Chapter 18
The Challenge of Modifying Management Leadership Behavior Towards Virtual Product Creation in Industry

Executive Summary

This chapter aims at explaining the challenges and typical behavior types of Management in enterprises within the new competence field "Virtual Product Creation" (incl. all aspects of Digital Engineering, Product Lifecycle Management, Advanced and/or Model-based Systems Engineering, Digital Manufacturing and related IT-technologies etc.). Management as an organizational task and opportunity to change and develop new digital engineering principles, processes, methods, tools, data models and engineering model types, is a rather new skill set which is often missing to drive digital innovations and transformations in industrial companies. This chapter is motivated by the author's broad industrial experience: with many enterprises. This new type of digital leadership in Management is often missing, or at least, not yet equally established or even well anchored as a valid career opportunity like in traditional engineering leadership positions or specific IT management ranks. Without solving this dilemma, no new fundamental approaches will be achievable in enterprises and today's operational flaws in digital product delivery will continue to exist!

Quick Reader Orientation and Motivation

The intention of this chapter is:

- to derive the essential leadership needs for Virtual Product Creation
- to explain approaches to develop Management skills for successful digital transformation in engineering and to train Management in digital leadership skills
- to describe the Do's and Don'ts of Management behaviors in digital business and associated decision making
- to provide advice for Senior Management in new digital leadership.

Many industries and enterprises suffer from a lack of leadership in determining, defining, developing and implementing fundamental changes associated with digital innovations and transformations of their business operations. Figure 18.1 provides an understanding of this dilemma in comparing the *traditional business objectives*

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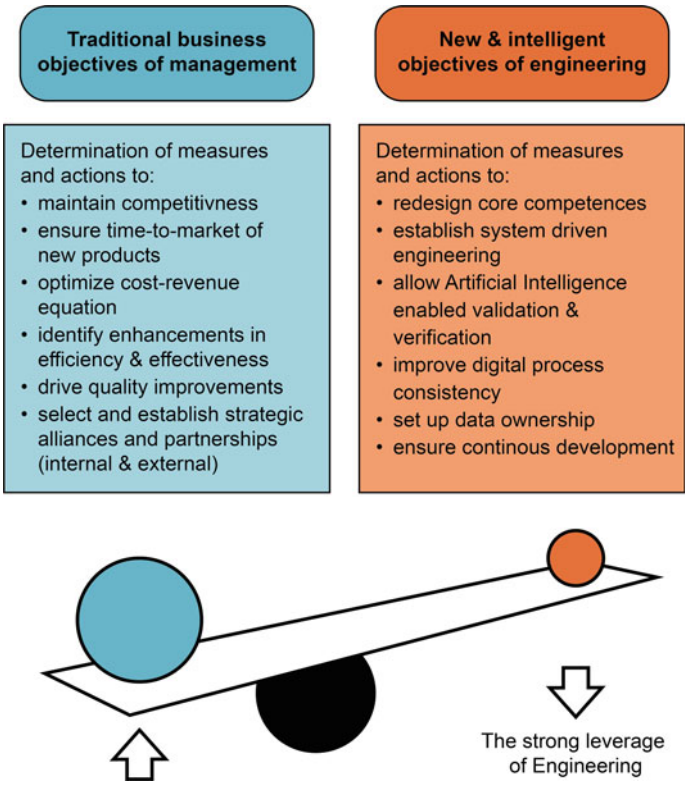


Fig. 18.1 The drift in management objectives driven by digital transformation

of Management with the *new intelligent objectives of Engineering*, which are not yet anchored and integrated into the roles, responsibilities and yearly objectives of (Business & Engineering) Management.

In the past, individual digital tools were introduced to transfer a manual task into a digital worksheet or model instance. Nowadays, major business approaches need to be transformed into a new digital operations set-up. These new demands require establishing end-to-end digital process continuations, data and information threads, new digital product intelligence, fully digitally enabled business practices as well as new digital business models and value creation elements. Even in areas where digital penetration has evolved substantially already during the last decades like in Engineering, it is now necessary to reach the next level of full digital, IT-based working environments amongst all roles and stakeholders. In addition, new (digital) engineering approaches have to be introduced to get complexity and dynamics under control with respect to digitally connected products, which require a constant feed

of digital IoT (Internet of Things[1]) type data retrievals, analytical interpretations and subsequent operational execution.

Traditional Engineering, Business and Project Managers continue to rely on getting such digital change management transformations primarily addressed by IT Management and/or by high-level process re-engineering. This, however, is no longer sufficient and successful, since fundamental new business approaches in digital operations require new and additional leadership beyond typical IT (hardware and software) and process skills:

- Socio-technical systems require new type of digital interactions,
- Product features and functions rely on software-enabled control algorithms,
- Continuous product and technical system validation and verification are dependent on new transparent digital information traceability,
- new digital engineering quality assurance approaches and mechanisms are missing in order to mitigate and control risks caused by Artificial Intelligence (AI) driven drifts in product and system intelligence and operations,
- Traditional business models lack capabilities to reflect and enable digital platform-based data value deliveries.

Some companies tried to solve this by introducing additional CDO (Chief Digital Officer) positions. This new set-up might have helped to encourage companies to pay more attention to digital business models and associated processes but failed in delivering solutions to the fundamental evolutions and revolutions as described above.

Which sort of knowledge and decision making capability does the new type of "digital literate" Managers need to apply in order to drive today's digital presence and tomorrow's digital future? This chapter will provide insight to this fundamental challenge. However, before providing an insight into it, let us understand which leadership decisions are necessary in today's digital engineering business and Virtual Product Creation (VPC) solution sets.

Please note some examples where today's Management teams (in Engineering, Business, Project Management and IT) often fail due to missing background and technology understanding, working experiences and skills as well as limited digital business acumen or missing data and cost/benefit estimations:

1. How to invest into future VPC competencies with respect to new digitally executed incremental verification of technical systems (products, production lines, infrastructures)? Which investment distribution in time, effort and budget amongst candidates suits the purpose the best, with respect to:
    a. IT technologies
    b. analytical and digital engineering methods and working principles responsibility processes
    c. new virtual test facilities and prototyping environments?

[1] Please compare all IoT (Internet of Things) related subjects and explanations in Chap. 20.

2. Whom to assign inside and outside the company to define and design the new digital engineering core competences for the future? Which approach to take to recognize shortfalls in the existing engineering set-up with respect to the necessary next level of digital sign-off rules and methods of highly connected, automated and/or autonomous technical systems? Will the company still be in business in 5 years from now, if current engineering practices are still in daily use, especially with respect to cover new products and systems with high degrees of SW-enabled and data driven system behaviors?
3. Which time is left to make the final decisions to establish the new hybrid symbiosis between classical HW-prototypes, dynamically updated digital prototypes and appropriate virtual prove-out environments? Which degrees of new digital prototyping is best suited to allow for integrated approaches that follow *model based (systems) engineering* and to leverage *smart service/IoT based* development patterns?
4. How to retrain the current engineering workforce and to merge in new digital talents and specialists from the outside (e.g. data scientists or analysts, computational engineers, system architects) in order to cope with the growing challenges of delivering "error-free or resilient" intelligent products in the global market places? How to establish new ways of Dev/DesignOps for technical systems?
5. Which criteria and arguments should be used to finally decide whether new information standards need to be developed, integrated into IT systems, and trained to the workforce as part of the next crucial digital transformation? Which of the existing information standards are no longer sufficient or fit for the future, how can such "short term non-productive" but "long term strategically critical" new digital capability be justified? How to take the lead in it? Which investments are necessary?

The next section will clarify which responsibilities of Management are essential for the digital engineering capabilities and intelligences of today and for the future.

18.1 Needs for Improved Digital Leadership of Management in Virtual Product Creation

The internal and outreach recruitment system to fill Manager Positions in product and manufacturing engineering relies on the classical two-fold T-model shape skill assessment approach:

(a) **The "vertical depth":** deep dive knowledge in a specific classical technical field (such as automotive engineering, mechanical engineering, electrical engineering etc.) with an evidence of ~5 years of operational experience "on the product" in industrial practice
(b) **The "horizontal breadth":** integrated or additional knowledge and engagements with respect to project management, simultaneous engineering and

collaboration, international business understanding and assignment and cultural leadership.

Once being part of the Management system individuals grow internally with their experience, performance, internal reputation and network connections as well as with their capability to comply with the internal leadership culture. External hiring benefit from unique, complementary skill sets but it has to adopt to the companies' behavior style very quickly to stay on the fast track for promotion.

Unlike new digital start-ups, pure software companies or leading GAFA[2] type tech and digital data corporations, the traditional industrial corporations still rely heavily on HW (hardware) product centric leadership capabilities. Those leadership skills do include the specifics of many years of product hardware development and prototype practice within a specific business (factory and OEM-supplier network) and innovation (material and production technology) environment. Adopting management skills from one industry branch to the other remains difficult still today!

Which Challenges Exist to Build and Drive the Digital Transformation?

The new world of sharply advancing digital driven business approaches and working pattern makes it necessary to rethink this traditional approach and also to introduce new career elements and skill-sets into traditional industrial enterprises. This cultural and career relevant change as part of the overall digital transformation in most of the cases happens slowly. In the best case, this transition happens evolutionary. In some cases it is caused rapidly by crisis modes that are resulting from declining market equations and major technological system changes (e.g. like the migration from combustion powertrains to electric powertrains). It is also increasingly driven by a sharp growth of SW enabled product intelligence which leads digital conversion approaches such as replacements of single engineering control units (ECUs) to overall digital operating systems for the management of embedded software intelligence in products. Those drivers are often recognized too late in order to change pro-actively the development approach in companies. Many traditional industries cannot change as fast as they should and, therefore, the development approach is oftentimes not handled as part of a disruptive full redefinition of the company. In order to provide more opportunities for business segments to develop in such a dynamic phase of transition, companies allow a separation of new skills as part of a spin-off. This helps to provide leeway for quick transformation apart from the rather static set-up of the parent company. The reasons behind such an approach are the human individuals themselves since they do not like to leave their own comfort zone that allows them to run business based on well-established experience. Consequently, they do not drive self-motivated new and unknown business behaviors and success patterns. The question remains, how do drive digital transformations more

[2] The acronym GAFA stands for the leading western world digital tech corporations such as Google (G), as most used internet search engine), Apple (A), as a leading digital technology company, Facebook (F), as most used social media platform, and Amazon (A) as the world leading online dealer. Their new platform based business capabilities builds up on unique digital leadership mechanisms beyond the traditional strongly hierarchical organizations.

dynamically even in segments of well-established industries like mobility and vehicle technology, machinery, aerospace and aviation?

The fundamental base challenges for digital transformations in enterprises are the following ones that are difficult to achieve by ordinary management principles and behavior with a focal point on operational control:

1. The first base challenge is to get the whole organization behind a *new digital approach* and not just specific teams. As a pre-requisite, a core management team has to drive consistently the associated culture, architecture and operational spirit forward. It cannot just be down delegated to others! Experts from inside or outside might help but cannot substitute the key management leadership drive.

   The hidden dilemma: unfortunately, progress with respect to the whole organization is only as quick as the slowest hitter is and the landmark where to hit the ball needs to be clear for all in advance! This, however, needs dedicated commitment and encouragement by the teams and their leaders themselves. Business as usual needs to be openly dismissed and new ground rules based on new principles need to be established.
2. The second base challenge is all about knowledge, understanding and motivation. In order to achieve an organization shift towards new digital working principles the organizational members need to reach a similar comprehension level of the new approach.

   *The hidden dilemma*s: in case of long standing and well as established industries and enterprises, it is difficult to get all members motivated and activated to learn new digital styles and technologies of working and operating, and also to trust them and to adopt them for the personal working system and environment!

   From human perspective, it becomes essential for Management to provide practice zones (even for themselves): *if you had not hit a ball for a long time, you need to create motivation to (re)start again and you need simply practice to resume professional levels in order to show off in your "new digital neighborhood*".

Digital transformation needs a new open mindset with trust and transparence to equally comprehend and appreciate the different dimensions and influence factors. As it was already introduced and explained in Chap. 6 ("*The set-up of Virtual Product Creation in Industry—best practices, error modes and innovation speed*") the dimensions of the Engineering Operating System (EOS) provide an excellent understanding of challenge to harmonize the success factors for digital business and working solutions:

- *Process and organization* (the classic strength of Management)
- *Tools and IT system integration* (typically foreign to the majority of traditional Business & Engineering Management, and therefore, delegated to the IT organization)
- *Virtual models and digital data sets and information* about physical objects (usually not known by Business and Engineering Management, not even well known to IT Management!)

- *Operational activities* of designers, engineers, analysts, process planners etc. (some knowledge exit due to personal background and practices; this, however, is in most of the cases outdated in Management)

In order to rebuild, to extend and to newly set-up Virtual Product Creation as a key engineering discipline in industry, Management has to provide step by step a vision, a mission and leadership (in person and as a team) with a passion to design and determine such new and extended capabilities.

Virtual Product Creation in industry needs the following five critical proactive contributions by Management Leadership:

1. Leadership in vision & mission of the new Engineering objectives and intelligences. Product Development and Manufacturing Engineering need appropriate digital enablers and solution elements. Management has the task to enable and support modified business objectives by appropriate new engineering approaches and solutions. Thus, Management has to start paying more attention to robust systems engineering and integration of continuous and agile SW development as part of embedded sub-systems with modular interface driven hardware architectures and component deliveries of products and technical systems. Do not talk about data, argue with data! Never accept fuzzy meta data reports about development status, ask for the evidence of functional fulfillment by the individual elements, and do not hesitate to view it live!
2. Achieve personal commitment of individual Managers as well as aligned Management team engagements in defining needs, alternative analytical capabilities and specific target settings of the Virtual Product Creation target architecture (which comprises new engineering principles, digital processes and workflows, new synthesis and analytic capabilities and overhauled or even enhanced digital tool sets and methods). Work pro-actively together with research institutes and consultants, but get entrenched yourself—become part of conceptual run-throughs already in POC (prove of concept) work, rather than getting show cased late deliveries with flaws.
3. Drive change management to modify the organizational and cultural set-up and building the core fundamentals of the new full digital engineering approach by:
    a. deriving new engineering system thinking and integration principles,
    b. establishing new types of design reviews and decision-making,
    c. allowing and requesting constant reflection of working and collaboration practices incl. lessons learned) and
    d. ensuring appropriate scaling up of the new-piloted digital behaviors.
4. Incentivize Managers to work directly with data and information sets offered by business intelligence tools in engineering business rather than just requesting passive Excel- and PowerPoint File documents and presentations. The management & control of Virtual Product Creation development, deployment and business integration as well as daily digital engineering operations (rather than just steering a project set-up of VPC) needs to become an active management type of tasks of modern and future Managers!

5. Establish dynamic and continuous leadership control of digital engineering delivery (architectures, software, digital models and data, digital prototypes etc.). Digital Engineering activities need to be driven actively and in a continuous (agile) way by Management beyond the classical stage gate concepts, rigid milestones and gateways of existing project management methods and toolboxes.

From the end of the 90s of last century, Management Re-Engineering programs, Business Schools and MBA type of knowledge have heavily influenced Upper and Senior Management.

In addition, Project Management has been introduced intensively in most of the industrial enterprises. Both elements have been driving the way of working of Management towards regular operations reviews. Such operating meetings have been "optimized" with respect to the overview of actions versus tasks and initiative targets.

As a consequence, (Upper and Senior) Management step-by-step migrated into their own world of documents, which was increasingly decoupled from the rising stage of digitalization in the engineering world. Figure 18.2 illustrates such situation:

- Since Managers are no longer able to work directly with digital tools as part of Virtual Product Creation, they request a down cascade of relevant information from a full 3D analytical model environment into an easy to use PowerPoint presentation with a pre-filtered reduction of digital content and information (step 1 from a to b)

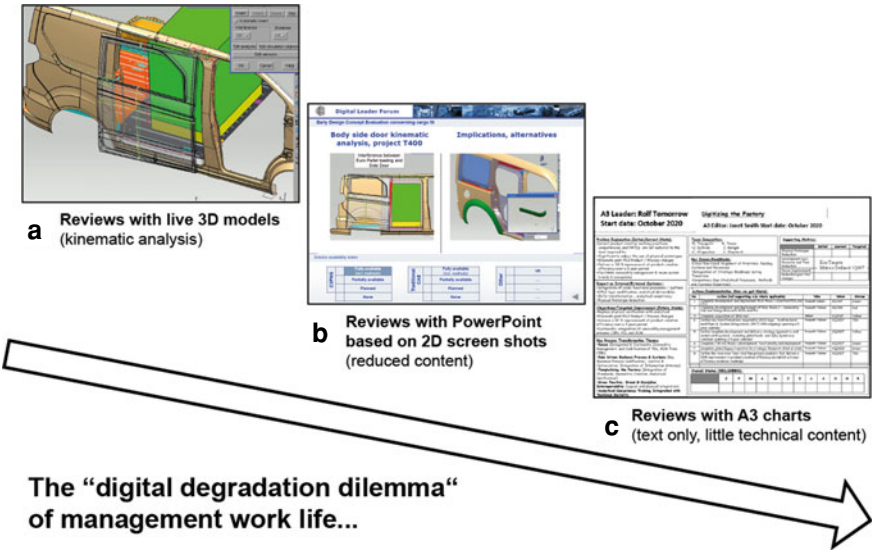


Fig. 18.2 Reduced "*digital content environment*" specifically prepared for upper and senior management

- In addition, especially for Upper and Senior Management, this type of information is further transformed into overall Management report sheets like an A3 documents (compare the background of A3 Management thinking in [1]) which are introduced to keep an overview about lessons learned, new business practices and management initiative and program description and status. From a digital point of view, those documents are nothing else than text verbatim and structured time & status elements without any trail or traceability back to the potential high value full digitalized materials (step 2 from b to c).

It shows that the digital transformation still has to change traditional Management practices in order to use digitalization consistently throughout all organizational working patterns. VPC and PLM solutions companies for a long time did not pay enough attention to this dilemma. Consequently, still today, there do not yet exist traceable "digital live/life interaction" dashboards for the diverse needs of management. It will be a major research and development task to build up *Engineering Intelligence Charts* that leverage diverse sets of digital and analytical data and models in engineering and production (similar to "Business Intelligence" charts). The complex socio-technical product-service systems of the future depend on a rich mix of partial system parameters and their dynamic control interaction via rules and/or data-based analytics. The resulting demand to observe, review and dynamically change their interdependence and traceability will grow substantially. This drives the need for live ("*exactly now*") and life ("*forecast, rewind of lifecycle periods snapshots*") interaction dashboards.

Traditionally, Management is powerful if it assumes responsibility and accountability of "something important" and hence feels ownership in command and control of it. Unfortunately, for a long-time engineering management in traditional manufacturing companies allowed itself a way out of direct digital responsibilities by simply leaving it with or transferring it towards IT organizations. The thinking behind such an attitude is simple: "digital means that software is engaged and software should run on computers, on databases and across digital networks. IT departments are responsible for such operations". The actual delivery elements created by digitalization were considered within this context as a storage element within the IT environment rather than as an engineering asset! The creation responsibility to change the underlying engineering working system towards new digital capabilities, elements and solutions is, therefore, oftentimes not proactively considered by engineering management. Consequently, many companies created *project type or "extra" organizations* to drive those digital elements within enterprises rather than integrating digital responsibilities directly into existing engineering departments. This even exacerbated decision making in assessing, deploying and execution new digital working solutions in industry. As outlined in Fig. 18.3, management is supposed to lead the digital transition overall and to have ownership for its robust set-up.

It starts oftentimes with a flawed ownership of scouting for, assessing of and proving out new forms of digital solution capabilities (see element 1 in Fig. 18.3). Only few companies have already established ownership for this including regular capability reviews to understand and drive such new digital engineering solution

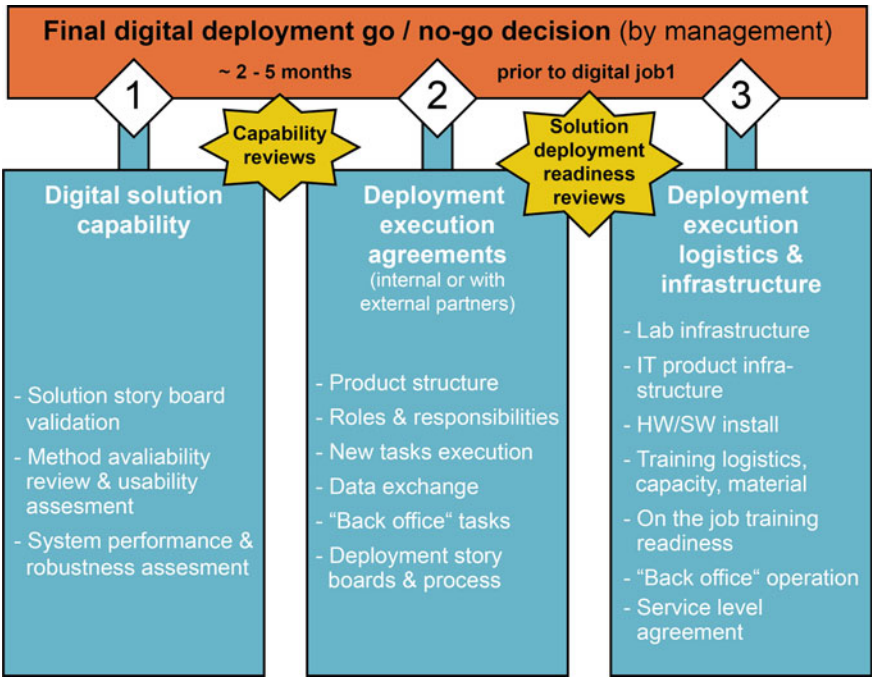


Fig. 18.3 The 3-pillar staggered digital management leadership responsibility

elements. Endless budget competing rounds as part of preparing for annual innovation funds are meanwhile exhaustively entertained in industrial companies to allow certain digital prove out work for the following business year. This painful waste of *creative enthusiasm and power* are significantly contradictory in order to establish meaningful ways of allowing continuity in digital innovation and progression.

The second challenge, however, is even bigger. As shown in Fig. 18.3 as second element, the critical task of developing, arbitrating and establishing agreements amongst all stakeholders for digital solution deployment, implementation and execution is key for any further digital success. It needs strong personality and leadership with direct contact to senior management to become powerful enough and successful. Most of the companies still experience constant failure modes with this element due to missing ownership and leadership for this task. Engineering managers sometimes are thrown into such leadership role as part of a sideway career step without having the necessary technical skill set or at least meaningful understanding of it. Hence, they act cautiously without strong mission and might look already for other or next career opportunities. In many cases, such ownership is not placed at the right level on the management hierarchy. Therefore, these managers do not have the right power to negotiate and determine necessary changes in digital engineering work practices across engineering and manufacturing disciplines.

For many companies the deployment readiness reviews and gateways for a new set-up of digital engineering roles and responsibilities as well as new working solutions are still foreign. Oftentimes, companies are unable to establish such transparent reviews due to their traditional set-up of concentrating on department internal rather than cross-departmental digital progression. Other inhibitors are created through a low-profile set-up of digital solution responsibilities within the overall management set-up.

The third major leadership task within industry digitalization and digital transformations is the responsibility of the digital solution execution and all associated logistics, infrastructures, reporting systems, steering and escalations mechanisms. Co-ownership between business engineering leadership and IT-leadership remains difficult due to different interests, success factors and associated business metrics. Business engineering management focus on getting delivered fully tested, robust digital technology for their work force with *no* or *exceptionally low* levels of bugs in digital application and digital workflow solutions.

Engineering management, thus, have major problems in accepting prioritized and force ranked software bug & error listings (and accepting implicitly that minor bug fixes might not get delivered at all!). In addition, training and competence set-up and progression is favored via the help of "on-the-job trainers" (OJT) who provide direct solution help at the engineer's work desk on the office or factory floor.

IT departments are more concerned about their responsibilities to provide a stable IT server and application factory according to certain service level agreements (SLAs) which need a buy-in and sign-off from business engineering leadership. This does include back-up operations, server uptimes and rapid data conversion and delivery services to the IT solution user base.

Overall, it is still a major challenge in companies to identify, shape and authorize the right management team, which assumes ownership and leadership for the ultimate decision and operation responsibility of digital solution deployment readiness and the final "*go or no-go decision"* with respect to full digital operation in business.

18.2 Management Behavior Do's and Don'ts in Digital Leadership

This section provides two examples of good and bad practices of management behaviors in leading digitalization, Virtual Product Creation and PLM in industrial companies. Those reflections should help companies, their management and future leaders to apply the right personal attitude, business acumen, digital technology assessment capability as well as appropriate motivations, judgement calls and leadership skills in the context of digital innovations and transformations.

The first example shows how political pressure is misused in order to rush for quick moves in a complex development context with immature digital solutions just to deliver success for personal career purposes.

Virtual Product Creation Experience in Industry
(*Management don'ts in digital leadership*):

Aggressive rollout plans for immature digital solutions in a complex development environment

The overall situation

The enterprise *Future Automotive* is under pressure: the scalability of their platforms and technologies needs significant improvements (new powertrain types, new connectivities and intelligent functions, location-based service integration etc.) in order to achieve higher margins in solution offering on the future mobility market. Therefore, a merger & acquisition strategy has been followed thoroughly. In consequence, the new partners and brands of this "fusion" must now work tightly together in delivering such new intelligent products, architectures and technologies. Unfortunately, as it is still usual in the twenty-first century, the individual company digital engineering solutions sets are diverse enough to prevent easy, efficient and effective engineering collaboration. Enterprises within company networks are, therefore, forced to entertain additional costly *digital bridging solutions* to "translate and deliver" engineering work results across the diverse sets of virtual product creation solutions. This accounts for approx. 20% extra cost which usually is covered by "hidden pockets" of the overall engineering budget spending. Nevertheless, the new enterprise transformation program "*Digital Innovation Edge*" has been funded and set up meanwhile to deliver within 4 years the new engineering capabilities of the future. This digital program has a similar size and funding schema as a typical full major vehicle platform delivery.

B. Mr. Tanterelli leads the global transformation program *"Digital Innovation Edge"* and has a group of seven managers reporting to him to ensure the appropriate development, delivery, deployment and daily execution of the new future digital engineering solution. Overall, approximately 400 heads are involved in this mission critical program.

Assessing digital solution readiness and deployment start

Mr. Tanterelli has invited all seven managers and various technical experts from five locations in the world to his digital headquarter facility in Shanghai, China. Overall, 4 days of common work in a team of approximately 40 persons are on schedule.

The first two days of technical deep dives are used via the help of *Digital Solution Capability reviews* (Fig. 18.3) to assess the true situation of the development status of the new digital platform (after 2 years of work). This is done together with three major digital solution providers and PLM vendors in order to prove, test and potentially sign-off the various digital capability degrees and to outline significant risks. The third and the fourth day are used to translate

these findings into a status for generic deployment readiness in order to potentially start negotiations with vehicle and technology development program management.

Now it is Thursday afternoon and Mr. Tanterelli has summoned a 2 h "*final conclusion and decision"* meeting with his seven managers and support staff (overall more than 20 people in the room). Mr. Tanterelli starts the meeting as follows:

"Team, it is now time that we deliver our solution to the company units, no matter what it takes. Last week, I already promised this to the board and you have enough time to assemble everything this week here in Shanghai. You know, that we have to to move fast and therefore, I expect this pro-active behavior from you all! Are you on board?"

Nobody said a word, although everybody knows that the digital solution still has major flaws and that even the digital solution providers and PLM vendors could not yet recommend the full business use of this platform. The risks that development projects would fail due to missing robustness, non-delivered functionality and limited scalability have been commonly assessed as far too high.

Mr. Tanterelli continues the meeting by addressing each one of the managers 1:1 in front of the entire crowd. He starts with his local manager who has been assigned to deliver this *new digital platform* to a local (China only) derivative of an existing technology platform: "Mr. Li, are you ready to use it and will you be successful?" Obviously, Mr. Li quickly nodded his head and confirms with a silent yes. Mr. Tanterelli continues this approach 3 times more with managers from other regions in the world who have easy circumstances with only limited content development projects which make it easy enough to potentially revert back to the legacy solutions. In the 5th term, B. Tanterelli directly turns to Dr. Ryan who has the unfortunate task to support a full-fledged global platform delivery program out of Europe amongst three brands within the first new fusion commitment of the global enterprise *Future Automotive*:

"So, Dr. Ryan, how is it with you? Tomorrow night, during your flight back to Europe, I will be participating after midnight local time in a leadership call with the US and Europe. In this meeting, I have to explain whether we will shift the important platform program "*EU fusion excellence*" to the new global digital platform, or not …? So, how will you advise your Vice President in Europe Monday morning on your return? I need to know this now!"

Dr. Ryan recognizes that now all 23 persons in the room were looking at him knowing that he will now have a hard time to say no to his international boss Tanterelli, who has earned a well-known repu-tation to get quickly hot tempered in situations where he does not get answers he likes. So, Dr. Ryan waits for 5 s before he answers firmly and clear so that everybody in the room can hear it.

"Mr. Tanterelli, of course I will tell you now exactly what I will tell my Vice President back in Europe Monday morning. I WILL NOT RECOMMEND USING THIS DIGITAL SOLUTION YET; it is not ready for productive use and would cause major problems to the *EU fusion excellence program.* Sorry, but I have to be honest with you and to the company and I am more than happy to explain it to you."

Mr. Tanterelli immediately changes his facial expression, stands up and starts to take full control again of the meeting.

The next moment, Mr. Tanterelli starts to shout to Dr. Ryan: "I do not accept your position, this is against the commitment I had given already and you have to follow my decisions! This will destroy your career …".

Immediately, all other members start to leave the meeting room and after one minute, Dr. Ryan is alone with Mr. Tanterelli. Even the overall pan-European superior of Dr. Ryan, Joe S., has left. It seems now that the meeting degenerates to a performance report meeting for Dr. Ryan. Nevertheless, Dr. Ryan stays calm and answers back to Mr. Tanterelli: "Please stay professional and calm with me, I would like to explain how I came to my negative conclusion and I would like to fill you in since this will be important for your meeting tomorrow and potentially also for your future career. Let us go to the board, I will explain …".

Mr. Tanterelli somehow understood that he should better listen now and he allows Dr. Ryan to provide this interactive briefing to him explaining the snapshot of findings from the various reviews on the days before, incl. all risk assessments. After Dr. Ryan had survived the next 5 min after this clash, half of the other members return back to the meeting room and become part again of the review.

Mr. Tanterelli at least commits himself that he will think about it until the next day meeting. On the next day, when Dr. Ryan is in the air on his flight back to Europe, Mr. Tanterelli reverts back to his prior position and promises the use of the new digital solutions to the "*EU fusion excellence*" program. For Dr. Ryan it becomes again a difficult meeting in the office Monday morning explaining to his Vice President what the real situation is. The following days were full of clarification meetings and excuses. Bottom-line, however, it is understood why the solution can not yet be used. Such promise on wrong digital capabilities happens again 6 months later and again it is too early. The "EU fusion excellence" program finally has migrated 4 years later to the new digital platform after it was proven out with another global platform initiative 2 years after the Shanghai meeting.

Progress in new digital solution offering takes time and integrity!

Lessons learned, bad practice and successful re-action:

- Coming physically together to interactively study progress and shortcomings of upcoming digital solutions is critical for success and needs to be

executed professionally; being in one location helps to grow together in understanding and common position, however, it does not prevent misuse of power!

- Making up a conclusion session to ask for non-critical buy-in to a pre-commitment, which was given by the most senior leader already far before such a review week is worst practice and should not be supported at all. Such bad management eagerness and misuse behavior destroy all trust levels of digital commitment and encouragement and adds negative damages to partnerships for successful digital operation.
- Putting individuals on the spot in a meeting amongst equals with the help of super power from a senior person constitutes bad and non-constructive leadership behavior.
- Other teammates also in management should help each other and should stay united to protect the team against such behaviors, leaving the room is the wrong reaction!
- Staying professional and calm in reaction in such a situation is best re-action and might lead to at least neutral moments in decision-making; however, it cannot achieve mindset shift at the other end.
- Overall, integrity of individuals are noticed by others and help changing the digital culture and management approach; however it takes time and needs similar behaviors by others in order to make positive impact.

Four years later, in an occasion of general reflection, Mr. Tanterelli thanked Dr. Ryan for his constant integrity and honesty in technical assessment and for his encouragement to speak up even in critical situations. He admitted that he did not find enough managers around him who offered such an attitude. Dr. Ryan accepted this late praise!

It should be noted that positive digital leadership is rare in management. Finding good role models remains essential to positively influence the digital culture and attitude of an entire organization. However, it is encouraging enough that such individuals exist even amongst management members who did not have the opportunity to deep dive in Virtual Product Creation technologies or specific digital engineering solutions.

The second example describes a digital leadership behavior characterized by a range of positive and successful general management attitudes: trust, capability to listen and comprehend, good personal preparation prior to important decision-making meetings, support of individuals in difficult situations like protest and rejection in critical meeting situations.

Virtual Product Creation Experience in Industry (Best Practice)

How digital solution implementation can rely on excellent senior management behaviors even in critical situations

The development situation

Senior Management had endorsed a major digital innovation and transformation program called ***"Digital Intelligence Future (DIF)"*** 3 years ago in order to reduce time to market by another 15 percent whilst increasing efficiency in delivering new powertrains, highly automated driving solutions for next generation interconnected mobility services by at least 30 percent! Those numbers are already booked as contributions within the future cycle plan. Now, after 3 years of global prove out in pilots of the new digital solution architecture the first major technology architecture program for level 3 highly automated driving is about to start in 3 months. The new *DIF* solution architecture comes with a new integrated PDM/FIE (product data management/functional intelligence elements) solution for hardware and product intelligence offering, incl. a dynamically coupled ALM (software application life cycle management) solution with an integrated SW delivery development (DevOps) and delivery (OTA, over the air) pipeline. At the same time, all (SW & HW) engineers need to undergo a new *Advanced Systems Engineering* training curriculum to change to a 70% MBSE (*Model-based Systems Engineering*) digital development solution. Management is targeted to become 50% more efficient by directly working with all digital elements in specific *Digital Management Browsers* (DMB).

The new *DIF* solution leverages engineering intelligence brokers with AR/VR (Augmented & Virtual Reality) interaction gadgets as well as IoT data platforms for data analytics. With the help of *DIF* each product in the field can be operated with a range of up to 100 digital twins, which themselves can be configured dynamically for different business, functional, safety and environmental purposes. The dream of digital thread and digital continuity, which became popular around the early 2020s, finally becomes reality. To be able to sustain leadership, each manager will have to train his/her AI enabled Digital Bot Assistant in order to keep abreast about the information and model inflation of the new world (individual have to work daily with at least 50 digital models.

Approaching the digital solution deployment agreement

Dr. Ryan knows that such transformation will be stressful and will cause fears and potential mistrust, especially within middle management. Those Managers are under enormous pressure to deliver the future new product types for the company with respect to the technology architecture for level 5 autonomous driving. Therefore, only selected individuals have been chosen, all of them with a strong record of excellent development and collaboration skills. Dr. Ryan

knows that there are even 2 managers amongst them who had the opportunity some years back to develop "their own project" *pragmatic digital development solution* for one of the internal "*Beat the competition fighter*" development projects. Such important projects to that time have all been designated with Greek goddess names such as Athena, Artemis, Aura, etc. to underline the "epochal dimensions" of such a project or the future product line-up. However, Dr. Ryan also knows that both projects have sunk 80 million cash for such short-term digital solutions that were neither architected to work robustly nor to be scalable for the entire company. Now, with the company initiative ***Digital Intelligence Future (DIF)*** it is the other way around: a team of 100 experts has been co-located in a central location with 50 satellite collaborators to pilot the new way of digital engineering of the future for 2 ½ years. A non-cycle plan listed experimentation vehicle was developed with this new *DIF* solution in 15 months in order to be sure that *DIF* would deliver all relevant digital capabilities. The new digital working styles, types and tasks could be tested, observed, measured and improved to achieve deployment readiness. Dr. Ryan now has the task to introduce all managers to this new digital future!

Preparing for the deployment readiness meeting with management

Dr. Ryan has agreed with Denise K, Vice President R&D that it will be essential to prepare the management team in a dedicated, mandatory meeting under the leadership of the Vice President in 4 major steps:

1. Understand the core changes and the urgency of action
2. Explain the plan for first 12 months of deployment and training
3. Align the motivation, provide faith by showing pilot results, explain the steering set-up and the explicit manager tasks
4. Wrap-up with and next steps for the next 3 months.

The day before the management cascade meeting Denise K. invited Dr. Ryan for a late meeting at 8 pm to her office to get last things prepared. After having run through all slides, statements and tasks, Denise K. concluded to Dr. Ryan: "Tomorrow's meeting will be a difficult one; I wonder how many slides you will be able to show without intervention from some of the "alpha" managers. Just be prepared for it and please stay calm. You simply cannot avoid it! I will stand-by and will react appropriately to cover the situation. Trust me, we are one team!".

Deployment D-day with Management

It is 10 a.m. and other than normal, everybody is already seated in the management oval room, 25 managers, 12 at the local site in Germany, 7 at the remote side in the UK and 6 in China. Denise K. starts this special meeting by explaining shortly but precisely what the goal of the meeting is: to get every

manager pro-actively on board to fulfil his/her leadership role in the most significant digital transformation in R&D in history of the company ever. She expects that everybody comes prepared for taking on personal assignments since everybody had received a preparation booklet by Dr. Ryan already 3 days ago. She looks around the local and virtually plugged-in management team and then turns to Dr. Ryan, who is seated directly besides her, and she finally says: "Dr. Ryan, please take us through our tasks step-by-step and explain them in all clarity, please".

Dr. Ryan switches on the newly 3D immersive Digital Presentation Streaming which has been replacing the formerly known PowerPoint presentation slides. This way, he can insert all live data from the new *DIF* environment piloted with the experimental car whenever needed.

Dr. Ryan starts—according to the agreed 4-step approach—by pointing out major drivers for the new digital development approach in the company. In minute eight of his presentation, on the fourth slide with the title "The plan for the first 12 months of deployment and training", one of the most experienced "alpha" managers, Gilbert G., suddenly and firmly interrupts him. He raises the question: "Dr. Ryan, are you serious, that we as managers have to really undergo a 2 weeks training …for these new digital gadgets? We have more important things to do than wasting our time with IT tools. Our engineers, designers and analysts are supposed to use them, but not us. We are the managers and not the digital workers!" Dr. Ryan looks around to all the other faces and they signal similar unwillingness and fears to him. However, all of them remain in tense silence. The internal voice of Dr. Ryan reminds him of the mission he is on and provides solid encouragement to him. Dr. Ryan responds clearly to Gilbert G.: "It might be unusual to you and your peers to make such a bold step to a new digital working environment of the future, but yes, I am serious about this step. Together with our global expert group and all management stakeholders in the ***Digital Intelligence Future*** team we have exactly decided this and do expect it also from you!" After 2 s of stunning silence across all rooms, major mumblings crop up everywhere. Another 10 s later another key manager, Andy S., raises his voice and directly addresses to the Vice-President: "Denise, it does not make sense at all to continue this waste of time here, this is unreal. It does not make sense that we get educated by a Digital Leader on how we as managers should digitally work in the future. It is up to *us* to decide what we need and want. Then we advise the digital experts what they have to deliver to us. This is the way, as we have done it in our "*Beat the competition fighter*" development projects some years ago. Please stop this here, immediately!" This speech killed all mumblings immediately. Again, stunning silence across all rooms.

Dr. Ryan has noticed that Denise K. has begun to scratch her finger knuckles during the last minute and has been changing her face color slightly every second onwards. The moment has come now as Denise K. had forecasted it

last night in the preparation meeting. Consequently, Denise K. starts to talk silently but *very* firmly to all managers.

"Team, you better think before you talk. You know what is expected from us. We have to lead and we are supposed to be the role model for our engineers, planners, controllers and teammates. The company made a commitment by heavily investing into the future and a whole team has worked hard on the *DIF* solution for a couple of years, the ***Digital Intelligence Future*** solution. It has been proven already that this new solution does deliver these long times awaited new digital capabilities. Now it is up to us to finally make a serious commitment. Let me ask you, as my direct reports: "Who of you does not believe in this solution or is not able to make a commitment to learn and adapt to this new digital working environment? Please speak up know before it will be too late!" Denise K. pauses for ~10 seconds, looks everybody in his/her eyes, also to those in the virtual rooms, finally turns to Dr. Ryan and says in a very calm tone: "It has been cleared up, everybody understands what it takes, please continue with your explanation and plan for all of us, Dr. Ryan!"

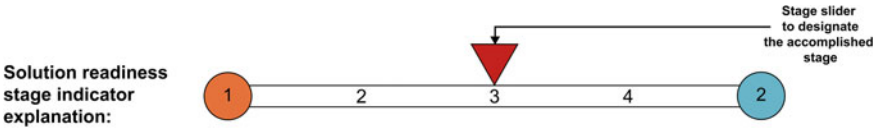
The meeting goes on in a very professional way; all managers get "pro-actively" interested in understanding the plan forward and to learn their personal role in the upcoming leadership events with their own teams.

After the meeting, Dr. Ryan was approached from almost every manager. The following weeks and months obviously were cumbersome and stressful; the productivity went down by 30% for the first two months. Before working efficiency went up again to normal it took 5–6 months. The new potentials started to pay back already after 10–12 months and the rollout extensions to other teams were signed-off 14 months after the first productive introduction! Digital transformation can work.

Lessons learned, best practice and encouragement elements

- Despite major investments into new digital development environments, many managers still have difficulties to accept their new leadership role and personal working activities in it!
- Timely, mandatory meetings to align management teams as part of major digital transformation initiatives are key!
- Management needs to engage with digital experts to become digital drivers, to mitigate criticism upfront and to provide trust!
- Team leadership and digital passion drive motivation!
- Management needs help in learning digital leadership!
- Digital future needs reactiveness and not concern behaviors!

Comparing the two lessons learned examples the question comes up to how industrial management approaches and measures the capabilities of new digital engineering solutions and their readiness for deployment (i.e. start of usage) and for scaling it up in ordinary or new digital engineering activities? This, indeed, is a major



a) Concept, solution, method offering	• VPC concept developed, • Base capabilities in IT applications identified • Feasibility given • Capabilities exist to demonstrate the main way of working with the new concept	• VPC concept refined and calibrated with day to day engineering examples • Needs for method & tool functionality indentified and agreed to be part of specific digital solution release	• VPC concept and Conceptual Information Model (CIM) finalized • Agreed way of using the solution for real life work • Dedicated project team + plan exist to develop the solution for specific job1	• All VPC working solutions are demonstrable in test labs • Method usability assesment done to point out critical areas for end user readiness • End user testing started	• All VPC solutions tested by end user • All methods and workarounds developed, defined and documented • Critical enhance-ments & priority 1 & 2 elements identified • Performance leads completed
b) Business needs, storyboard, integration, R&R commitment	• Business need for new/revised VPC concept and digital solution identified by experts and endorsed by management	• High level business goals and process integration model established • Identification of which functions & departments and job oles are affected and in which development phase	• Deployment story board development finalized and agreed by key leaders from the functional activities (and respective management)	• Final agreement within organizations on usability of the solution delivery & related story boards • Business impact and value analysis completed • R&R agreed	• R&R and resource estimates finalized • Formal commit-ment by senior management to get individuals trained to start productive use of the new solution in a given develop-ment project

Fig. 18.4 Stages to describe and measure digital solution readiness

shortfall in industrial companies and is not (yet) treated serious enough by a robust management framework. The overall framework introduced by Fig. 18.3 in many cases is not executed thoroughly and are not underpinned by explicit management tools.

Dr. Ryan in the industrial examples of this book obviously uses a detailed "*solution readiness stage indicator*" in order to drive, validate and sign-off precisely the readiness of digital capabilities before they are treated as verified candidates for deployment. Figure 18.4 shows the two levels of readiness assessment and declaration:

(a) The level of concept, solution and method offering
(b) The level of business need, engineering storyboard integration and commitment for roles & responsibilities in the organization.

The stages 1 through 5 provide a precise readiness clarification with a gradual progression of individual characteristics such as principle solution understanding, conceptual fit to engineering examples, match to enterprise needs, working demonstrations and detailed method and digital application readiness. Those stages also address various aspects of business goal fitness.

Due to a missing understanding of such a management control approach, the majority of companies leave it up to individuals to find ways of how digital application functionality can be used without any stringent fit to the digital innovation and transformation goals of the individual company. It is somehow comparable to the situation in the beginning of the twentieth century in the physical world with

the *non-factory like* individual machine shop working habits: at that time there did not exist any consistent factory approach for effective and efficient production line readiness levels.

Which Other Digital Challenges Exist for Management and How to Build the Digital Transformation?

The following general observations might help management to find their own way to set-up, drive, architect and steer digital innovations and digital working transformations within their organizations:

1. The challenge is to get the whole organization behind a new digital approach and not just specific teams; unfortunately, progress is only as quick as the slowest hitter is!
2. In order to achieve an organizational shift towards new digital working principles the organizational members need to reach a similar comprehension level of the new approach.
3. Without charismatic leadership of individual senior managers, it is almost impossible to drive the digital transformation. If a senior leader personally buys-in, shows trust, willingness and also a certain degree of dependency to/on technical expert teams, then this time of bond serves for the entire organization.
4. To drive appropriate communication and sensibilization of *digitization* in management, it is necessary to know the structure of the company and its management schools and behaviour types. Depending on the size of the company and the management structure, it is essential to adapt the communication strategy accordingly when communicating *digitization.* Different situations exist in different types of enterprises, not all can handle *digital innovation and transformation* in the same way:

    - ***Mega-companies: 200.000+***: these enterprises can set-up special digital departments in order to prove out new technologies before making them matured enough for large scale application; due to their size and global footprint with regional business and culture differences many efforts are necessary just for alignment and reconciliation of local digital working practices. In these types of companies, the internal structure of the company and the strategies of certain functional areas or managers associated with it add to the challenge. In order to stand out from the crowd of other areas, departments try to distinguish themselves from others with the help of digitization projects. This can lead to unexpected headwinds when attempting digitization, even despite the fact that it makes sense. Consequently, this might cause extra efforts again in terms of re-alignment and reconciliation to fit to a common enterprise approach.
    - ***Major companies with 50.000+ employees (often tier 1–2)*:** big enough to tackle new digital capabilities once it fits to their business models and technology roadmaps. These companies are often highly dependent on technology shifts at and on alternating business equations of OEMs. These

companies increasingly compete with OEMs on new technical system technologies and the resulting product intelligence leadership (especially in the mobility sector). As a result, a higher versatility of innovative digital solutions and future Virtual Product Creation capabilities are necessary. Speed of realizing digital innovations is significantly higher compared to mega companies.

- ***Medium to Large Size companies with 500 to 5000 employees or even beyond)*:** In many cases, still owner lead, where digital innovations need explicit senior commitment and convictions; digital transformation can be handled quite consistently if the business equation allows for it. It is highly dependent, though, from overall technology level and from willingness of the owner group to recognize digital innovations as key enabler for their future. In most cases, digitization is targeted at a specific area of the company. Therefore, it is important to address the manager responsible for this specific area of the company, in a double sense. The respective executive must be convinced that digitization is either necessary or delivers added value (measurable benefits). The path to corporate management (or owner) leads through this executive.
- ***Family-owned or owner-managed SMEs*:** such companies are usually strongly owner-oriented with regard to important business decisions and with respect to the right type of digitalization. Finally, the decision on where and how to invest into digital capabilities is made by the owner. In such companies, it is often the owners or their children who have built up the company and/or made it successful. Therefore, the introduction of digitization requires special sensitivity on work ethics and work attitudes and needs to respect the internal (analog) spirit & soul of the company.

It must be communicated to the company resp. its management briefly, precisely and transparently with detailed information at hand, where the advantage of digitalization for this company lies. Neither an international "fad" nor digitalization purely for the sake of digitization will lead to a positive decision in the management of the company.

The company's benefit from digitization can have several manifestations, either one of the manifestations alone or as a combination of these:

- Cost savings (product, internal processes)
- Reduction of development time for a new product
- (reduce time to market)
- Reduction of production time for a product
- Increase in product, process and service quality
- Shortening innovation cycles and ability to react to new consumer and technology trends
- Achieving competitive advantages, if applicable (incl. "white space" products)

For managers to be able to decide on a digitization project, it is important to show them which of the above points is to be achieved. Based on this, a decision can

be made about a digitization project and its direction according to the company's priorities.

The following section is devoted to the question of how the next generation of digital leaders can develop as part of future management teams.

18.3 Development of Future Digital Leaders in Management

In order to meet the expectations and needs described in the previous two sections of this chapter, it becomes obvious that new digital leaders should be appointed, trained and supported for their development in engineering and manufacturing management. Independently of specific structural organization particularities of individual company specifics, it is essential to establish a new management skill-set, motivation and desire & passion to lead in comprehensive digital business and work situations. The following eight elements of management skills for Digital Leaders are key to achieve the goal of pro-active and competent digital innovation and transformations in industry. Those skills obviously need to be pooled with and cross-linked to the ordinary technical skill-set and experience in engineering and manufacturing (according to the industry branch necessities).

The following eight critical digital leader capabilities need to become part of any professional Management Development Program in industry:

- **(New) Digital business attitude**

Still today, there exists a puzzled picture on digitalization and digital business, especially within (traditional) industries. The first school of thoughts, mainly represented by the traditional management groups, considers "digital business" either

– as *new type* of "internet related" data business supporting services such as social media, internet browsing or other ordering and payment services or
– as a *traditional type* of internal company information technology-oriented service business to keep computers, workstations, voice-over-IP and data base servers up and running.

In any case, this first school of thoughts does not see itself in digital driving position; this is the task of others!

The second school of thoughts, mainly represented by the CDO (Chief Digital Officer) and related digital business consultants, favors a viewpoint that digital data should be treated as assets that must be used as new value creation elements on their own and are core elements for any digital business model in the future.

The technical IT related management and expert groups mainly represent the third school of thoughts. Here the belief is that digital business is closely connected to algorithms, software and software applications.

Digital Leader Management in the future needs to stay away from such single sided views on digital business and has to comprehend digital business on all levels in intra and intercompany business. Hence, it will be indispensable to teach and train the next generation of *digital leaders* in feeling and executing personal ownership to lead and guide new digital business understanding in traditional R&D, engineering and manufacturing operations. In addition, such new management needs to understand and live the difference in the digital approach: active usage of digital assets and provision of positive incentives for all participants to act that way will become the norm for successful leading companies of the future. The lagging ones will continue the obsolete set-up of three different schools of thoughts.

As it was envisioned already by the French existentialist Antoine de Saint-Exupery in the first half of the 20th century, which is reflected by his quote:

> If you want to build a ship, don't drum up people to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea.

It is now the time to teach all management members the endless immensity of the digital elements, irrespective to whether they are compared to clouds, lakes, atmospheres etc. The desire to design the new world with such new digital business perspectives will also boost the positive and successful usage of Virtual Product Creation and its future capabilities.

- **Personal skill-set and experience in digitalization**

If you become responsible for something you have been working with for a long time or at least for a while, then you feel comfortable with it since you are a successful practitioner, even a true expert or at least an insider of this skill. If you receive responsibility for something that you have no real working experience with, you feel unsure und not capable of leading and driving it into the future. This describes a phenomenon that unfortunately still is in the way for more progressive and natural drive for digitalization in many companies. Today, many managers in execution power have limited and not up-to-date working experience with digital engineering tools of Virtual Product Creation. Consequently, they are heavily dependent on merely reflecting the associated digital innovations, actions and transformations on a digital meta level rather than on a digital execution level.

Investments are necessary into their own digital skills and into their competence to seek and find future ways of digital working. In addition, as digital leaders, they need to be trained to fight against their own traditional controller law that follows the "compulsive return of invest" syndrome: only invest if you are 100% sure that your "digital dividend" will pay off. In management, digital leaders should be supported in their development and given the necessary encouragement, competence and capabilities in order to provide "innovative digital start-up environments" in the company eco-system together with a reliable "safe harbor" commitment. This means, that the risk to fail with new digital working solutions needs to be pro-actively managed and not necessarily eliminated to zero.

On a personal level, all management members should accept to learn the digital groundwork situations by being actively trained and introduced to such situations

at least one day per month. The digital leaders amongst them should be motivated enough to do so once per week! Overall, managers need to be trained in getting familiar with new digital technologies on a personal level rather than getting presentations only along the digital hype cycle enthusiasm by consulting companies.

- **Digital Leader influence to executive management levels**

Very few individuals exist high up in the management hierarchy to combine the following three capabilities: digital technical competence, digital business acumen and digital strategic thinking.

Therefore, it becomes crucial that digital leaders in middle management have good personal relations and contacts to the executive level. In many European and Japanese companies, there exist a connectivity gap of such desired close relations. Many proactive plans around digital innovations and transformations consequently do not find their ways at all to the top of the company via the ordinary vertical management meetings circles, or they get "brainwashed", "skewed" and "compromised" heavily on their way up. This slows down the overall digital transformation capability, quality and speed.

Therefore, it is highly recommended to train Digital Leaders in management to establish different kinds of "short-cut" channels, interactions and briefing types with and to Senior Managers, either on a personal mentor type basis, in their explicit role as a Digital Leader for a certain group of senior managers, or as part of specific senior executive digital review board. At the same time, it is crucial to learn a narrative explanation style for "rather difficult to understand" digital technologies and data/model realities in order to increase the chances to reach out to the comprehension, interest and motivation level of senior management. Digital Leaders need to have the skill set to explain the most relevant elements of Virtual Product Creation and digitalization in management language and show cast them with respect to executive buy-in comfort zone.

- **Dedicated digital training elements for management**

The times in which Management only works with office applications on a computer are over. Meanwhile, management rather gets actively involved in digital engineering work streams and digital sign-off of product functions, risk assessments, verification and production release.

The future will demand that Management gets intensively trained in data analytics, artificial intelligence, driven assistance and resulting digital intelligence assessments as part of the new world of decision making in Management.

nIn terms of comprehending and driving this new intensive style of digitalization, it becomes essential for Management to be technically well educated in core digital solution elements such as data, algorithms, engineering models, databases, information models, all as part of the company specific digital environment.

New digital training classes for Management should, therefore, cover the following core elements rather than software application functionality only:

– In our company, in my area of responsibility, what are the data, what are the underlying information models for them and what do they stand for? Where are they used (process and activities), in which way (e.g. digital methods) and by whom (job roles)?
– How to change and manage data and information successfully inside the company and across partners and the supply chain?
– How to establish a sufficient information model for digital business, whose views can and should be offered based on the different business perspectives?

- **Ownership for Virtual Product Creation capabilities**

One of the most critical challenges in industrial companies are expressed by the following question: who in the company receives which type of ownership to care about the digital future, the opportunities for different working practices, the associated engineering data and digital models as well as the digital business set-ups (incl. digital business models)? In most of the companies, it is difficult to funnel all relevant capabilities for such important range of ownerships into just one person. Thus, a well-aligned cross-functional team approach might rather be more stable to drive forward all of those necessary ownership set-ups and responsibility accountability duties.

Hence the Digital Leader training and education for management needs to provide the following critical elements which are supposed to be part of the final capstone team course with the help of practical assignments amongst the management training participants including their specific "home departments and digital responsibility areas":

– Technical competence to understand and assess how ownership should be established for new digital technologies and practices.
– Business experience to judge about the impact on existing and future digital business practices and analyzing the different forms of ownership around it (ownership for data, information, knowledge, engineering activity, digital model preparation, validation and verification, transfer and logistics to other users and customers, review and archiving, knowledge creation and fusion, etc.).
– Collective team ownership and split-up of responsibilities to ensure a consistent way of operational digital practice and the right strategic balance for the future.

- **Driving digital value creation and digital business benefits**

The strength of traditional successful engineering management is to oversee the situation, determine the performance and keep a good outlook. Based on these observations and use of management methods and tools, the future and the target of the future state can be determined, long before you realize it.

Unlike this traditional management approach, the existing way of analyzing, developing and driving Virtual Product Creation and its digital capabilities is not based at all on any solid *digital value* and *digital business benefit* theory foundation

or underlying *digital value creation* model yet. This makes it difficult if not impossible to synthesize and develop the appropriate justifications for new improved digital engineering environments.

In order to make enough progress in this digital capability dimension Digital Leaders in industrial management need to be trained to collaborate closely with research institutes. They are currently in the process to create industry compatible models for *digital value definition* and the alignment to corresponding *digital business benefit* models (beyond the traditional value stream analysis of the physical world). The author of this book suggests the definition of digital value creation as described in Fig. 18.5 and the definition of digital business benefits as described in Fig. 18.6.

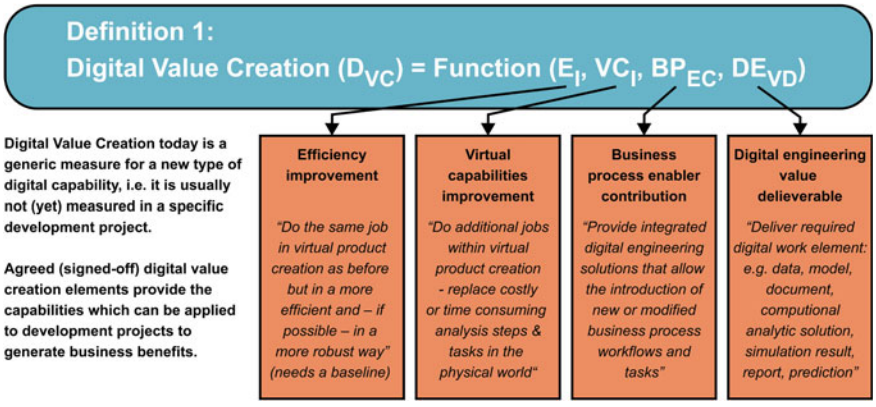


Fig. 18.5 Definition of *digital value creation*

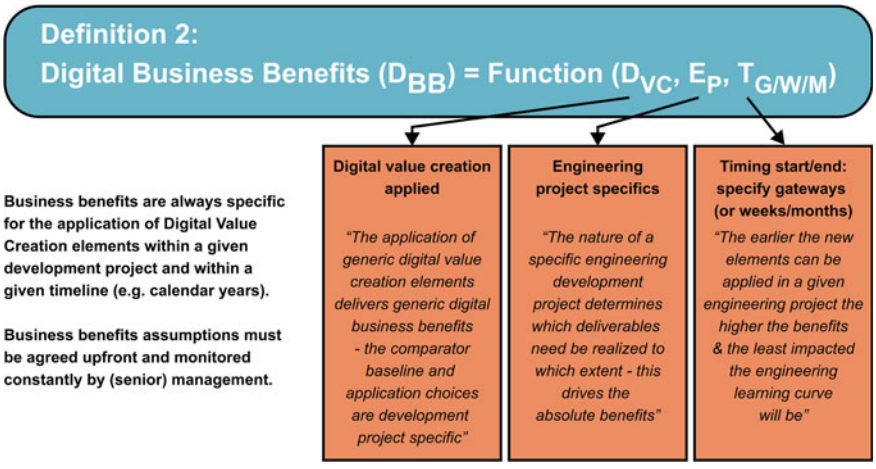


Fig. 18.6 Definition of *digital business benefits*

Digital value creation depends on the individual company specific absolute value factor "*digital engineering value deliverables*" that need to be assessed and determined first. Such determination does not exist in industry today yet. Based on this anchor element, additional relative factors such as "*business process enabler contribution*", "*virtual capabilities*" *improvements* and "*efficiency improvements*" come into play to increase or decrease the value. Whether there exists a certain time dependency drift (or not) in the generic core anchor element "*digital engineering value deliverable*" is still subject for fundamental research. No industrial standards exist yet for such digital value determination. Industrial Digital Leaders, therefore, need to apply their own skills to further drive such a digital value system within the various development streams of companies. The "*digital business benefits*", as second measurement scale, are built up on the "*digital value creation*" determined before, adjusted by the relative factors "*engineering project specifics*" and "*timing*" (usage related). Those foundational academic models Virtual Product Creation research can be now used to create first value assessments in industry in order to improve the understanding on how to drive digitalization.

- **Leading and managing digital transformations**

Digital Leaders in management will only be successful with a solid understanding of how to unlock the organizational rigidity and to drive changes in the business and technology culture. This new digital transformation capability becomes decisive as a personal and collective management skill. Training programs and respective personal education advisory are key to teach and train the new generation of digital leadership in building up and using the right leadership network to establish the targeted lobbying for systematic digital transformation steps. Leading for new digital set-ups and working activities require appropriate change management attitudes of managers. The personal motivation to drive and live the new digital value creation elements and to modify long lasting procedures of the traditional analog world into the new digital spectrum becomes essential. This becomes even more critical in order to convince the peers in middle management leading to a more transparent digital data-based management routine.

Cloning of the same character for a successful manager, as it was done in the past as part of the management cultures and associated management development programs in enterprises, is no longer the right approach. It leads to non-diverse leadership attitudes, which creates risks for broader digital mindset integration into business organizations.

Digital leaders in management need to embody a positive mentality and attitude, which clearly articulates opportunities and successful ways forward rather than pondering on pessimistic outlooks and preaching cautious ways of acting only. These new attitudes need to be learnt and practiced:

– Start with the positive message, the goal, the incentive, the aspired target, the motivation and explain the way forward on how to get there. Traditional professional management skills such as control, risk assessment and progress monitoring will kick-in as needed.

- Achieve a clear and precise explanation of digital elements, their need and their usage. Describe the digital transformation with specific examples from digital engineering workflows on the office and shop floor.
- Use the leadership instruments in meaningful ways: "give the right amount of cocaine, provide the right drug" (i.e. bring incentive and motivation into play), control the media with which you want to report about it in a responsible way and deploy "military and police" to help keeping order during the digital transformational steps.
- Deliver the right target setting for management and technical leadership in order to provide clear orientation like the ordinary Engineering Management is used to: e.g. in car development the product attributes such as vehicle acceleration from "0–100 km/h" in x seconds …, maximal weight of…, etc. Everybody needs to know the targets!
- Listen, understand, engage, support, judge and decide.
- Set-up ownership, trust and empowerment rather than check and control only.

Never start with only the pessimistic and trouble related picture!

- **Setting vision and mission for the digital future**

Establishing a clear vision and mission is essential to get momentum behind the digital transformation and digital future. Such vision and mission should not be too complicated. Both are important to convince all members about the way forward and the business rationale behind it. Vision alone does not makes sense without a mission how to accomplish it. Mission needs more explanation and most importantly a solid budget for its realization! Individuals, teams and organizations will sense this difference quickly and will follow pro-actively if the future perspectives have been cleared, especially in regards to the personal future circumstances.

Providing an appropriate period for vision and mission operations is essential. Allow for a minimum of 2 years, if not a minimum of 3 years in bigger organizations, avoid going beyond 5 years into the future (in Europe, America and Australia, in Africa and Asia longer time periods might be possible from cultural point of view but less from digital technology point of view!) Be mindful to allow for internal digital lab and pilot experimentation and experiences with new digital solutions (PMTI, i.e. process, methods, tools and information standards) in close interactions with specific business and engineering initiatives. Digital Leaders should always reflect on known dilemmas when they design the digital future prove out environment:

- Existing future evaluation approaches often just provide lab activities on synthetic use cases as playground to keep a safety net against failures ("do not make your hands dirty" in case of occurring problems and negative results")
- Companies would like to create fast moving digital islands with a kind of start-up mentality within their organizations but do not provide to them the right base financing to establish full technology solutions. Consequently, many new digital solution principles do not get scaled up within enterprises and might even gain bad reputation unnecessarily! Successes get socialized, failure get privatized…

Digital tool driven transformations and those solely based on tool migrations or harmonization are not sufficient at all to declare a new digital future! Digital leadership also knows how to avoid part time hobby type of digital transformation approaches (accounting for another additional 5% leadership objective task for the year).

New digital transformation programs need a solid understanding of the following two challenges and limitations of today's digital business in industry:

- The change of IT departments in industry: the core of IT gets step-by-step reduced to the core responsibility of running the infrastructure and the associated server and network utilities in a robust manner (operational service). For the transformation aspects, it becomes more and more critical that IT departments accelerate their work on enterprise architecture frameworks and interconnected data bases and lakes to be offered as scalable services to all functional activities in the organization
- New digital capabilities like data analytics (based on data science principles) and data engineering need to be established in the functional activities of engineering and business rather than in IT organizations (compare also Chap. 21). Today, this is usually not the case yet since new digital approaches are oftentimes treated as a skill or task in the IT department per default.

Every organizational change is accompanied by a certain amount of unrest in the beginning and, depending on the extent of the digitization, a decline in productivity of varying degrees until the new processes have become established (compare the examples given in Sect. 18.2). Management must be clearly informed about the advantages of the proposed digitization (cost savings, competitive advantages, securing the future ability to work etc., see also digital business benefits above) and need to have the certainty that digital business processes will not be disrupted during the changeover phase.

A parallel strategy with a demonstration environment in which digital business processes are mapped without influencing day-to-day business is helpful but requires extra efforts. In such a demonstration environment, the new digital work processes can integrate down to the last detail and finally it can be assured whether the digitization meets the expectations of the desired process optimisations, or just to a certain degree, or not at all.

It is also important for Management to be able to stop digitization projects at any time if the expectations are not met ("emergency exit") without causing damage to the day-to-day business. This is only possible in a separate and encapsulated demonstration environment. Such demonstration environment provides management the certainty of encountering few surprises during a changeover and of ensuring protected business operations. A step-by-step approach is advisable and facilitates acceptance by management and employees. However, once being started with the full rollout in production environments all preparations steps need to be finalized according to the staggered approaches shown in Figs. 18.3 and Fig. 18.4.

Reference

1. Sobek DK. Understanding A3 thinking: a critical component of Toyota's Pdca management system. Smalley, Art. ISBN: 9781563273605