Chapter 9
Product Development

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Product Development leads to the establishment of sales and production, i.e. new business ready to be exploited. Because the synthesis of sales system and production are closely related to product synthesis, the question of integration becomes central to this activity. For conceptualization this means added complexity of concerns and influences, and more generally that the complex organization of the product development should be established. We bring an understanding of conceptualization's relations to this complex organization.

9.1 Expansion to a Complete Company

Product development is the fourth module in our **Encapsulation Design Model** introduced in Fig. 5.8. Product development describes the linking activity that draws together market research, product synthesis, manufacture, and sales. In this

M.M. Andreasen et al., *Conceptual Design*, DOI 10.1007/978-3-319-19839-2_9

module user needs are actually satisfied. Seen from the conceptualization perspective, the aim of this chapter is to explore the organizational implications and procedures underpinning successful product development, and especially how they influence conceptualization. In particular we explore two major elements:

- Where is conceptualization positioned in relation to the product development process?
- How does product development influence conceptualization and vice versa?

Dissolving these points, we will emphasize the role of conceptualization in supporting integration. This is not only organizational but also intrinsic to the concepts and wider design process. This multifaceted role demands what we call dispositional thinking. We deal with this at length in Chap. 13 but here it is sufficient to understand this type of thinking as the ability to arrange the product, its realization, and its use activities to best satisfy the user and lifecycle actors.

Product development is normally used to describe everything from project initiation to product launch. This means that conceptualization is implicitly found in companies' procedures or scholars' models—often described as integrated product development. In this chapter we use this integrated model in order to better understand the link between product development and conceptualization (Fig. 9.1). This is achieved in three steps. First, Sect. 9.2 explores the **nature of product development**. Second, Sect. 9.3 identifies the **game rules for conceptualization** by explicitly splitting out conceptualization. Finally, Sect. 9.4 brings these together by explaining the organizational dimension that we call the **product development machinery**.

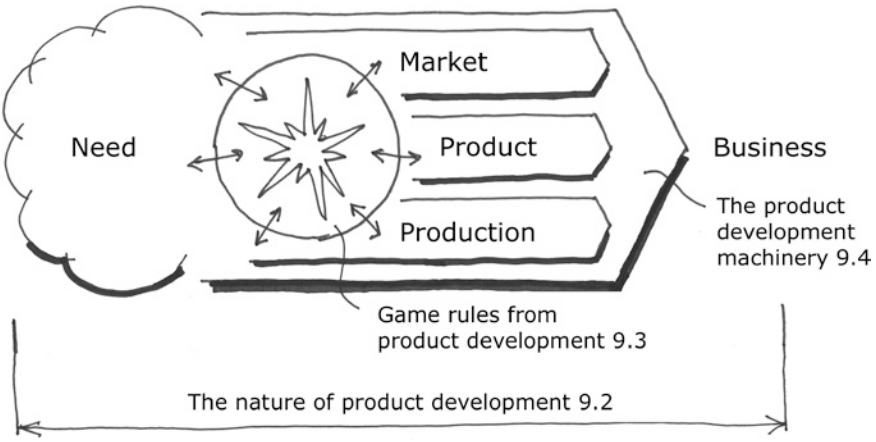

Fig. 9.1 The model of integrated product development used to structure the chapter

9.2 The Nature of Product Development

Broadly, new product development is concerned with the creation of new products. Here we refine this scope as follows:

> **Definition**: **Product development** is a company's activity associated with creating new business based on developing and launching new products. The activity is initiated by need and market research, as well as ideation, and ends with production, distribution, and sales.

In addition to new product development there is a range of alternative approaches to developing new business including copying products, buying patents, licences, designs or consultant support, and buying other companies. Although these can be lucrative, they are less concerned with conceptualization, hence our focus on product development. Here, product development is composed of elements incorporating both innovation and operational activities. Ultimately, in order to successfully produce and sell products the development activity needs to utilize knowledge from across a company. The complexity of this organizational perspective is illustrated by Hales and Gooch (2004) model of a development project as part of a much wider context. Hales' layered model of project context is given as an example of this in Fig. 9.2. Here, the core design activities are depicted as the vertical sequence starting with 'competition'. These activities are nested within six layers: design, project, management, company, market, and environment. This graphically depicts the many conflicting influences on the design activities and product development. In summary, the design process and the organization are fundamentally interconnected and need to be managed holistically if a successful outcome is to be reached. As such, this section explores how that can be achieved from a design perspective.

9.2.1 Integrated Product Development

In order to understand the advantage of thinking about product development as integrated with the wider organization let us consider disintegration. We have already discussed the many incremental steps towards specialization and departmentalization in industry. Here, manufacture can be achieved with almost no contact with development, or recycling with no contact to sales. When this type of disconnect occurs, we do not need to look far to find product and business failures. In order to combat this organizational disintegration, product development actively integrates methods and procedures such that relevant issues from all stages are taken into account during the design activity. This manifests in product development through the explicit integration of two other development activities,

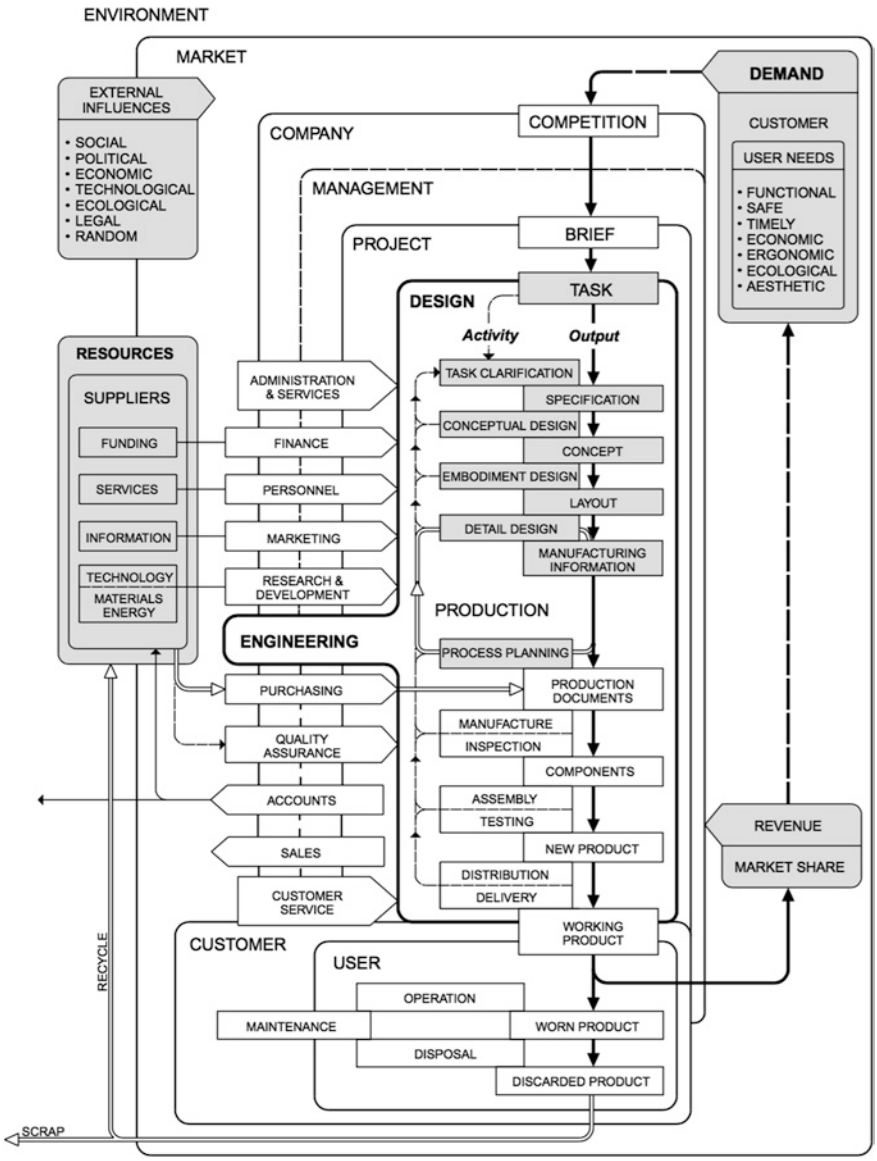

Fig. 9.2 Model of product development activity and organization in context (Hales 1993; Hales and Gooch 2004)

establishing the production and sales requirements or needs. Where these activities are fully integrated, the 'best' business result is possible. This is the reasoning underpinning the Integrated Product Development model advanced by Andreasen and Hein (1987) (Fig. 9.3). The model's terminology differs slightly from this book's terminology.

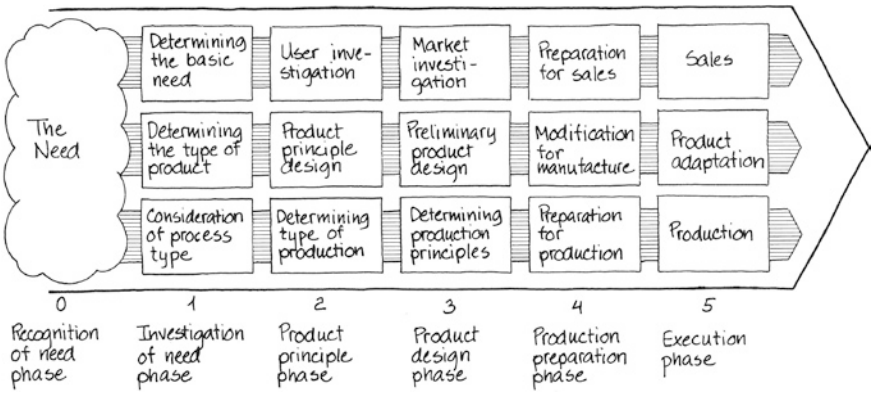

Fig. 9.3 An ideal model of integrated product development combing the three development activities: sales, product, and production, Andreasen and Hein (1987)

We see this model as exemplary in its clear progression and therefore use it as the basis for our explanation of product development. The model explicitly brings integration to the fore as a core part of product development where no one element can succeed alone if the best result is to be achieved. The model spans from need to execution and is widely represented in industry. The main virtue of this approach at a practical level is that it defines the roles of marketing and production in the early design phases, helps in aligning the milestones of each activity, and shifts the focus to the process as a totality where all aspects must perform concurrently.

9.2.2 Use of Procedures

There are many proposals for models of product development, comprehensively reviewed by Clarkson and Eckert (2005). These include descriptive models, e.g. Hales and Gooch (2004), prescriptive models, e.g. Cooper (1984), and combined models, e.g. Ulrich and Eppinger (2004). The models are widely used in industry, although for different purposes and in different forms. Here, model use can range from setting a common mindset to specific procedures. Such procedures typically form the basis for developing a project plan, as well as detailing activity and time plans. We have already introduced procedures in Chap. 5 but revisit them here in order to explore their use in product development.

Development project procedures serve several roles: they become carriers of best practice, they help transfer experiences from past projects, and they support more cohesive management across projects. In the organizational context they help to highlight input from marketing, sales, and production, as well as other specialist areas, such as finance, quality or environmental experts. This can facilitate the

distribution of electronic and mechanical tasks, the planning of special milestones associated with regulatory approval or the management of relationships with other companies in a network. In a company, procedures are usually thought of as universal and exceptions are avoided. However, as discussed in Chap. 5, to be most effective, procedures should be adapted to each project's specific context. Part of this adaption is tailoring the specific methods associated with a procedure. For example, one project may demand a greater focus on design for manufacture, while another may need more extensive ideation and coordination.

> A company's design procedures mirror its practice and should be tailored to the issues and context affecting the specific company.

An example procedure is shown in Fig. 9.4 from the company Bang and Olufsen. This procedure reflects changes made after a new development strategy, focusing on lead-time reduction, was introduced. The main adaptions from more generic procedures are the increased focus on prototyping and the reduced number of phases. In particular, the start of each phase is carefully managed with a critical review of requirements. Overall these changes reduced the lead-time from 127 to 72 weeks.

Of particular note in the Bang and Olufsen case is their recognition of the importance of concept definition and subsequently product design. This enabled them to more effectively judge project progress and plan the related organization processes accordingly. This key relationship between conceptualization and development is expanded on in the next section.

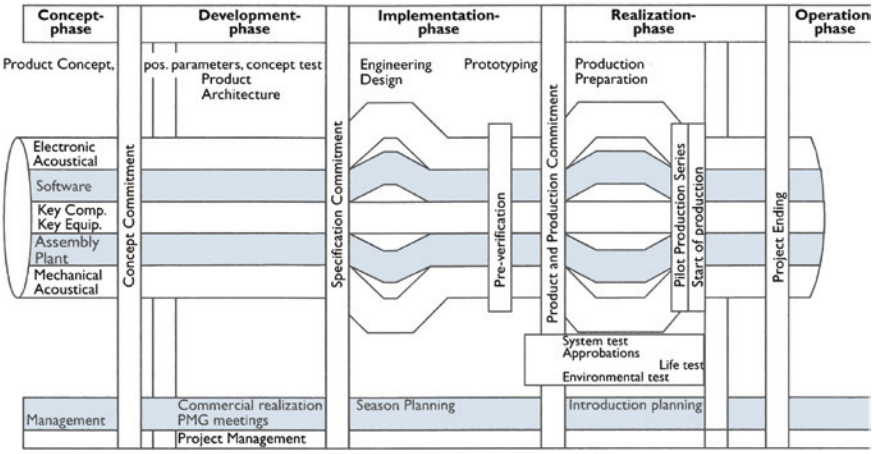

Fig. 9.4 Bang and Olufsen's product development procedure. *Horizontal lines* depict activities while *vertical bars* denote milestones (Kirkegård et al. 1996)

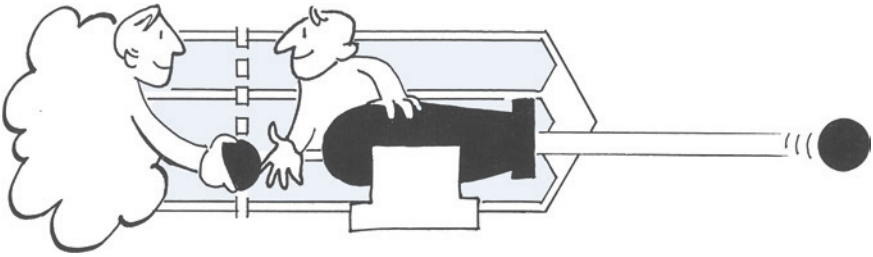

Fig. 9.5 Two product development cultures: ideation and execution (Andreasen et al. 1989)

9.2.3 Conceptualization in Product Development

Although it is typically advised that conceptualization be integrated into procedures, many companies resist this. Here, the decision to initiate a new project is considered so important and ill-defined that companies often prefer to isolate these 'front end' activities in order to reduce risk and attempt to ensure quality in the scoping work before initiation. This tendency leads to our description of two distinct activities Exploration and Concept Synthesis—each addressing one aspect of concept integration in product development.

Depending on how these activities are included in a company's procedures, two cultures appear (Andreasen et al. 1989). The first is an innovation culture where conceptualization thinking is fully integrated. This type of culture is characterized by its ability to create new business potential, address user needs at a low cost, create tractable concepts, and best utilize a company's strengths and weaknesses. The second culture is more execution- and sales-focused. Here, realization of the product is primarily achieved through production and marketing. As such, this type of culture relies on its ability to identify the basic idea underpinning a product and leverage this through marketing. Overall the focus is on cost reduction and optimization of overall work processes including quality and efficiency.

Both of these cultures provide advantages at different stages of the project and thus should be integrated as suggested in Fig. 9.5. For example, the first culture is poorly suited to logistical optimization while the second can stifle technical innovation. As such, design teams sometimes attempt to shift culture during a project, often through staff exchange and tightly controlled milestone reviews. Alternative structures include the use of specialist conceptualization teams who 'consult' on a number of projects. This conditional dependency between conceptualization and product development is one of the key rules when developing your product development game plan.

9.3 Game Rules for Conceptualization

There is a growing recognition of the huge influence new products have on the composition and operation of a company. As such, it is key that we understand these influences and the basic rules by which they affect a company. In particular, we seek to answer: how can management ensure a positive, successful direction? In this section we discuss the main 'rules' to be considered in the conceptualization and how they impact company success.

First, it is critical that a product's **identity** aligns with that of the company's wider corporate and design identity. This includes aspects, such as quality, service, and warranty support. Without this alignment new products can damage not just their own sales but the wider brand and perceived integrity of all the company's products. In particular this requires close collaboration between the designer, project manager, and top management. The major exception to this is where a company is specifically trying to change its identity through, for example, rebranding a new product. An excellent example of this type of alignment is outlined below in order to demonstrate the real world impact of these rules—when successfully employed they impact every aspect of a companies' operations.

Example:
The Philips corporate identity. A case in point is the way Philips manages its brand identity throughout their product portfolio. Philips is a large manufacturing company of products in the area of healthcare, lighting, and consumer lifestyle. Their corporate identity is focused on three core values (Philips 2013):

- Philips is a caring brand that puts people and their needs first.
- For Philips, innovation is the lifeblood of the company.
- At Philips, innovation is about making meaningful impact on people's lives.

The Philips brand identity is intended to be recognizable throughout their portfolio by Philips consumers and users and includes graphical elements, the products, and services that form the brand line, as well as communication in terms of photography and tone of voice. Philips uses the brand identity to "celebrate the company's longstanding heritage as a leading international technology company and reconfirm its passion for delivering meaningful innovations that matter to people", says Thomas Marzano, Head of Brand Design, Philips. For product developers who work in or for a corporate environment it is imperative to not only design to serve human needs, but to do so in a way that fits the corporate identity. Modern organizations want their products to be perceived as part of the brand and its corresponding values. This also works the other way around; through good design, products serve to express and communicate an organization's brand identity and increase its perceived value by the customer. Figure 9.6 shows Philips' humanized environments for a hospital's scanning equipment.

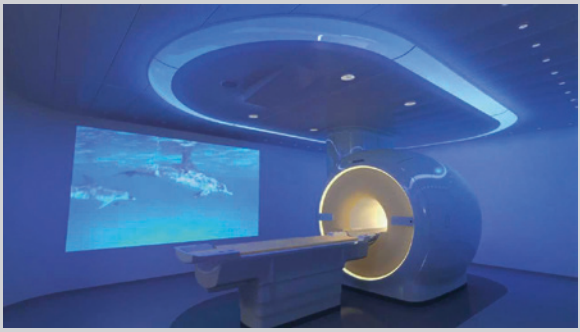

Fig. 9.6 Establishing a friendly environment for a hospital's scanning activities, Courtesy Philips Healthcare

Building on this, new product launches heavily influence the **strategy** of a company. As such, product development must account for the overall strategy it is contribution. This is typically characterized by the development of strong links between top management and the design teams. In practical terms, design teams bear a responsibility for understanding and addressing the strategic areas discussed in Chap. 2. This is particularly important with regard to market and production in an increasingly global product development domain. Closely related to this is **policy** alignment. Here, company integrity, goals, and performance are realized through direct action. These can include employee conduct, equal rights, and human relations considerations. In the context of conceptualization policies related to, e.g. branding, product testing, quality assurance, and supplier relations need to be considered as a core part of product development.

Finally, effective product development exploits a company's **resources** to their limits. Essentially, the ambition of new development should be to leverage the knowledge available in the company in order to outperform competitors. Bringing in external resources can also play a key role where networking or open source strategies are favoured. An important consideration here is knowledge management and the ability to monitor and adapt to changes in the technological state-of-the-art or developments by competitors. If this is effective, new innovation opportunities can be identified early.

Innovation not only concerns new products but also company identity, business, production, marketing, and sales. Product innovation can be an important driver for wider company level innovation and, as such, should be aligned with corporate strategy. However, this is a two-way relationship: strategy should inform development but at the same time designers and their managers have the responsibility to articulate new possibilities or potential innovations. This give and take is illustrated in the following example.

Example:
Organizational innovation. As part of a wider consultancy project Andreasen et al. (1989) developed a new approach for fostering innovation, illustrated in Fig. 9.7. This dealt with four main areas: the frames and surroundings, i.e. the company's situation in the market, legislation, etc.; the goals that the company wanted to achieve; the tasks that are currently executed or planned; the development system, where product development took place. The aim of this approach was to explicitly identify the interdependencies between these four elements in order to better align them with respect to the company's overall innovation strategy.
In order to realize the aim of improved innovation, four steps were proposed: *believe*, *is*, *should be*, and *became*. The first step describes the current 'official' picture of the company. This is labelled *believe* because the official picture is often far from reality. Here, this picture was developed from organizational diagrams and interviews with management. The next step focuses on establishing what *is* or the true picture of the company. This 'true' picture was built up by empirically mapping the surroundings, goals, tasks, and development system, based on analysis of current projects and interviews. Next, the *should be* step was used to define the ideal outcome desired by the company based on the previous analysis. This included the identification of key performance and product portfolio gaps. Finally, the *became* step closes the loop and acts as a measure of what actually changed in the company after the consultancy process was complete. Ultimately this process was widely used and resulted in three key conclusions:

- Diagnosis of company issues is possible through empirical analysis and offers a robust basis for proposing improvements to both the company and development system.
- The main management tools rely on alignment between vision and goals, which are then supported by specific, actionable tasks.
- Any changes to the development system should be associated with explicit measures so that the feedback and improvement loop is integrated in the development process.

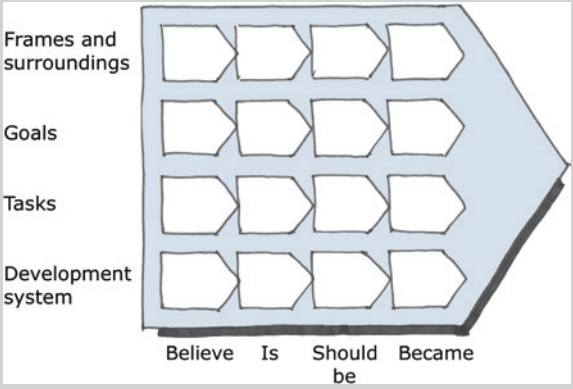

Fig. 9.7 Basic pattern for an organizational innovation process

Product life thinking focuses on alignment between new product development and product life elements including after-sales service, maintenance, and disposal. Although this sounds simple on paper, in reality the stakeholders later in a product's life are often unknown at the product development stage and thus significant care should be taken in considering these elements. We discuss this further in Chap. 13, but suffice to say here, product lifecycle considerations cannot be ignored in a successful development process.

Finally, the last factor we will highlight here is **integration**. This is both crucial and multifaceted—linking to all the other points in this section. Ultimately, effective integration and alignment of these factors is what makes or breaks a successful product development process. As such, this brings us back to the concept of integrated product development. In this integrated paradigm the designer plays a central role summarized in the following:

> One of a designer's key roles is as an integrator and aligner of design effort.

The 'rules' outlined in this section serve to guide designer's thinking when they are planning how conceptualization should be best integrated with the wider process and company organization. Integration is a challenge for the staging, not only on a team level, treated in Sect. 4.4, but also on the level of the whole product development machinery, which describes the tangible structure of the product development process.

9.4 The Product Development Machinery

As we have discussed throughout this book many parts of a company contribute to the development of new products, not just the development department. Instead the development function can be seen as an amalgamation of inputs as illustrated in Fig. 9.9a (Andreasen et al. 1989). These inputs can be further decomposed into seven distinct sub-systems as shown in Fig. 9.8b (Sant 1988) and summarized below:

- **Organization structure** defines the arrangement of tasks, responsibilities, and staffing.
- **Decision structure** links strategy, tactics, and operational decisions to the tasks to be carried out and the associated organizational units and results.
- **Social system** defines the formal and informal goals, norms, and values, underpinning staff's activities and cooperation.
- **Methods and tools** define the approaches used to complete the product development tasks.
- The **knowledge structure** collects and develops knowledge by connecting the internal and external knowledge sources used during development.

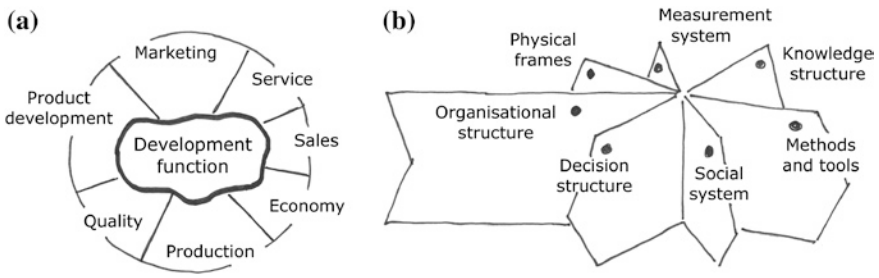

Fig. 9.8 A company's development function (**a**) and the seven sub systems in the development system or machinery (**b**)

- The **measurement system** is the means by which strategies, goals, and subgoals are monitored. This includes and integrates operations level key performance indicators.
- **Physical frames** denote the environment where the development activity takes place.

These seven subsystems form the 'machinery' through which product development is realized. As such, we now explore the implications of each one in greater depth.

The first subsystem to consider is the **organizational structure** as this is the core around which tasks and staff are arranged. In the context of a project, organizational structure is dynamic, changing as the company matures. For example, companies often start with an entrepreneurial approach before becoming more specialized as functions are split into decentralized divisions. Typical steps in business development are: introduction, growth, maturing, and liquidation. At each step there are certain high-level goals related to company output and competitive advantage that are reflected in its organization.

Traditionally, companies execute product development in the form of a project. This means that tasks are defined with respect to time and output, often in a cross-functional organization. A well-known example of this approach is the matrix organization; where the company's various functions deliver staff to teams that each has a project leader. A quirk of this structure is that staff often experience conflicting management between the function leader and the project leader. A number of other approaches are also found at different steps in company development. For example, experimental, opportunistic activities are more common in the entrepreneurial stages, while splitting research and development into specialist groups is usually adopted when the product is mature and optimization is the main driver.

Closely tied to the organizational structure is the **decision structure**. Decisions typically follow the formal hierarchy in a company and, as such, are closely related to organizational approach. The decision structure is what transforms goals and strategies into concrete plans to be realized as specific product development tasks. A strategy group or a product committee usually manages product development, while new products are dealt with by thorough product planning activities

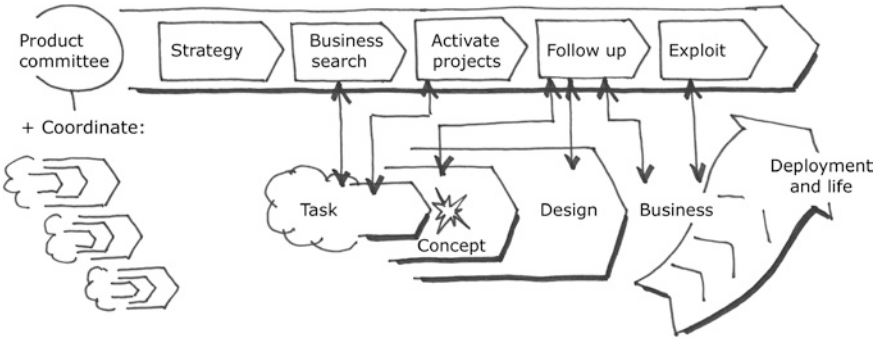

Fig. 9.9 The product committee plans and coordinates the development activities

(Andreasen et al. 1989). In order to support new product planning there is typically a following group (sometimes made up of top management) that is responsible for ultimate approval of concepts and launch decisions. A key concern here is in the effective integration of exploration and concept synthesis activities between product planning and product development. The relationship between these various bodies is illustrated in Fig. 9.9.

Although the formal structures outlined above play a core role in shaping product development, one of the most important sub-systems is the **social system** linking people. The social system describes relationships, competences, political power, and collegial networks in the company. These relationships are often invisible to outsiders and transcend formal role descriptions. The success of the social system is critical to effective performance and cannot be underestimated. For example, consider the shear volume of books written on company culture and 'winning' teams.

While the social system may dominate staff interaction, **methods and tools** dominate the technical aspect of product development. This is also true of models to a lesser degree. As we discussed in Chap. 4 these elements are inseparable from a company's problem solving approach and knowledge. Tools provide supporting procedures for engineering, integration, and management tasks. Methods and tools affect every aspect of product development from planning to environmental impact analysis. As such, they need to be carefully tailored to each project in order to be combined and executed effectively in the wider community of practice. In particular conceptualization is dependant on creative mindset, and communication tools.

The **knowledge structure** is a mental construct describing the knowledge elements of product development. This includes how knowledge is collected, structured, communicated, and utilized in development. It is not enough simply to store knowledge, if it is to be used it must be easily available, readily applicable, and concrete. In particular it is important to consider how knowledge should be articulated in procedures and methods. For example, in the conceptual part of new product development, application knowledge is closely related to a designer's awareness

of creativity in a tacit form. This is then transformed into ideas and concepts that can be challenged and assessed. In a company, knowledge structures are interrelated with organization structures, development approach (from scientific to craftsmanship), and with the marketing focus (from broad branch to customer insight).

Finally, all of these subsystems are in some way reflected by changes in a company's performance. As such, the last subsystem we will deal with is the **measurement system**. This is often treated as a simple measure of economic balances, frequently made with ridiculous precision in comparison the large number of elements not measured or controlled, e.g. development cost in relation to turn over, number of new products, and innovation. In this sense the vitality of a new product can be seen as a balance between the projects' business results in the first three years after launch, the actual person-hours used, the number of corrections to components or production, and the estimated production performance verses reality. Successful measurement takes into account both individuals' and teams' performance without losing sight of the overall strategic goals. In particular measurement should be used as a feedback mechanism for directing changes and ensuring that things are in fact improving. However, a word of caution is that measurement must always be considered holistically. For example, design influences all aspects of the product lifecycle. As such, using design-focused measurement might cut costs at the design stage only to incur serious problems in, e.g. product quality during production, resulting in extra costs exceeding those savings made during development. In the conceptualization context measurement is about alignment with strategy and the overall plan for innovation. This concerns the amount of effort to be invested in conceptualization activities and how the outputs of these can be assessed. This dimension is normally related to the goal formulation for the product but can be expanded to reflect the team's performance in order to account for more social dimensions.

Ultimately, the model shown in Fig. 9.8b should be used to develop a deeper understanding of the many factors influencing the successful progression of product development. However, the nature of the culture in each company will determine the magnitude of influence each element exerts on the overall process, e.g. a focus on strong staff performance measurement or the promotion of certain design support tools. As such, the designer must weigh these sub-systems against both the company and the type of product development to be undertaken.

9.4.1 Types of Product Development

In the context of conceptualization, the main aspects of product development we must consider are the types of concepts, products, and development projects we find in industry. In this regard we group projects into the three types described here for simplicity.

In the development of **new products**, often called innovative design, conceptualization takes the form of an explorative, experimental activity. This applies in both entrepreneurial and established contexts. Here exploration and concept synthesis are in focus and, depending on the situation, are augmented by product design and product development in the realization of the concept.

More usually a project will build on past solutions or technologies via **incremental design**. Even in novel new product development elements of this type of design are almost unavoidable, as all technologies build on some established elements in their realization (Arthur 2009). Here, the main challenge facing companies is in establishing a sufficient competitive advantage. This could be through product branding, reduction in resource use or in reduction of risk through the use of past partial solutions. In this context conceptualization requires insights from the existing product catalogue, company assets, and precise market information. Although these elements are needed to allow the conceptualization activity to remain targeted, care should be taken that creativity is not stifled. The key risk here is that product development becomes a non-reflective upgrade process of mindlessly customer-driven design, leaving no room for innovation or significant change.

The final type of project we deal with is the **platform-based design**. In the broadest sense platforms describe a common core from which multiple variants can be created. This core can be anything from a specific technology, key design principal or specific visual design. The main challenge in this context is developing a sufficiently innovative platform such that its lifespan is adequate to develop a range of products without being overtaken by competitors. Further, it is necessary to constrain the compatibility of new products to the common platform in order to reap the benefits of platform rationalization. This constraint must be balanced against the demand for innovation in the company. Here it is easy to lose sight of the platform's competitive power, when its dominant influence on the designer is constraining their work, especially where there is a conflicting demand for innovation. Thus communication and alignment of expectations in project execution are key.

Example:
Handpresso's development. Following up on the examples related to Figs. 3.8 and 7.1, we want to explore the established business. Nielsen Innovation is a consulting company, which decided to establish production and sales of their new product. In order to do this they established a network of producers and market organizations. The product was launched at a show in Milano 2008 and 300,000 have now been sold in more than 50 countries. The brand is supported by the basic innovative idea and by winning seven international design prizes. Today the company launches new products like their device for making coffee in a car (Fig. 9.10a). The inventor's approach to design is inspired by Leonardo da Vinci's statement: "Simplicity is the ultimate sophistication". Early in conceptualization the innovation company had the dream: A Handpresso integrated in a Swiss army knife (Fig. 9.10b).

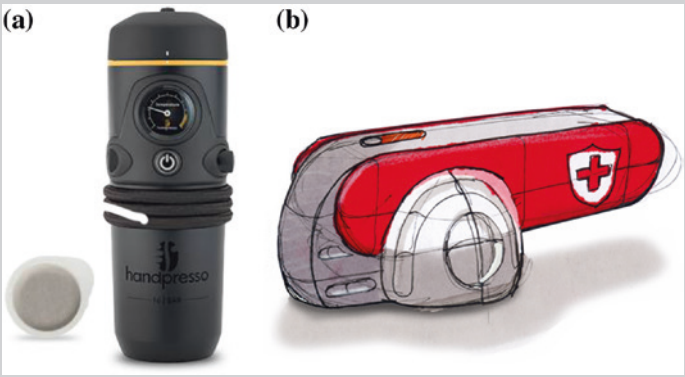

Fig. 9.10 **a** The new car espresso maker **b** The inventor's ultimate dream: a Swiss army knife with integrated Handpresso, *courtesy* Nielsen Innovation, France

Although it is beyond the scope of this book to further explore product development by its self, we do dissolve the question of how functions, properties, and dispositional reasoning can be aligned with these different types of development (Chaps. 11–13).

9.5 Conclusion

Product development forms the fourth module in our Encapsulation Design Model and has been extensively discussed in textbooks, such as Ulrich and Eppinger (2004). However, this discussion has had a tendency to focus more exclusively on product development's engineering aspect. As such, our view of product development, as part of a wider process and underpinned by conceptualization, takes a broader perspective, including those elements which 'cannot be engineered' yet are still inarguably part of product development, e.g. market, customers or sales. In particular, our view of product development coupled explicitly with the exploration and concept synthesis modules allows us to more fully explore the product life synthesis and the creation of products that are fit for life. In doing this our discussion of product development has focused on its wider relationship with conceptualization and the other aspects needed to tailor development activity for a product's whole life. In the next chapter we bring these elements together in the final module of the Encapsulation Design Model, Product Life Synthesis. This brings a product's lifecycle to the fore and explicitly integrates this with the design process.

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