Chapter 2
Change, Development, and Conceptualization: Setting the Scene

From a design perspective, our society is a result of the incremental development of numerous societal systems into a complex web over thousands of years. Societal and human demands are met by our efforts to develop new knowledge and technologies, and deploy these in products and systems. Our focus here is on this transition into products and systems via more or less industrialized design processes. In exploring this we take an 'onion peeling' approach to gradually dig down from the fundamental nature of developing societal systems to our final focus on conceptualization and design. We explore how the creation of influential, sustainable, and valuable products requires the designer to empathically and technically understand the wider societal context and consequences of their actions. Thus, we close this chapter by outlining the designer's role and challenges in this context, mirrored by what we see as the role of this book.

2.1 Describing Conceptualization: Peeling an Onion

In order to understand the role of conceptualization and the nature of concepts we must first take a broader look at our society and its development. In doing this we consider societal change, development, and innovation to better understand design, and thus conceptualizations', role. Thus, let us start peeling the onion (hopefully with fewer tears than in the real activity).

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Our society is characterized by numerous interacting and interwoven systems that support our life, industry, and development. At the heart of these (from an engineer's perspective) are complex technological systems that form the basis for new product development, as well as the context in which these products will ultimately be used. The dominant driving force for change in these systems is human need, curiosity, and ingenuity. This is reflected in the competitive nature of human civilization, with individuals, groups, companies, and states all vying to better their peers in terms of, e.g. esteem, power, safety or health. From a design perspective we can reduce these drivers to the more neutral concepts of '**need**' and '**intention**'. We do not mention innovation here because it is the result of development, not a driver for it.

Human design activity is the 'machinery' through which products are developed. This normally takes place in companies and relates to the creation of tools, products, equipment, plants or complex systems, all embedded in the wider context of the market, society, and the environment (Hales and Gooch 2004) (see Chap. 9 for more discussion and illustration of this idea). Here, products can be one-of-a-kind, variant, series or mass-produced. Thus, the market forms the basic arena for design, with economy as the frame, technology as the fuel, and the perceived need for innovation (tied to the fundamental drivers noted above) as the driver.

Although this industrial setting might seem limited, the heart of all design efforts is the kernel 'concept'. This articulates the core idea, the response to the need and intention, the proposal for the product's realization, and the process of creating new business and need satisfaction. As such, when we deal with conceptualization we deal with the core of all design activities.

Example:

Creating a concept. Two designers were tasked with generating new concepts for an insulin injection device (an 'insulin pen') manufactured by Novo Nordisk. Novo Nordisk sells insulin and related products to diabetes patients worldwide. As part of the treatment schedule patients must regularly measure their blood sugar level and inject themselves with insulin.

As a first step the designers defined the current need, technological, and market situation to create an initial mission statement: "*The need for discretion in injection and the device's appearance, as well as the need for easy storage outside the home, are fundamental elements defining a product's position on the market. The key means for satisfying these needs are: minimal weight and size, and reduced time and complexity of injection. These should be integrated with user friendliness and safety*".

In navigating between the company's existing products, competitors' products, and the designers' own ideas, a concept emerged from a combination of these. This was called the 'Minimalistic device'. It had the following characteristics as is illustrated in Fig. 2.1:

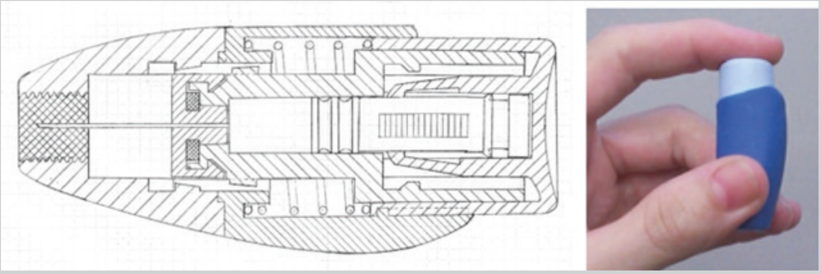

Fig. 2.1 *Left* Concept proposal for a 'minimalistic device'. *Right* Mock-up for showing the finger grip

- **Attributes**: a prefilled device with half the length of similar products, e.g. FlexPen®. The short length was achieved by detaching the dosing mechanism from the prefilled cartridge, which is now stored side-by-side.
- **Target group**: type 1 diabetic who needs rapid-acting insulin at his disposal.
- **Positioning**: small, low weight device that fits in a pocket and supports one-handed operation.

To allow themselves maximum freedom the designers separated their technical solution from the products' raison d'être, i.e. the *idea in* and the *idea with* the product. Here, the use activity is key to the patients and must be logical, simple, and safe.

- **The idea with the product**: discretion is satisfied by the small size of the device without sacrificing quality or safety in the operation and dosing.
- **The idea in the product**: the dosing mechanism is detached from the cartridge and dosing is achieved using the same mechanism as in the existing product.

Important questions for this concept (and in general) are: does it address the need, intention, and task, and is it tractable? In this case the designers felt the concept was satisfactory, although the assembly/disassembly required for use was not ideal. Other engineers at Novo Nordisk considered manufacturing, sales, and business perspectives to judge the concept. This resulted in mixed feedback and the concept was added to the company's idea bank but not progressed further (Courtesy of Jonas Mørkeberg Torry-Smith and Jacob Eiland).

Based on these considerations our onion peeling takes us through the following layers, illustrated in Fig. 2.2: **change and development in society** (Sect. 2.2), **knowledge and technologies** (Sect. 2.3), **industrial product development** (Sect. 2.4), and **conceptualization and design** (Sect. 2.5). Finally, we reach the core and explore the nature of conceptualization in Sect. 2.6.

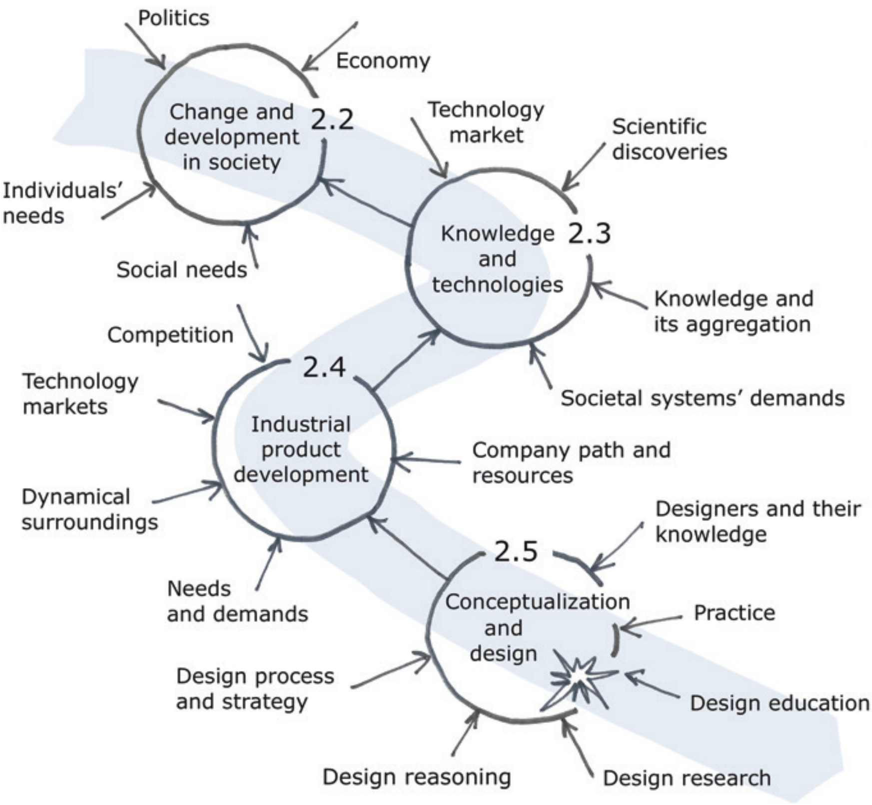

Fig. 2.2 From societal systems to conceptualisation and design in four layers

2.2 Change and Development in Society

In children's books we find exciting illustrations depicting the nature and complexity of our society's systems, e.g. Fig. 2.3. These show the 'anatomy' of our society with many interwoven systems supporting daily life and linking to larger systems such as trade, fabrication, finance, health care, education, transport, etc. Any new product that is conceptualized is based on activities and technologies belonging to these systems. Further, once the product is realized it will itself become part of these systems.

From this complex interaction between societal systems we can distil out a number factors relevant to design and conceptualization.

First consider **societal needs**. Typically societal systems are partially public, e.g. traffic signals, and partially private, e.g. cars. Public systems serve general societal needs while private elements serve individuals' needs. At the societal need level key drivers are societal necessity and industrial possibilities. **Individuals'**

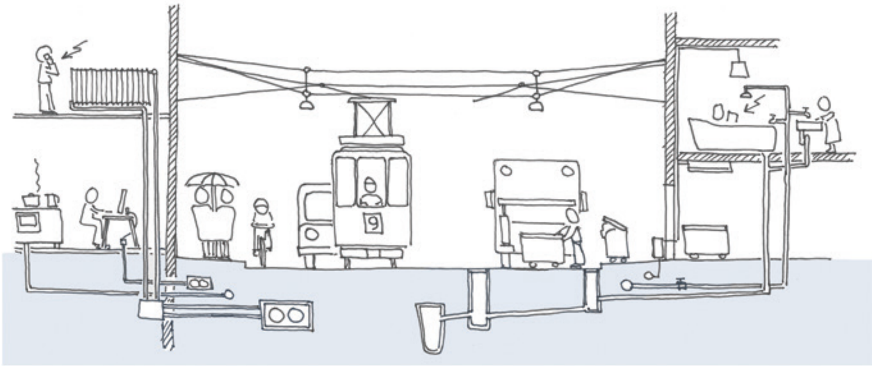

Fig. 2.3 A cross-section of a city street with communication, energy, and many other systems

needs, on the other hand, deal with how people live their lives in the context of the wider societal systems. This includes leisure, education, and all other personally important systems such as health, food, or media streaming services.

At a higher level still, all of these systems exist with respect to economic, environmental, and political structures. Here, **economy** defines how systems emerge and develop. In both large and small projects financing is a critical factor. Those involved in the development of new systems often experience economy as an 'iron ring' of limitations. In particular, designers are constrained by national economic considerations such as productivity, societal costs, and export value. As with economic factors the **environment** affects the scope of designers' activities. The pressure from a growing population, consumption of natural resources, and the damaging effects of human activity and need satisfaction are serious conditions that cannot be ignored. Further, as with all human endeavour **politics** affects how we realize our goals. Government and public institutions are involved in the creation and maintenance of public systems, and set the 'game rules' for societal and individual initiatives via legislation and regulation. Finally, consider **knowledge and technology**. Technologies are, on one hand, the machinery of economy, and on the other hand, the core of any societal system. Thus, the topic 'technology' forms the next layer of our onion.

Although these individual factors form something of a 'schoolmasterly' list interesting things happen when we consider the tensions between them.

Such a field of tension is *democracy, power, and knowledge*. The development of new systems and technologies is in the hands of companies deciding economy, politicians who formulate infrastructure and investments, and engineers and other carriers of technological knowledge. Ultimately, it is engineers and designers who develop and utilize technologies (Jørgensen 2008). However, it is by no means a given that these three entities will work together or are in line with what an educated citizenry might actually want or need.

Another example tension is *consumption, technology, and environment*. Since the 1960s, environmental considerations have invaded our consciousness. The explosion in technology and consumption of products has produced a situation where humanity is actively damaging our planetary environment and driving it rapidly towards unsustainable conditions. Here, technological development (and its facilitation of population growth, etc.) can be seen as a major contributor to this problem while at the same time posing one of the most viable solutions.

Example:
Social complexity and concepts. Right-turn accidents. Denmark is a country of cyclists (despite the less than Hawaiian weather) with a large percentage of the population preferring to cycle rather than drive. This has a positive impact on health and environment but comes at a price. The risk of being killed in an accident is five times higher for a cyclist than a car driver. In particular, the popular press has focused on accidents where right turning trucks cut-off and run over cyclists. There are about 50 such accidents per year and although the number is not large they have severe consequences for the cyclist, with about five cyclists killed annually.
Analyses of these right-turn accidents identified a variety of causes: wrongly adjusted truck mirrors, poor visibility, cyclists' behaviour, inappropriate road signs, and poor driving of the truck. The lack of a common cause means that it has been hard to effectively tackle this type of accident. However, because of their prominence in the press a private company arranged a competition looking for ideas to solving the problem. Over 1500 solutions were submitted, with the top three being: (1) to supply the truck with a light that activates with the right-turn signal and shows the truck's blind spot on the road, warning the cyclist, (2) to colour the cycle path where the cyclist and lorry's blind spot interfere, again warning (3) to automatically detect the cyclist's position in the danger area and alert the truck driver. These ideas were based on an ideal situation with responsible, considerate behaviour from all actors. However, in order to produce these solutions different actors must take responsibility and invest in them, e.g. in legislation for trucks or new training for cyclists. Key weaknesses are that not all trucks and not all crossings will be equipped with these concepts, and not all cyclists will understand them.
For the problem-solving, conceptualizing designer, balancing potential effects against investment is key. In particular, increasing the probability of positive effects and reducing negative effects. One example of a good concept, balancing these issues, is a Dutch proposal that builds on the idea of forcing the cyclist and truck into perpendicular positions for the right turn, as illustrated in Fig. 2.4.
The strength of this concept is that it clearly indicates its special design for right turns. Both cyclists and drivers have to be alert; neither have 'special rights'. However, the required investment is high and space-consuming, and has not yet been analysed for its efficacy in accident prevention. Further, to

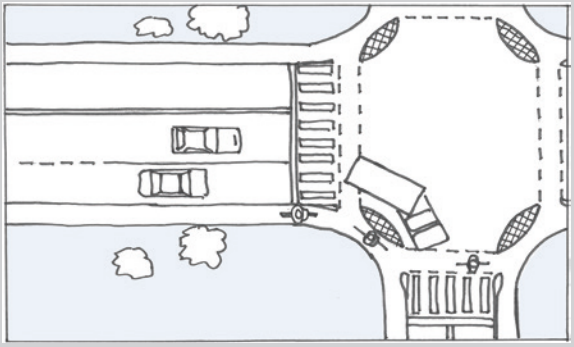

Fig. 2.4 A Dutch proposal for a lane layout to better position right turning cyclists and trucks

be a good solution, the stakeholders must accept it. In this context the proposal has clear advantages for cyclists and it is hard to imagine right-turn accidents with the new layout.

Just as in this case, real-world design problems are complex, with many actors and related systems. They are not clear: there is a need to do something but the diagnosis is weak, and the many actors have different value systems making it difficult to satisfy them all. Finally, for most actors it is easier if someone else solves the problem.

2.3 Knowledge and Technologies

Human knowledge is the result of cultural development and is composed of scientific discoveries, industrial advances and innovations, and human ingenuity and experience. Social and technological aspects are interwoven in a socio-technical totality, where a web of technologies orchestrates our daily lives. This makes us highly dependent on complex organizational, mechanical, and industrial systems. Underpinning all this are **state changes,** i.e. something changing from one state to another, often more valuable or practical. In Chap. 8 we discuss how state changes form the core of new product creation but it is sufficient here to acknowledge their importance.

We observe an endless number of natural changes: flowers grow, we get old, mountains are eroded, etc. In response to this, humans have used tools to intervene and bend nature to our will from our earliest history: catching fish, hunting animals, farming grain, building shelters and houses, using fire. Key to this human intervention is the use of tools or, more generally, **technology**.

Definition: A **technology** is a combination of material devices, procedural prescriptions, and intentions that are interwoven with humans' work and social activities, articulating and structuring humans' behaviour and life in society (after Jørgensen 2008).

When settlers moved west in the European colonization of North America they were dependent on that period's encyclopaedias, which for example explained the technology of soap making. Thus, our definition highlights the inseparability of the social and material realms, and points to how technologies define our lives. Ultimately, technology is executable; a device processes something, i.e. a state change happens (Arthur 2009).

Everywhere in the systems mentioned above we find technologies; agriculture, communication, transport, energy, health care, education, trade, and so on. Design aims to satisfy human needs but also takes its starting point in, is created by, and realizes its lifecycle through this web of technologies.

Technological development has its origin in science, is synthesized in design activities, and is managed through the technologies' deployment and service. However, it is also thought provoking to remember that many inventions are created without scientific insight. An example is the steam engine, which sparked the creation of new scientific fields to explain and optimize it, including thermodynamics, solid mechanics, fluid mechanics, and the theory of mechanisms. Based on this we might ask: what are the factors influencing the creation of knowledge and technology?

- **Scientific discoveries**: these are widely believed to be the main driver for technology development but in many cases industrial and entrepreneurial contributions are just as important.
- **Industrial development**: competition and market demand drives development and especially incremental change in the industrial sector. Many developments here are simply seen as new products despite actually representing new technologies.
- **Technology markets**: technologies have value and thus there is a market, need, and competition. Technologies can be purchased, licensed, or developed based on demand.
- **Societal systems**: developing and maintain societal systems drives a huge demand for new technologies. A 'good' example is our capacity for producing innovative military technologies.

Further to these, knowledge and technology development themselves provide a catalyst for further development. "*We hope in technology to make our lives better, to get us out of predicaments, to provide the future we want for ourselves and our children*" writes Arthur (2009). The real challenge in the development of societal systems and technologies is not the act of creation but to manage the consequences of our actions without shying away from new possibilities through fear or ignorance. Here, there are few objective truths and the risk of paralysis and shortsighted, partial decisions is high. As such, we have an obligation to understand our design efforts and their potential consequences but also to challenge the current status quo and develop new things. Thus, knowledge and technology are both the core of, and the means for, new product development.

2.4 Industrial Product Development

Industrial product development includes all the activities from ideation to launch, takes into account the whole product lifecycle, and incorporates the material cycle from raw supply to recovery and reuse. Product development describes a totality, independent of the type of product being developed, e.g. new, incremental or platform based.

In our onion metaphor the product development layer deals with a company's efforts where the following factors are key:

- **Needs and demands**: companies operate in arenas determined by their customer offering (consumers, public institutions, other companies) and thus face competition. Even a supplier of sub systems has to understand and respect the ultimate goal if they are to compete. As such, recognizing and interpreting needs is the main driver for new development.
- **Company path and resources**: typically, a company is largely determined by its path, i.e. its past products and experiences, and choice of new strategic directions. Here strategy should balance ambition, resources, competition and financial limitations.
- **Technology market**: technical knowledge and mastery is the fuel for product development whether it is available internally or brought in from the technology market.
- **Competition**: despite the many 'me too' products, competition drives companies to reflect on and strive for better customer-oriented features and qualities, for customization, and for more dynamic responses to the changing market.
- **Surrounding's dynamic**: all product types react to technology development and market changes through organizational change and striving to be agile and reactive.
- **Conceptualization and design**: the core of product development. These are the predominant activities in launching competitive products and thus form the final layer of our onion.

Based on these we can define product development from two perspectives, the user and the company.

Definition: Product development (user perspective) is the creation and launch of products with new or different functions and/or properties, which offer new or added value to the customer/user.

Definition: Product development (company perspective) is the use of exploration, design, manufacture, and marketing/sales to launch new, product-based business utilizing the company's resources.

Although products satisfy human needs these are not ease to observe, articulate or quantify. For the observer they are mental constructs based on interpretation of unsatisfactory situations. When products are developed their role as need satisfier should be predictable. Thus, the designer must be aware of new needs and need interpretations, and be able to translate these into the product and the business (see Chap. 6 for more).

Above, we saw the role of technologies and their relation to societal, industrial, and user's needs. Here, we see an **evolution** of general technologies in all systems, e.g. the increasing range of cars or efficiency of mobile networks. Similarly any single product also evolves, with contributions from different companies and occasional breakthroughs by innovative products. This gives a performance **S-curve**, through characteristic phases from introduction to growth and finally to maturity, where new technologies oust the old.

Companies' development processes normally follow a path or historical route paved by past products and technologies, and directed by strategic plans for the future. This builds on the, often incremental, steps between product generations, with reuse forming a basic building block for product development. However, judging a path's viability and redirecting via strategy are not easy.

Example:
Coloplast's path. Coloplast A/S is the world's leading supplier of intimate healthcare products (Fig. 2.5). The idea for core product area, ostomy bags, originated from a nurse in 1954: to attach a bag to the patient with an adhesive ring. The development included both Coloplast, at that time a plastic foil producer, and health professionals. The company's product development in this area follows a characteristic incremental pattern, where knowledge from every new launch is followed up and leads to innovations in materials, adhesives, and use. At the same time, the company grows internationally to develop sales channels, healthcare networks, and professional quality assurance. The company today is characterized by systematic development of networks and communication with patients, with the motto 'to create solutions that enable people to do more'.

Fig. 2.5 Ostomy product from Coloplast A/S and its production facilities (courtesy Coloplast A/S)

For each project the designer must understand its link to these evolutionary patterns or risk being left behind. We must answer: what is the history and evolution of the relevant technologies? Where are the company's products and technologies on their S-curves? What is the company's path in terms of history and future strategy? And finally, how is the progression of the project related to the changing perceptions of need and market?

Although we introduce product development as a single, well-defined phenomenon it actually concerns the design process, strategic reasoning and designers' skills, independent of project size. Further, project size, complexity, and cost all influence the organizational setting in which these activities take place. In order to deal with this we discuss three general types of product development in this book: **new product design** where there is little prior domain knowledge; **incremental design** where company path and gradual improvement are dominant; and **platform based design** where product family and modularization are key.

2.5 Conceptualization and Design

Finally, we come to the core of our onion: *conceptualization and design*. This is dominated by a number of factors that we introduce here and explore throughout this book.

- **Design practice**: the designers' knowledge, ability to learn and approach to design work. These are applied in the context of the task and project, and integrated to form a team's community of practice.
- **Designers and their knowledge**: the designer is the carrier of knowledge, competences, and skills. Ultimately progress comes from the designers' cognitive activities.
- **Design process, methods, and staging**: practice is structured by the use of methods and shared design processes, in conjunction with the designers' own skills. These are brought together in the staging, i.e. the coordination of a team's knowledge, tools, and communication.
- **Design reasoning**: creating new products takes more than just planning and design knowledge. Design builds on fundamental reasoning about functions, properties, and the final product.
- **Design education and research**: design is not a science but is subject to scientific study from which key insight and direction can be drawn (indeed this forms the basis for this book).

This short sketch of design sets the scene for a general discussion of conceptualization before we explore these elements further in specific chapters. In particular, we come back to our onion metaphor to highlight that each layer influences and is influenced by the designers' work, summed up in Fig. 2.6. Conceptualization links to and influences each layer, while also reacting their influence in the formulation of goal and task. Going forward we need to understand what makes up a concept and conceptualization, and where this takes place.

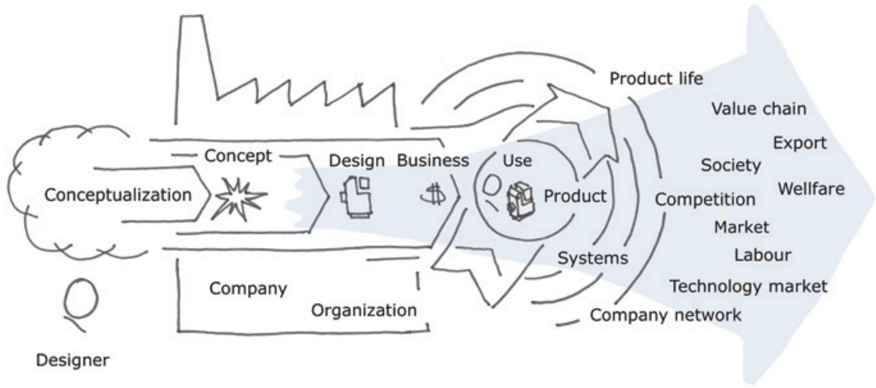

Fig. 2.6 Conceptualization and its influence/influenced by relationship with the wider world

2.6 Understanding 'The Conceptual'

A concept is an 'on the way' solution and thus partial and intermediate in its nature. Creating a concept is challenging because it must simultaneously answer the need and project goal, how the project can be realized, and combine multiple design entities. A concept mirrors the designer's understanding and interpretation of the design situation. This means clarity and precision in this understanding is critical because the concept is a point of no return.

2.6.1 The Need for 'The Conceptual'

Conceptualization describes the manipulation and combination of ideas. Concepts are at the core of a product, elucidating its utility and value. Thus, just as with a product, concepts have to be designed, drawn, and described so that others can understand and build on them.

Example:
Edison. Cartoonists' symbol for a creative idea is Edison's incandescent bulb. In reality Edison and his staff were the first product developers, using a systematic, professional approach to create not one, but hundreds of ideas and products. Fundamentally, Edison was a businessman, excelling at creating products from other peoples' ideas and inventions through experimentation and holistic thinking. One example was his experiments on adding sound to moving pictures. The concept was to record the sound on a steel wire and then (with difficulty) synchronize it with the pictures. Although rudimentary, efforts such as these paved the way for the incremental development of the modern film industry. Edison was so eager to test his idea that two staff members were asked 'to act'.

In everyday language ideas and innovation are almost overwhelmed with jargon and are imagined as almost mystical abilities in the popular consciousness. This mysticism and jargon typically drown out the majority of the actual work done in product development! As such, we focus on the real activities and design work that are responsible for producing new products.

> The challenge for **conceptualization** is to create products by rethinking or imagining new situations and needs, and subsequently to translate these into new products with functions, utility, need satisfaction, excitement, and leading to a new level of sustainability.

Our society is flooded with new products, systems, and services, all begging for our attention (and money). These can range from seemingly identical products to true innovations, with many seemingly superfluous. Thus, we must consider the argument for creating a new product, does it have a compelling reason to exist or raison d'être? A precondition for this creative argument is conceptualization and professional design work.

2.6.2 What Is a Concept?

Design literature traditionally talks about ideas, principles and solutions: **ideas** are sudden initial thoughts, imaginations or visions; **principles** explain how things work; and **solutions** address problems with utility and value. None of these words is useful for describing the proposals created in during design. Hence we must add **concept** to our design vocabulary.

The design process is initiated by need perceptions, intentions, and ideas. During the process there is normally a strong desire to stop and check alternatives and answer the following:

- Are these design proposals good answers to the need, intention, and task?
- Do these proposals differentiate us from existing solutions or lead to really new products?
- Do these proposals represent the best possible use of available knowledge and technology?
- Are they tractable in the actual organization?

A design proposal at this stage, able to answer all of these questions, is what we call a **concept**. Thus, concept selection is a bottleneck in the development activity, where concepts are considered from two perspectives: do they contain the right answer, and can they be realized?

Definition: A **concept** is a design proposal that is detailed enough to justify if it is a good answer to the task and intention, and show a high probability of realization and success.

This definition is **preliminary**. We need a deeper understanding of concepts' nature, content and function before we can define them fully at the end of this chapter.

2.6.3 Concepts in the Literature

Most authors refer to a design entity called 'concept'. In the widely used book of Pahl and Beitz (2007) the design process is prescribed as four phases: clarification of the task, conceptual design, embodiment design and detailed design. Here the concept is the final output from the conceptual design phase. This phase is made up of establishing a function structure, searching for solutions and combining them into variants. Finally, the best variant is selected to give 'the concept'. In order to call something a concept in Pahl and Beitz's world it must describe:

- Is the task clear enough for us to create a design from this foundation?
- Do we need more information on the task or context?
- Can we reach our formulated goals within the economic frame?

Although the concept seems to concern clarification of insight, it is defined by the design's characteristics. Pahl and Beitz (2007) recommend that designers "*examine very carefully whether novel or more suitable paths may not be open to him. To that end he should have recourse to abstraction, which means ignoring what is particular or incidental and emphasizing what is general and essential*". The output from the concept phase is a final concept variant, where the solution principle and key embodiment features are determined. At an even more detailed level French (1985) sees *a scheme* as the output from of the concept phase. This describes solutions for the main functions as well as for cost, weight, and the main dimensions to be determined. Similarly, Roozenburg and Eekels (1996) state that in the concept phase "*broad solutions are to be generated and evaluated to provide for a suitable point of departure for embodiment design and detail design*". Here, selection of concepts is based on criteria related to use, visual impression, production, etc. Therefore, we can see that concepts must be more than just principles.

All of these authors focus on the concept as a foundation for embodiment and detailing, while our definition sees the concept as both the answer to need/intention and foundation for a tractable design and successful launch. We also see concepts described as 'complete' solutions in a preliminary state. This is in contrast to our more open interpretation where concepts can be partial and related to the reuse of known solutions.

2.6.4 Concept's Relativity and Meaning

Concepts contain 'differences that matter', i.e. they are superior to existing products in some way. A strong, innovative concept is one that sets a new agenda, reference or trend: '*since the appearance of this product we wouldn't dream of returning to the old ones*'. However, the majority of new products are variants or incremental improvements, and it is normal for new products to be based on previous or competitors' products. Here, the basic need satisfaction, use activity, principles, and functionality are known. In this context a product concept need not be described fully in all dimensions because the involved designers can fill in the gaps based on past products or experience, Fig. 2.7.

As we noted above the hype surrounding 'innovation' leads to the belief that a concept should describe a new principle, invention or idea based on a new physical phenomenon. This is seldom the case in practice and is not necessary for innovation. Many design scholars use the word 'principle' to articulate a design's basic (technical) mechanisms. For example, there exist many kinds of corkscrew, with differences in the pulling mechanism or in the choice of materials, handgrip, etc. As such, users' experience and perception of goodness goes far beyond the simple underlying principle.

In our preliminary definition we focused on the concept as the designed, specified, and modelled entity. However, the observer's interpretation and perception are just as important. These bring the concept into a context and add value to it, leading to the following heuristic.

> The concept is not just in the device but also in the **meaning** users give to the device and the context they use it in.

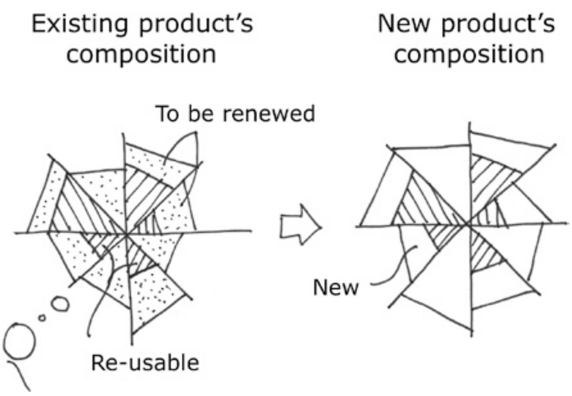

Fig. 2.7 A concept based on past products where the designer supplies the missing elements

Based on this we might ask: can we create a new concept just by bringing known products into a new context and establishing a new meaning? The answer is yes, although an established, successful product can lose its meaning and purpose when faced with a new or changed context.

2.6.5 Concepts' Composition

When a new product is launched several things can change. For example, new use activities are established that demand new systems and services, which lead to a new business strategy. When launched a product enters a unique lifecycle where it serves the user, creating several design entities: the product, new business, use activity, and product lifecycle—including several life activities (Hansen and Andreasen 2010). These are illustrated in Fig. 2.8 with respect to our Encapsulation Design Model. Each activity is an interaction between lifecycle systems, service, and actors. The use activity describes a cycle of activities in the hands of the user (see Chap. 10).

Central questions are: what belongs to the design project and what design entities need to be created? In the ideal world we would be able to manage every aspect of the task from company staging to resource allocation, sales, and distribution. Further, although the core result is the product and its use activity, we might also consider certain systems encountered during the lifecycle. The real goal of a project is to create a certain business result characterized by market share, customer identity, time span, or sales income. Thus, when companies strive for innovation they often innovate in multiple dimensions. For example, they might shift to a service business, change their product assortment accordingly, and create a new service delivery strategy.

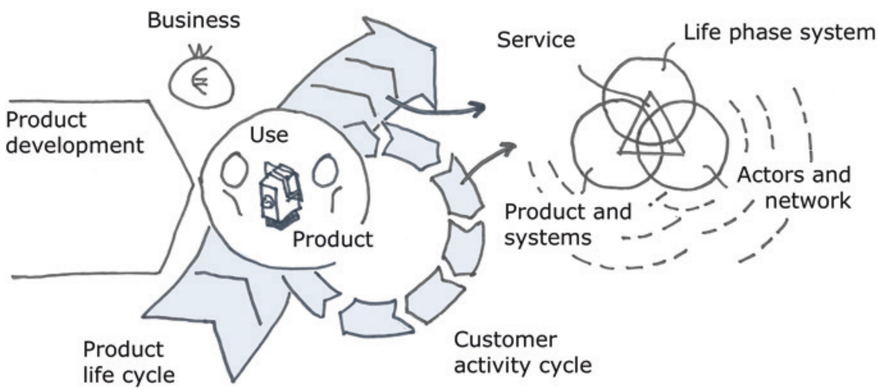

Fig. 2.8 Product development leading to various design entities

Innovation can point to a wide range of dimensions, not just in the product.

In Fig. 2.9 we illustrate a certain totality of design entity dimensions with respect to management, product planning, product development, and lifecycle concerns. Development projects can cover one or more of these dimensions. Although our focus is on new product development projects, in reality it might be relevant to create several developments in parallel with the product. Figure 2.9 shows an example plot for a project with rather substantial innovation activities. From this we can see that when we discuss what belongs to the design project we must consider this meta level, i.e. the level at which we get a complete picture of what needs to be innovated.

A product design activity is often followed by several other innovation activities; the designer needs to consider a **meta-level view** to identify and integrate these dimensions.

These development dimensions both influence the design activity and are influenced by the design/concept. We treat these alignment aspects in Chap. 13 on dispositional reasoning.

2.6.6 Product Concept or Just Concept?

Product development projects contain many different conceptualized entities (Olesen 1992). At the core is the **product concept**, created early in the design

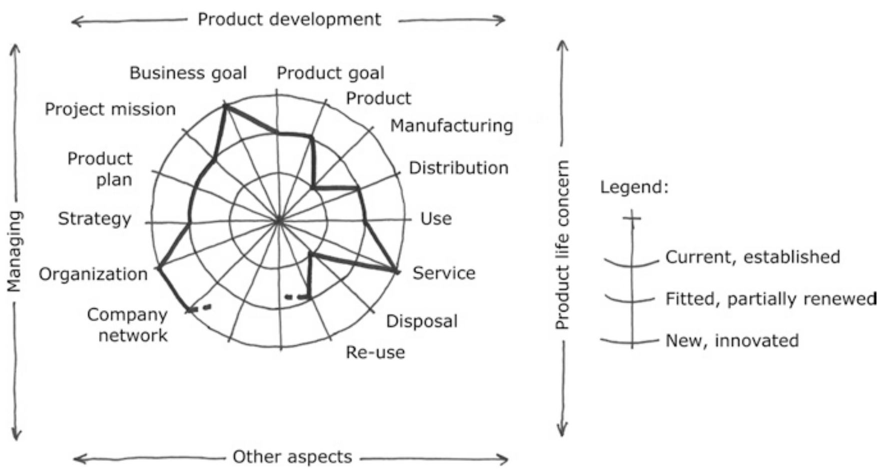

Fig. 2.9 Dimensions and levels of development related to industrial activity

activity and characterized by function, use, utility, and the actual design solution. The background and reason for the development project (and the product concept) comes from a **meta-level concept** that has been perceived or developed at a higher level in a company or organization, e.g. a new business idea concerning market, manufacture, and finance. The actual project may be one component of this meta-level concept. Finally, the product concept is normally composed of **partial concepts,** i.e. concepts that form part of the argumentation for the product and its realization, e.g. product structure, supply, production, distribution, sales, and use. The conceptual core can be linked to one or more partial concepts. This apparent expansion in the use of the word 'concept' should be understood broadly.

> A product concept's **argumentation** might rely on its own basic idea or on related partial concepts (dealing with, e.g. ideas for realization, distribution, and lifecycle).

When we discuss the flow and logic of the design process (Chaps. 5–10) we will further explore the product concept's composition.

> When creating a concept it is important to remember how it can be **composed,** i.e. combining both meta-level and partial concepts related to the product's composition.

2.6.7 Summing up Concepts

The idea of composing concepts might give the impression that they are simply jigsaws to be assembled. However, life is not so simple, their composition is dependant on many factors. One dimension highlighted by Andreasen and Hein (1987) is **clarification** of: intention and goal interpretation, need, user behaviour, application, competition and market, available technology, and knowledge. This clarification is related to the arena of conceptualization.

Another dimension of knowledge is the insight related to the product. Initially the product is based on assumptions concerning functionality and properties, its ease of production and assembly, and its reliability and robustness. The design activity should lead to factual insight into these aspects, outlining technological concerns as well as the risks associated with launching the product.

Although ideas are popularly thought to be valuable in and of themselves, this is not the case in reality. The value of an idea is dependant on its ability to deliver. As such, ideas need conceptualization to create value. This value grows as the product is synthesized and prototypes produce justified functionality and properties. A characteristic example is patents. Patents can describe solutions with no justification in the real world; instead they are built on imagined applicability and importance. Thus, once a patent has demonstrated its applicability in the hands of a producer its market value is increased.

The **arena of conceptualization** is the complex of evolving systems and technologies that serve our society. Our onion metaphor points to design as the core of innovation and development. In order to ensure vitality and value in the design activity we have to focus on the kernel: the concept. Here, the aim is to *ensure you are doing the right thing based on valid understanding of the need and the effects of the product*. **Conceptualization**, the nature of the product to be designed, and the nature of the need to be satisfied, points to the requirement for ideas and the combination of meta-level, relational, and sub-system concepts. Here, the aim is to *ensure you are making the best use of knowledge to create the best possible product*. Together, these point to a designer’s dilemma: how to balance efforts to clarify the arena and efforts to create the product? Based on our discussion in this chapter we are now able to go a level deeper in our definition of a concept.

Definition: A **concept** is a proposal for a product’s composition and issues that is detailed enough to justify it as a good answer to the task and intention. Further, the task and intention are justified with respect to the conceptual need satisfaction and the knowledge required, i.e. the probability of successful realization, need satisfaction, and success in the widest sense.

Note that this definition highlights the arena, the concept itself, and the knowledge accompanying the concept.

2.7 Conclusion

This chapter has led us through a breakdown of society’s systems to this book’s focus: conceptualization and design. Understanding ‘the conceptual’ means rethinking or imagining new situations, needs, and possibilities, and accepting the double task of clarifying the situation and conceptualizing the design. This leaves the question: how do the designers see and experience their situation? We will approach this by first explaining a brief history of design to give a foundation for understanding the rest of this book.

2.7.1 The Designers’ Situation

The designers’ role and situation have changed radically since the days of the lone craftsman, where one person cared for all aspects of the design and sale of a product. Today we face disintegration: design is separated from production, marketing, and sales. However, the designer still retains their key integrating role. Cantamessa (2011) describes this progression in three major steps, illustrated in Fig. 2.10:

- **1969–1979**: Fig. (2.10a) the ‘Fordish’ era toward the end of the ‘American century’ of innovation and technological enthusiasm. Products were feats of engineering and/or aimed at mass production in large, integrated firms. The Fordish paradigm of mass production and mass consumption is coming to a close.
- **1979–1999**: (Fig. 2.10b) the customer-centric post-Fordish era where products compete to win customers’ attention and money. A new paradigm emerges: design is focused on the customer and their perception of the product.
- **1999–today**: (Fig. 2.10c) the ‘yet to be named’ era where firms move from supply chain to ecosystems, from products to systems, platforms, product-services, business models, and policies. This again moves into a new paradigm where the customer and innovator are blurred.

The message we draw from this progression is that we face an era of design where a designers’ tasks are immensely expanded in scope and challenge. These point to key features of future design situations (McAloone et al. 2007). Design is becoming a **globally distributed** activity, with the attendant temporal, spatial, and cultural challenges. In this context, designers are increasingly expected to show **social responsibility**, taking into account sustainability and ethics, and requiring the designer to understand both **lifecycle** and **product**. Building on this holistic understanding there is also a shift towards **services** as key deliverables, not just products. Ultimately, these expanded responsibilities require designers to understand the context, complexity, and business potential of their and their colleagues’ actions.

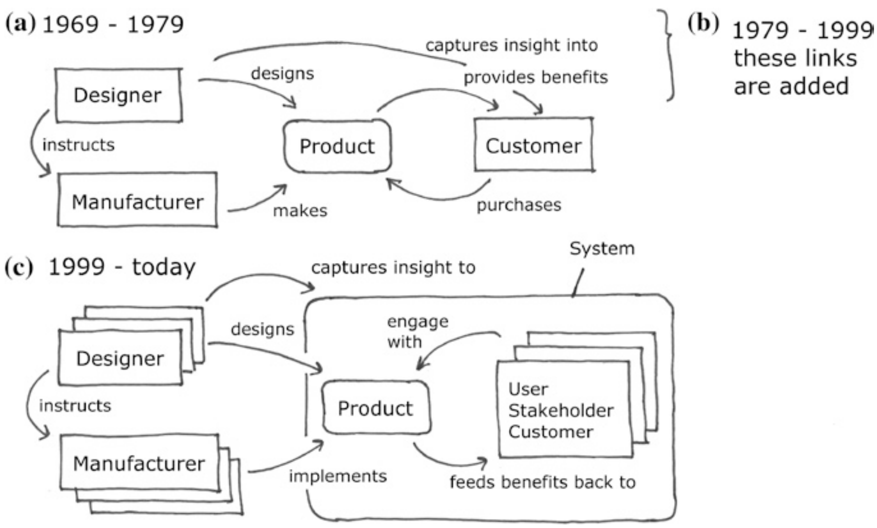

Fig. 2.10 Three phases of development in the twentieth century

2.7.2 *Needs and Challenges*

This progression in the design landscape and our initial discussion of conceptualization reveal a number of **needs and challenges** for the design practitioner, which we seek to address in this book. In particular there are **specific needs** related to the three groups of readers and their situation. In **design practice** methods and reasoning are becoming ever-more complex, with reliance on computer support always increasing. As such, there is a renewed need to better understand the logic behind design thinking and design practice. In **design education** diversity of design fields is a significant problem. As such, we go back to the core of all design, building on fundamental design reasoning and conceptualization (Andreasen 2011). Finally, in **design research** there is a similar need for consolidation and support in applying research to practice (Andreasen and Ahmed 2006; Andreasen and Wallace 2011).

In **conceptualization** key challenges stem from handling the many composed elements related to need, context, intention, possibilities, etc., which all feed into the 'good solution'. This can only be tackled by reasoning about functionality, properties, need satisfaction, and value across the whole product lifecycle. The challenge for the **individual designer** is to balance the demands of structured planning and methods against the individual and team's efforts to: **stage** the design activity to best realize their abilities, knowledge, and creativity; '**design the design activity**' to best realize strategy, procedure, and creative effort; maintain **creativity** and personal, entrepreneurial goals; and maintain **transparency** with respect to ecological, ethical, and legislative demands.

2.7.3 *From Here*

Bearing these needs and challenges in mind, and considering the fundamentals of conceptualization described in this chapter, our next step is to look at how we might answer some of these issues. **Part II** takes us into **the design machinery** where we will explore the designer's competences and skills, the staging of the design activity, and the creation of new products.

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