PESTLE. *See* Political, economic, socio-cultural, technological, legal, environmental (ecological) (PESTLE)
PHYD. *See* Pay-how-you-drive (PHYD)
Pilot series, 135, 140
Planning a factory, 150
PLC. *See* Programmable logic controller (PLC)
PLM. *See* Product lifecycle management (PLM)
Political, economic, socio-cultural, technological, legal, environmental (ecological) (PESTLE), 245
Porsche, 215
Porter, M.E., 76, 77, 193, 257, 258
PPC. *See* Production planning and controlling (PPC)
Preliminary development, 35, 121, 122, 127
Preliminary series, 142, 153
Process
  business, 7, 23, 98, 100, 106, 109
  enterprise, 6
  logistics, 138
  procurement, 137, 144
  product development, 35, 118, 125
  production, 146
  sales, 169
Process classification framework (PCF), 98, 100, 101, 125
Procurement optimisation, 142
Product data management (PDM), 62, 65, 132
Product development, 35, 117, 176
Product documentation, 38, 39, 48, 59–62, 131
Product lifecycle management (PLM), 65, 66
Product manufacturing, 36
Product portfolio, 108
Product requirements document, 130
Product specification, 120, 130, 144
Production, 145–158
  assembly, 153, 157

assurance, 152
batch, 35
build to order, 33, 121, 145, 149, 157, 169, 171, 176, 228, 230, 273
build to stock, 32, 121, 145, 169, 171, 177, 228, 263, 273, 278
completely knocked down, 145
development, 35
digital copy, 272
engineer to order, 33, 145, 230
equipment manufacturing, 153
initial batch, 154
manufacturing, 155
mass, 35
one-off, 35
parts manufacturing, 153, 155
pilot series, 154
planning and management, 149
preliminary series, 154
raw materials processing, 153, 155
resources/tools, 151
scaling-up, 36
series launch, 154, 155
start-up, 153–155
supply, 144
Production model
large-scale, 84
Programmable logic controller (PLC), 157
PSA Peugeot Citroën, 261
Public transport, 13, 242, 249, 252, 264

Quality assurance, 208

Range of models, 9, 105, 108, 252
Reithofer, N., 79
Renault, 109, 261
Request for information (RFI), 143
Request for proposal (RFP), 144
Request for quotation (RFQ), 143
Requirements documentation, 120, 144
Research, 121, 122
market research, 162, 164
procurement market research, 137
RFI. *See* Request for information (RFI)
RFP. *See* Request for proposal (RFP)
RFQ. *See* Request for quotation (RFQ)
Risk, 111

Safety system
airbag, 126
child seatbelt, 113
passenger space, 126
seatbelt, 126
SAIC Motor, 261
Sales concept, 167, 170
Sales strategy, 169
Samsung, 262
SAP, 101, 112, 137, 195, 210
Sarbanes-Oxley Act (SOA), 213
Schaeffler, 111
Scheer, A.-W., 100, 168
SCM. *See* Supply chain management (SCM)
Security, 113
Series launch, 35, 117, 127, 129, 135, 142, 153, 155
Series model, 129
Series preparation, 153
Service level agreement (SLA), 224
Service oriented architecture (SOA), 100, 230
Service portfolio, 108
Shewhart, W.A., 203
Simulation, 125
computational fluid dynamics, 64
finite element method, 64
multiple-body, 64
process and function, 65
production, 146
SLA. *See* Service level agreement (SLA) (SLA)
SOA. *See* Service oriented architecture (SOA)
Software, 1, 2, 7, 22, 33, 37–39, 46–49, 57, 59, 64, 65, 76, 95, 101, 112, 113, 116, 124, 126, 127, 131, 148, 192, 195, 210, 211, 227, 243, 266, 277
Software defined environment, 277
Sony, 30, 243, 262
SOP. *See* Start of production (SOP)
SOX. *See* Sarbanes-Oxley Act (SOX)
SRM. *See* Supplier relationship management (SRM)
Stakeholder, 107
Start of production (SOP), 36, 127, 137, 139, 155
Strategy, 5, 76
business domain, 77
corporate, 76, 108
Supplier evaluation, 141
Supplier portfolio, 137, 140
Supplier relationship, 140
Supplier relationship management (SRM), 135, 140
Supply chain management (SCM), 65
Suzuki Motor, 262

System
APS (*see* Advanced planning and scheduling (APS))
CAD (*see* Computer-aided design (CAD))
CAE (*see* Computer-aided engineering (CAE))
CAM (*see* Computer-aided manufacturing (CAM))
CAS (*see* Computer-aided styling (CAS))
CMS (*see* Content management system (CMS))
CNC (*see* Computer numerical control (CNC))
communication, 1, 5, 22, 44, 48, 56, 57, 68, 69, 84, 114, 123, 131, 187, 223, 224
DMS (*see* Document management system (DMS))
DMU (*see* Digital Mock-Up (DMU))
DTP (*see* Desktop publishing (DTP))
ERP (*see* Enterprise resource planning (ERP))
infotainment, 38, 44, 57, 70, 84, 124, 244, 253
MES (*see* Manufacturing execution system (MES))
multimedia, 57, 59, 69, 165
navigation, 1, 12, 38, 52, 57, 69, 76, 84, 252, 265
PPC (*see* Production planning and controlling (PPC))
purchasing, 143
SCM (*see* Supply chain management (SCM))
SRM (*see* Supplier relationship management (SRM))
warehousing, 145

Tata Motors, 262
Technical drawing, 38, 54
Telematics, 68
Telematics service provider (TSP), 69
Telematics unit, 70, 276
Tesla Motors, 2, 4, 173, 250, 264, 277
The Open Group Architecture Framework (TOGAF), 21, 22
Toyota Motor, 4, 10, 30, 88, 107, 113, 139, 148, 156, 162, 178, 204, 207, 215, 222, 242, 254, 261, 272
Traction control system, 126
Transformation, 265
Transport modes, 15, 31, 34, 240
Travel capsule, 3, 244, 273, 276, 278
Treasury, 217
TSP. *See* Telematics service provider (TSP)

Unimodal, 13
Urbanisation, 81, 243, 251

Value creation, 4, 5, 12, 32, 88, 90, 93, 100, 272
chain, 241
VDA. *See* German Association of the Automotive Industry
VDE. *See* Association for Electrical, Electronic & Information Technologies
VDI. *See* Association of German Engineers
VDMA. *See* German Association for Mechanical Engineering and Equipment Construction
Vehicle classes, 9, 62, 67, 119
Vehicle concept, 35, 38, 127, 129
Vehicle configuration tool, 33
Vehicle data, 189, 250, 256, 263, 276
Vehicle design, 126–129
Vehicle identification number (VIN), 170
Vehicle life cycle, 4
Vehicle testing, 65, 121, 125
Verizon, 69
VIN. *See* Vehicle identification number (VIN)
Volkswagen Group, 10, 30, 42, 43, 54, 57, 68, 105, 121, 150, 162, 166, 178, 215, 218, 250, 255, 261
Volvo Car, 30

Warranty and goodwill, 191, 207, 210, 213

Zachman, J.A., 21, 38
Zetsche, D., 107, 243