

Yes, Archimedes' Principle can be used to find the density of a solid object as well as a liquid.


Design Handbook

A Methodical Framework

Wim Zeiler

First print



 Noordhoff Uitgevers

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First edition

Noordhoff Uitgevers Groningen/Utrecht

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Preface: from methodical design to integral design

In the educational sector, a lot of emphasis is often placed on the conceptual architectural and less on the constructional development of a particular design. However, it is also of great importance to provide knowledge on how you can achieve building a design in the best possible way while ensuring it really provides an optimal solution for the given design task. The process of achieving a good design includes the consideration of a number of aspects such as, usability, feasibility, sustainability and energy issues. The use of a design method makes the design process systematic, integrated and transparent, and therefore with significant less risk.

The described methodological approach is based on the work of Prof. dr. ir. HH van den Kroonenberg (professor in the field of Design and Constructional Engineering 1972–1991, Faculty of Mechanical Engineering, University of Twente) and the additional work by ir. F.J. Siers to promote these ideas. Further parts of text by Dirk-Jan Verheyden and Steve Landuit were used for the chapters on value analysis and design for X.

As a design novice, you will be introduced to a methodical approach of designing. You can then judge for yourself which components of the methodical design process are useful for you and which are less useful. Methodical design leaves room for an individual design approach that every experienced designer has developed in practice. For experienced designers, the book is intended as an overview of methods and structure in support of their skills, and least of all as a mandatory process.

The advantage of the design method described here is its ease of use, allowing the reader to use the described methods systematically and realize the design tasks, even if they are completely new. It also provides room for you to develop your own approach and apply this effectively in new situations. During the design process, you will create an overview of the areas that could be studied and investigated, helping you to expand your knowledge. That way, you will gain more insights into how the different disciplines are interconnected. Methodical design can certainly not be seen as a prescription or recipe that always ensures a good design. Success is not assured and depends on many factors. Nevertheless, it does provide a solid, systematic and intelligent way to proceed, which increases the chance of successful completion of the design process more integral.

Oosterhout, spring 2017
Wim Zeiler

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Introduction

The future will bring us many challenges concerning scarcity of raw materials, food, water and a healthy environment. With this in mind, it is important that new products are designed in a different and better way. Hopefully the new generation of designers will be better equipped to find the solutions needed in the tension between the economy on the one hand and sustainability on the other. This means that the new generation of designers has the key to the future.

‘Sometimes it falls upon a generation to be great, you can be that great generation.’

— Nelson Mandela, 1918-2013

Make use of unknown possibilities, find new paths. Leave the beaten track, because you will only slip. Accept the challenge to find the good out of the infinite number of possibilities. Perhaps this book can help you.

Structure of the book

Design Handbook contains fourteen chapters. The book starts with a chapter on why, what, when and how regarding design. Then, in chapter 2, a part of the history of design is described as an introduction to the description of the methodical design process in chapter 3. ‘Methodical Design’ consists of four phases: these four phases are discussed in Chapters 4 to 7, followed by a chapter with examples (Chapter 8).

At the beginning of each phase chapter, the main structure is always outlined first, after which the different steps of the relevant phase are discussed in paragraphs. Actions and tools that can be used for this purpose are mentioned in a scheme for each step. Examples are shown in Figures 0.1 (main structure) and 0.2 (scheme of one step).

FIGURE 0.1 Example of the main structure per chapter

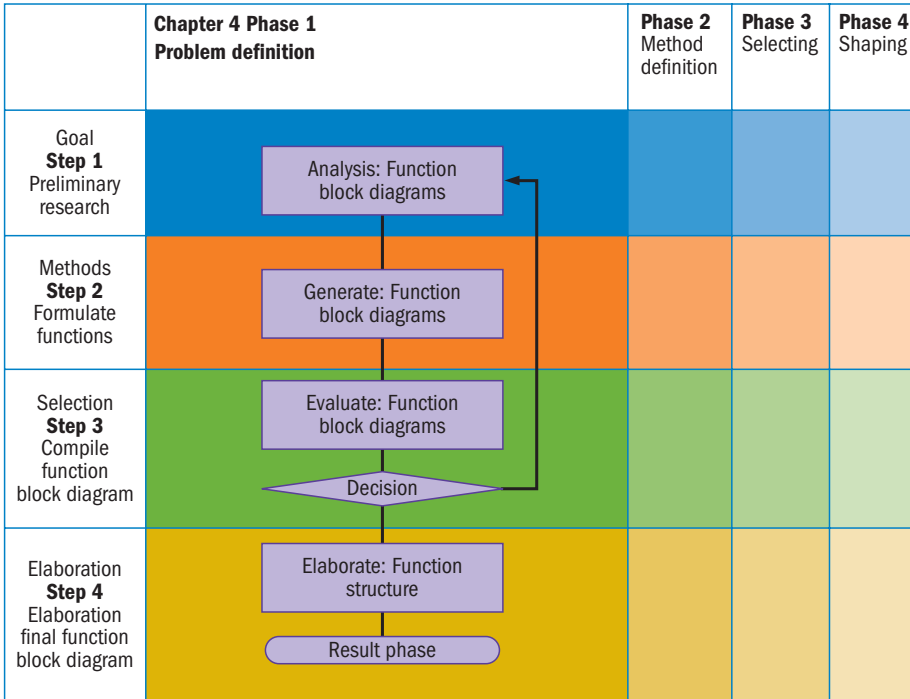
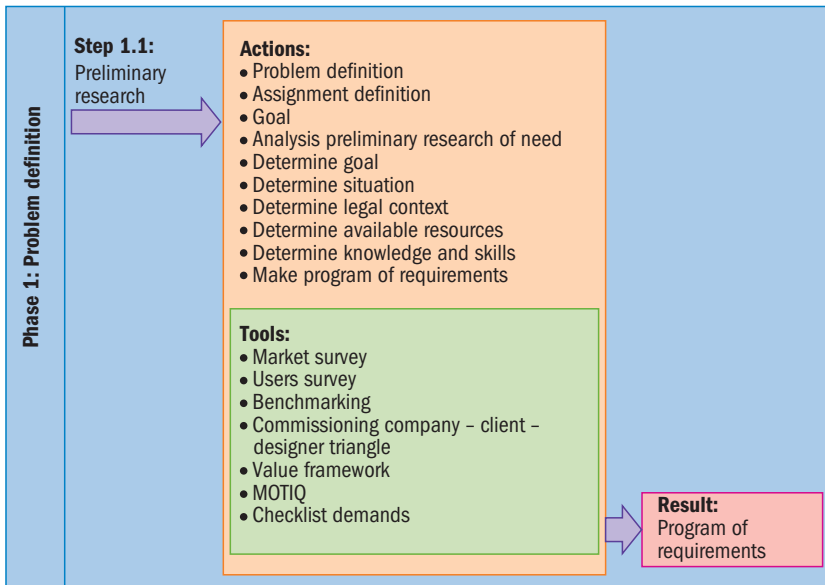


FIGURE 0.2 Scheme in step 1.1 Preliminary Study



Following the four phase chapters and the examples in Chapter 8, there are five theme chapters. These chapters provide you with additional methods that you can use within the framework of the four-phase model of 'Methodical Design' and help you to go through the process of objectives, solutions, selection and elaboration to achieve an 'Integral Design'. Finally, Chapter 14 provides you with a method that approaches designing in a completely different way and could, perhaps, be a new direction for the future of designing.

Each chapter begins with a list of paragraph titles, a list of questions that are answered in the chapter and a brief introduction of the content.

Using the book

You can use this book in several ways:

- a chronological
- b get started immediately
- c start with methodical design
- d as a reference

a Chronological

You will first read about design and its importance in history. From this context, you will learn about 'Methodical Design' and you can make this method your own by studying the four chapters explaining each different phase and the examples in Chapter 8.

After you have made 'Methodical Design' your own, you will discover other methods in the theme chapters. These can further assist you in any phase.

b Get started

You will start designing and try to set up the design process using the examples of Chapter 8. If you get stuck, you can refer to the relevant phase chapter for more information and background.

c Starting with 'Methodical Design'

After reading Chapter 3, you will start on the four phase chapters and the chapter with the examples (Chapter 8).

d Use as reference

Once you have made the method of methodical design your own, especially the theme chapters offer you a good overview of other supporting methods with specific themes, such as formulating an objective, generating solutions, selecting techniques, the elaboration and the 'Integral Design'.

'The world is getting only more complex. Entire industries are undergoing seismic transformations wrought by technology, global economics forces, and a host of cultural factors. Designers are becoming central to addressing the large, ambiguous problems of our time. Whether the arena is health care, economic development, learning, or public policy, design methods are helping solve seemingly impossible problems.'

— Patrick Whitney

1

Why design?

- 1.1 The economic importance of design**
- 1.2 What is design?**
- 1.3 Social relevance of design**
- 1.4 Gaining knowledge through research**

Anything used by humans that does not naturally occur in their environment has to be designed. Designing is very important in the development process of humanity: it stimulates the creation and actual development of complex objects. Design and the actual creation of an object were initially interconnected and later they became more separated, turning design into a specialized craft. Section 1.1 shows why designing is becoming increasingly important.

While everyone understands what design is, a consensus definition is however difficult to obtain. Therefore, there are many definitions and descriptions of design, which are often focused on specific aspects of design. Section 1.2 provides some definitions of design and explains the development of the definition of 'design'.

In section 1.3, some of the major societal challenges and needs associated with design are discussed; it is important to consider your role and responsibility as a designer in the development towards a more sustainable society. Section 1.4 describes briefly how you can gain more knowledge to improve your designs through research.

1.1 The economic importance of design

It is important to continuously strive for improvement: cost-effective, sustainable and better products and services. The design process is the core of the entire development process; this is where functionality, manufacturability and economic feasibility are united. Some design methods are developed to support design processes or possibly improve them. Important are:

- improving product design; in terms of usability, functionality and life cycle sustainability
- improving implementation process; in terms of manufacturability of the product
- improved design process; resources and time to make the design

Innovation

There is also a trend towards developing entirely new things: Innovation is a vital necessity for businesses and organizations. Dutch companies cannot compete just on the basis of price. Wages are much lower in other countries and our high productivity is almost achieved by others. Knowledge competition is becoming increasingly difficult because knowledge is easily accessible through the Internet. Economic growth must therefore arise from other added value.

Organizations can differentiate themselves from their competitors by introducing the use of creativity with new products, services or processes that are preferably not easy to copy. Dutch companies can only permanently distinguish themselves by constant innovation. Therefore, creativity is seen as a fifth factor of production, alongside knowledge, land, labor and capital. Actually a new creative age is beginning, a period of increasing and fast innovation. Design is the key, because there is no innovation without design!

Innovation

It is good to take a closer look at what innovation is because there are different definitions. Innovation can be defined as:

'Successfully coming with something new.'

— P. Jes, 1978

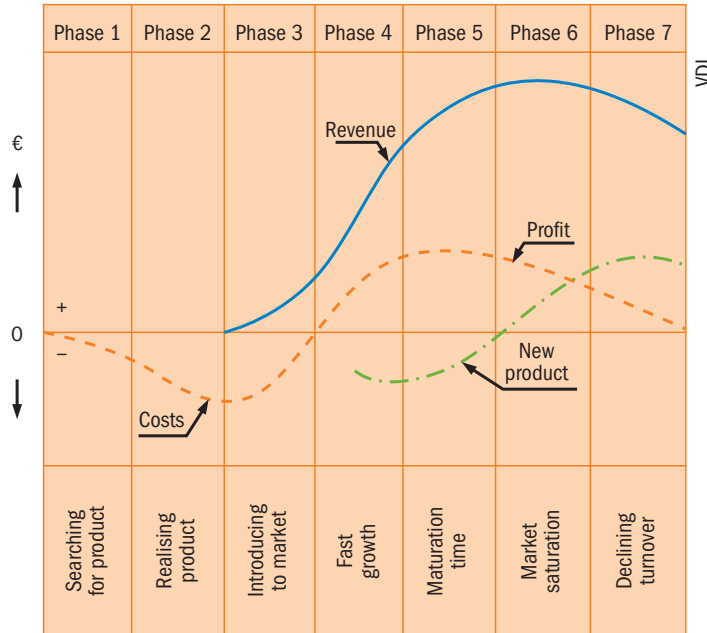
It sometimes seems that innovation has only recently become a trend, but according to this definition it is a subject that people have been aware of for a long time. The difference is that the importance of innovation has only become apparent in the last couple of years.

Life cycle

For companies and organizations, it is important to constantly come up with new products or processes. Each product or process has a certain life cycle. There are initial costs for researching, designing and producing a new product. And income will only be gradually generated after the new product has been introduced to the market (see figure 1.1). After a while, if the product is successful, it achieves a turnover level and finally generates some profit. When the market becomes saturated after some time, the revenue decreases and the profit level goes down. It is important to then again introduce a new profitable product to the market. It is therefore essential to be constantly engaged in the design of new products so that the profit gained from one product can be partly

used for investing in new products. This is a prerequisite for the company to remain profitable and to ensure the economic survival. All this highlights the need to continuously invest in the development of new products.

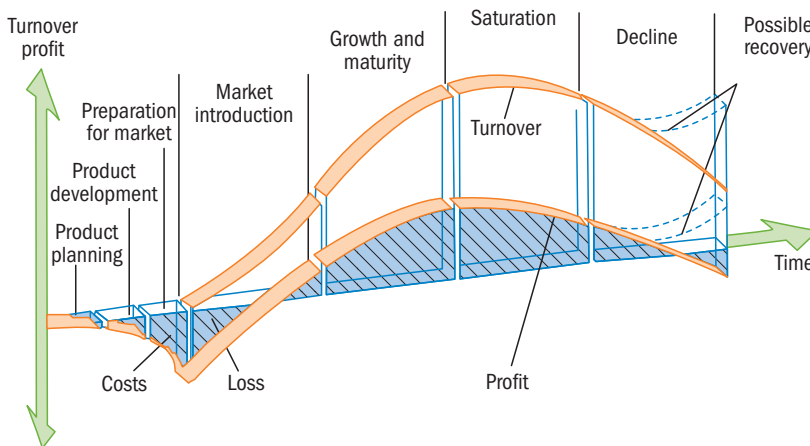
FIGURE 1.1 The various phases of the life cycle of a product



Source: Buys J.A., During W., Jes P., Kroonenberg H.H. van den, Marinissen A.H., 1982

The first phase of the life cycle of a product is further elaborated by Kramer (1986), see figure 1.2. It is remarkable that the introduction of a next new product has been omitted, while this is a necessity for the existence of a company.

FIGURE 1.2 The financial results of a product during the life cycle related to the revenue

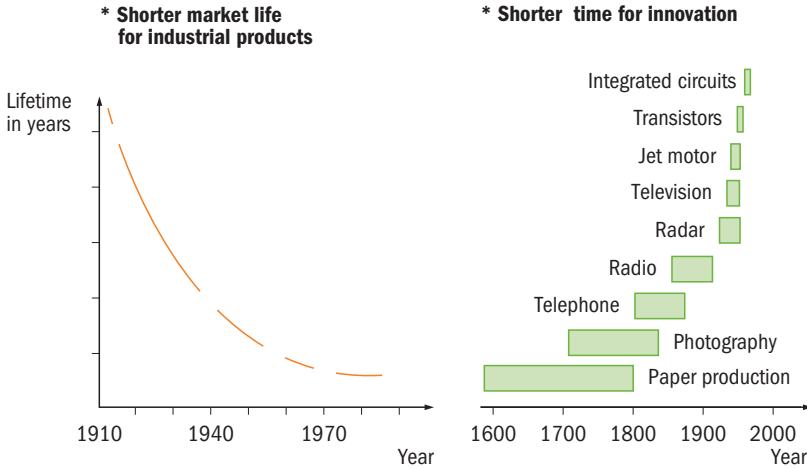


Source: Kramer F. in Pahl G. et al., 2006

Shortening of the life cycle

One of the current challenges for businesses is that the life cycle of a product from initiative to end of profitability is getting shorter. This is due to the massive reduction in the development time of new products, see figure 1.3.

FIGURE 1.3 Shortening of the life cycle of a product

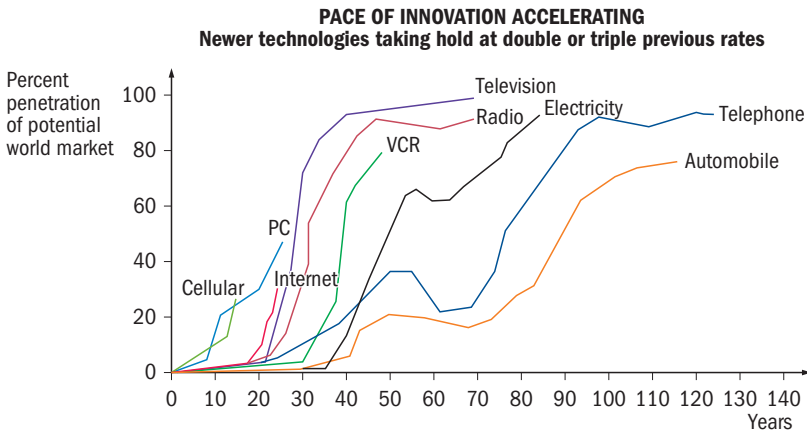


Source: Andreasen M.M., Hein L., 2000, Integrated Product Development, Institute for Product Development, Technical University of Denmark, Copenhagen

Reduced development time

As a result of the reduced development time, customers are quickly seduced by new products from competitors. It is therefore necessary for companies to continuously, rapidly and efficiently introduce new products to the market to stay one step ahead of the competition or at least keep up with them. It is therefore no surprise that the pace of innovation is accelerating, see figure 1.4.

FIGURE 1.4 The acceleration of innovations

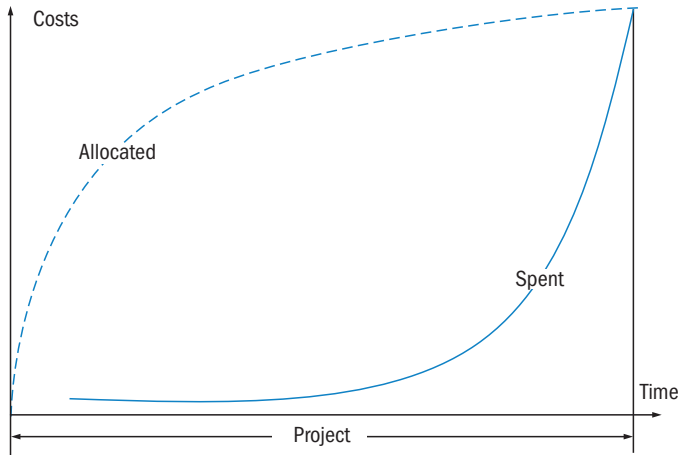


Source: Joseph Jacobsen, Organizational and Individual Innovation Diffusion, Global Innovation Outlook, 2004, IBM, p.6

The design process

Knowledge and information are important components in the design process. Ullmann (2003) shows this in two dimensions: the knowledge of the design task and the design freedom of the solution space, see figure 1.5.

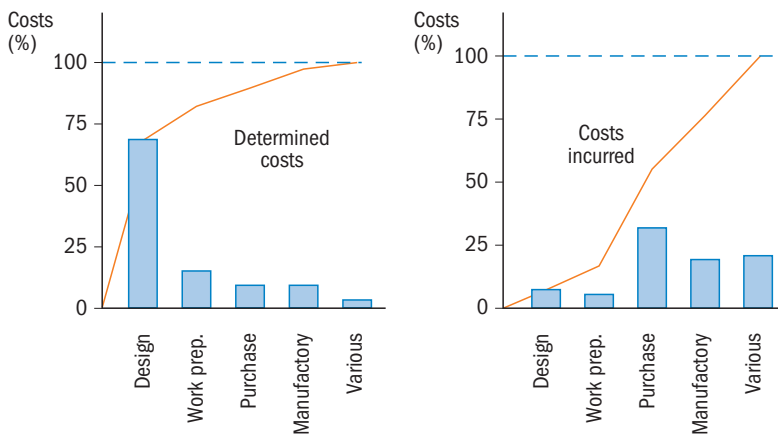
FIGURE 1.5 Cost level during the course of a project



Source: Andreassen M.M. and Hein L., 2000

There a little information available at the beginning of the design process, while this is the moment that the important decisions are made. Although costs are low in the beginning, it is during this time that the decisions made establish most of the costs as shown in figure 1.6.

FIGURE 1.6 Evolution of fixed costs and expenses incurred during the lifetime of a product

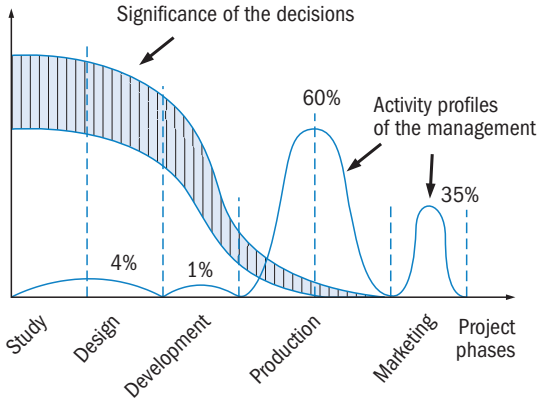


Source: Methodic Design, V.d. Kroonenberg 1978



Traditionally, the attention of the management of a company is focused less on design and much more on production and marketing (see figure 1.7): marketing formulates the preconditions for the new product and/or market approach and production adjusts many issues immediately in the operational organization.

FIGURE 1.7 Importance of decisions per life cycle stage of a product

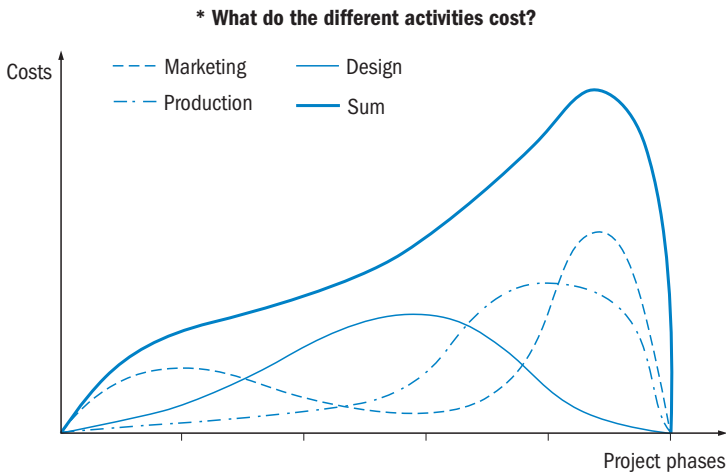


Source: Andreasen M.M. and Hein L., 2000

Little attention to design

Management has given design relatively little attention because of a lack of an understanding of how important this phase is for the final cost of a product. Managers are usually more focused on current, immediate costs instead of future costs, which is why they pay too little attention to it. After all, the direct cost of marketing and production are higher than those of the design, as shown in figure 1.8. Research by Arthur D. Little (Buijs and Valkenburg, 1996)

FIGURE 1.8 The direct costs of the different activities: marketing, design and production



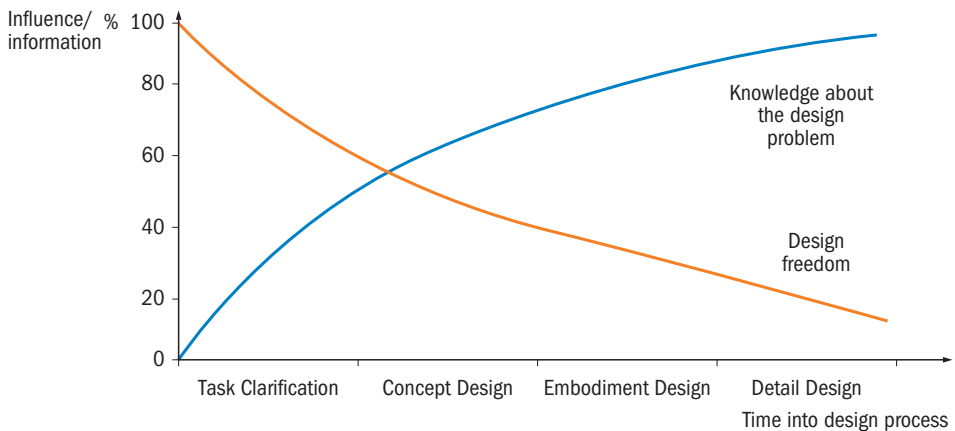
Source: Andreasen M.M. and Hein L., 2000

shows that management hardly takes an interest in the design process until the moment of the prototype or zero series (Eger et al., 2010). This is, however, changing because design is now increasingly seen as the key to success.

At the beginning of the design process there is very little information and a lot of freedom to make decisions. The freedom to make decisions is getting smaller with every decision that is made. The effect of a decision early in the process is often great even though there is little information available to base the decision on.. This is called the influence/information contrast, as shown in figure 1.9.

Influence/
information
contrast

FIGURE 1.9 Influence/information contrast in the early stages of the design process



Source: Ullman, 1992

The contrast between little information to support decisions on the one hand and the importance of these decisions on the other causes great risks in the design process. A wrong decision at the beginning of a design process can have major financial consequences later in the process. It is therefore important to design in a structural, transparent and systematic manner and communicate about it in a clear and concise way. This enables you to receive better feedback about your design, which leads to a better substantiation for decisions in the design process. As a result, the risks are reduced and the chance of a successful product is increased.

Risks

1.2 What is design?

'Design' sounds like an easy word, but it is challenging to find a clear-cut definition. Often it is useful to look for a definition in the dictionary. Webster gives the following definition:

'Design

To plan and make decisions about (something that is being built or created).

To create the plans, drawings, etc., that show how (something) will be made.

To plan and make (something) for a specific use or purpose.

To think of (something, such as a plan): to plan (something) in your mind.'

— www.merriam-webster.com

This descriptions only indicates what the designer does and how, the why is missing. Now some definitions are provided by two important thinkers of the last century on design: Herbert Simon and Donald Schön.

'Design is planning a series of actions aimed at changing existing situations into preferred situations.'

— Simon HA, 1966

This definition implies that you have to start from an existing situation, but it need not always be the case if you are designing something entirely new. Furthermore, design is more than simply planning a number of actions. An important aspect emphasized here is that design often consists of a series of actions and not just one single action.

'Design is a reflective interaction with the realities of a design situation.'

— Schön D., 1983

This definition emphasizes that design is an interactive process in which reflection on the course of the design process is very important. Nevertheless, 'realities of a design situation' is vaguely formulated. For this reason the definition by Harry van den Kroonenberg is provided, one of the most influential Dutch scientists in the field of design:

'Design is to indicate the best solution to serve a need, using available resources and in compliance with standards of physical and social nature.'

— Kroonenberg H.H. van den and Siers F.J., 1992

The definition of design was taken from the University of California at Los Angeles (UCLA) by Van den Kroonenberg. The definition talks about 'the best solution'. From this you can deduce that there are different solutions for a given design problem and therefore a selection should be made. The standards of physical nature in the definition refer to the possibilities and limitations of nature and physics. These are of both a physical and technical nature. The aforementioned standards of a social nature relate to the limits set by society. Those are of economic, social, legal or ethical nature. Nonetheless, the search for a good all-encompassing definition continued. The designer's faculty of ADMS in Eindhoven used the following definition:

'Design can be seen as a purposeful and creative activity of both idea- and decision-making. It is both an investigative and problem solving activity that takes place under conditions of uncertainty and risks. This includes the use of both practical experience and engineering principles and, to an extent, scientific knowledge and understanding. But the core of the design activity continues to be an imaginative leap of an unambiguous (experienced as poor) situation to a potential (a more desirable, more ideal) future situation.'

— Daru R., 2002

This definition emphasizes, among other, the uncertainty about the possible, desired, ideal future situation. This uncertainty will always be there in the design process. After all, the success of a product can only be determined afterwards. The definition of design can also be viewed from a much broader perspective, as evidenced by the following definition:

‘Design is a synthetic activity aimed at establishing new or modified artefacts, processes or systems, with the intention of creating value in accordance with predefined requirements and desires (e.g. mobility, health).’

— Meijers A.W.M., Overveld C.W.A.M. and Perrenet JC, 2005

This definition shows that designs are not only focused on products, but also on processes or systems, which must comply with certain requirements and wishes in order to meet the need. However, the term ‘synthetic activity’ is too complex on the one hand (‘synthesis’ means putting together individual elements into a new whole) and too limited on the other because design goes beyond synthesis; it also involves analysis, evaluation and development. It is also important to emphasize the decision-making process during the design process. This is expressed in the following definition by Von Stamm:

‘Design is the conscious decision process during which information (an idea) is transformed into a solution or something tangible (product) or something not tangible (service).’

— Stamm B. Von, 2008

This definition indicates that besides designing a ‘product’ or a device, you can also think of a film, travel insurance, software, process etcetera. Design does not only relate to inventing something completely new but can also include changes or improvement to existing solutions:

‘Design is to combine, mold and transform existing ideas into new ideas. The greater the knowledge

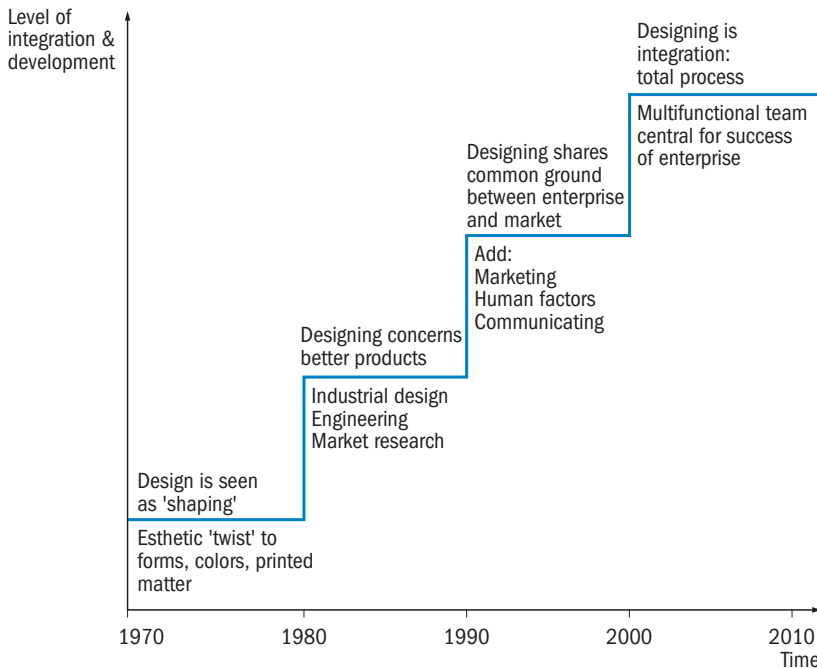
of existing ideas, the greater the chance of a new, innovative idea.'

— Breedveld P, 2011

This definition reflects on the fact that during the design process you can make good use of what exists in order to come up with new ideas. Nevertheless, the definition is too narrow.

Generally you could say that the concept and significance of design is growing, as shown in figure 1.10.

FIGURE 1.10 The growth of the importance of design



Source: Fairhead, 1988

1.3 Social relevance of design

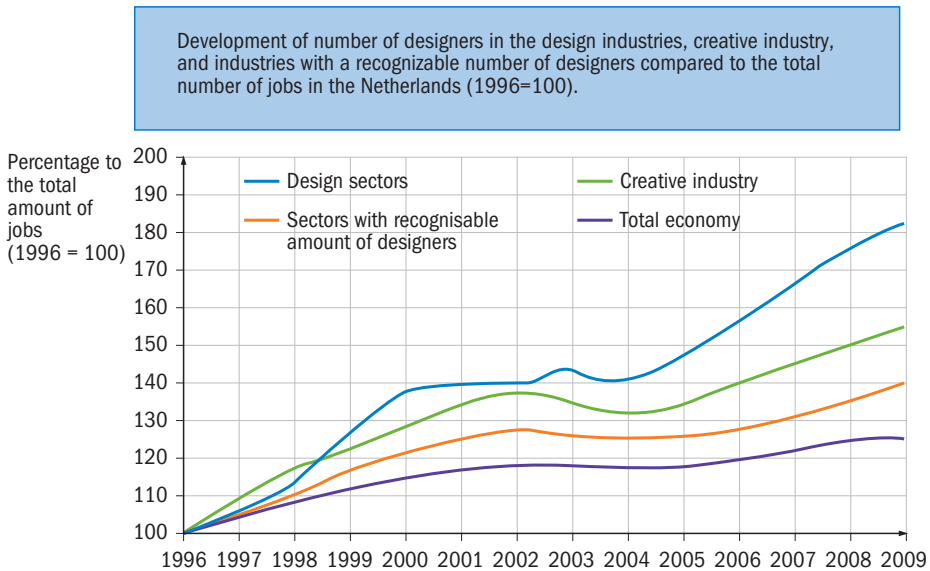
There is an increasing awareness of the importance of design for the success of companies, which has led to an increasing demand for designers to develop new products and services. The British Design Council (Slamm, 2008) research showed that in 2002, 75% of small (up to 50 employees) and medium-sized companies (50–249 employees) had design as an important integral part of their production process.

Economic significance

Design is also of great economic significance in the Netherlands. The Dutch design sector had, according to the Central Statistical Office (Lanjouw, 2004) and TNO, an estimated added value of 2.6 billion euros (Rutten et al., 2005). This value was equal to that of the Dutch air transport and even larger than the annual added value of the petroleum industry (2.1 billion per year). The design sector is important for increasing the innovative power of Dutch business. The aim therefore is to double the value of the design sector to 5 billion euros and more in the coming years. Emphasizing once again the importance of design and the possibilities that a designer will have in the future.

Figure 1.11 shows the development of employment in the design industries and industries with a recognizable number of designers, in the period 1996–2009. This figure displays the overall economy and the creative industry. As you can see, the design industries grow faster compared to the average growth. Economic growth is the strongest in industries with an innovative purpose.

FIGURE 1.11 Development number of jobs in the design industries in the Netherlands (1996–2009)



Source: TNO

Solving social problems

Besides creating direct economic, social value, designers are also increasingly involved in solving major social problems:

- health
- safety
- environmental problems
- resource scarcity
- energy issues

After all, the newly designed products serve to contribute to a sustainable environment and society. As a designer you can make a significant contribution to this.

a Health

In the field of the development of biomedical products in particular, design contributes towards positive improvement in the health of human beings. New medical equipment and new facilities for drugs enhance the ability to fight diseases.

Yet technology can also have a negative impact on the health of human beings. This particularly relates to the environment as well as working conditions in certain professions. As a designer, you will need to ensure that workplaces are created without undesirable adverse health effects occurring. You also need to ensure that the products you design do not damage the health of the user. User-friendly designs by applying ergonomic principles is therefore an important task for designers.

Biomedical
products

User-friendly
designs

b Safety

Increased use of advanced technology entails risks to humans and the environment. The safety aspects should not be neglected when new technology is introduced. You need to design optimal, safe constructions. It is obviously not possible as a designer to make your processes/products completely risk-free, but it is possible through careful design to reduce the consequences of any accidents. If something goes wrong, the outcome should be predictable and it should be made clear how to intervene to prevent undesirable effects.

Especially the latest technology contributes strongly to reducing safety risks such as terrorist attacks, for example through the detection gates at the airport. In addition, cameras contribute to security by supervising entertainment venues in cities.

c Environmental issues

Closely linked to the challenge of energy and raw material consumption are environmental issues. The use of energy and raw materials results in very different waste products. All kinds of side effects during the manufacture, use and disposal of products also cause problems. Especially the acidification of the environment through dry and wet deposition (acid rain) of sulfur and nitrogen oxides, global warming due to CO₂ emissions and the hole in the ozone layer caused by the release of CFCs are examples of this.

As a designer, it is expected that you are aware of all the possible side effects that could be caused by your products. You also need to consider the possibility of removal of technical products when they are decommissioned. Supply chain management, the integral attention for the entire life cycle of a product, is an important aspect in the design of products.

Supply chain
management

d Resource scarcity

The increasing scarcity of raw materials requires you as a designer to design with a minimum of material consumption. You have to aim at an optimal life cycle of the technical equipment, and when the inevitable end comes, a large portion of the materials should be recovered through recycling. In this way, you contribute to a sustainable use of resources. This inevitably has an impact on the requirements of modern technical equipment.

Recycling

e Energy issues

Modern man uses more energy, which results in the problem of depletion of energy resources and the need to find new sources of energy. Above all, this energy must be safe and should not be harmful to the environment. Energy consumption will increase, especially in developing

countries, where a strong growth in population is expected, which will be accompanied by a growth in energy consumption per capita. The aim is to achieve a sustainable energy supply. In 2050, the built environment should be energy neutral, while nowadays 40% of all our energy goes to the built environment. Major changes are necessary and therefore also many new products. As a designer, you have to strive for solutions that conserve energy, both during manufacture and in use, and also after use. The energy issue imposes a special responsibility on the designer.

As a technical designer, you do not have to provide an overall solution for the problems discussed above. It is expected that you take this into account and that you provide solutions for increasingly complex problems in order to satisfy the identified needs.

1.4 Gaining knowledge through research

When designing you apply your knowledge and possibly new knowledge to the products that will be designed. This new knowledge can be acquired largely by studying (physical/natural) processes. Often it turns out that additional research is needed. This raises the question of how research relates to design.

The difference between research and design

Research focuses mainly on the analysis of an existing structure of which the function and purpose should be determined in order to obtain new knowledge. It is to discover the relationship between things that are already there. This conclusion-oriented research can lead to a *discovery*. The researcher will then have stripped the yet unknown natural phenomenon of its 'covering', so that it can be added to scientific knowledge.

Design is mainly focused on synthesis; assuming a purpose and function, a structure is to be determined. Design puts the emphasis on acquiring new applications for existing knowledge or, generating something new from the existing; synthesis.

Design is therefore different from research, but often needs research results. The methodology of research may also help to structure design as a process. Design and research are therefore interconnected in different ways.

When a natural phenomenon is not the subject of research, but a product made by man, the research process is similar. The first aspect in the analysis of such a product is its physical structure. This mainly concerns the relative positions of the constituent elements. In the end, the analysis results in a representation of the structure, a sketchy, global indicator, which shows how the product works.

To gain insight into the operation of a design, it is worthwhile exploring the function of each element, and also according to what (logical) principle the device functions. The function of a product indicates which features the product should have in order to achieve the desired objective. The purpose of a product is not always clearly determined during an analysis. A consideration of the larger whole of which the product is a part frequently provides insight to its purpose. Through analysis, the researcher determines the structure, function and purpose of the researched product.

Structure

Function

Purpose

Recent developments

Products were designed by a designer on the drawing board or behind the screen. This way of working enabled him to generate a number of alternative possibilities. From these options, he was able to choose the variant that would be manufactured.

This option was formerly hardly used to develop multiple variants and from there on make informed choices. Often the first draft was progressively improved through trial and error and adapted until it met the requirements. Today there is a need for multiple alternatives and a more conscious and transparent decision about the different solution concepts. Because of rapid developments in the technical sciences and society, businesses cannot afford to get to the right product design through trial and error. The risk of failure or a longer development process can be reduced in a good way by choosing the best solution from multiple alternatives.

The related changes in society have led to increased complexity of the problems, with greatly increased costs and corresponding financial risks. Characteristic of this new phase is the awareness and the need to:

- ensure the safety of people and goods during every technical operation
- improve working conditions
- use raw materials and energy in an economical way
- have the least amount of impact on the environment

Characteristic of current industry practice is that the designers have less and less time to design products. New products should also be realized immediately and should be readily applied. This often involves completely new designs, of which no examples are available. In this case you can, as a designer, not fall back on experience with similar designs: after determining a problem, you often rely on familiar situations. This results in a quick decision process towards a solution because of the time pressure. If you cannot distance yourself from this, chances are that the resulting products lack the desired improved characteristics compared to existing products. If you do not have a sufficient overview of the multiplicity and diversity of the factors involved, the chance of making wrong decisions increases. This is how end products are realized that possibly do not meet the client's expectations. Sometimes, mistakes can still be restored by bringing significant additional expenditure (see example 1.1).

Trial and error

Less and less time to design products

EXAMPLE 1.1

Designing a schnitzel crusher

A trading firm found that its customers – butchers and industrial kitchens – needed a schnitzel crusher. A design and construction agency was commissioned to design and manufacture such a schnitzel crusher. The designer first studied what such a device would have to do: crush different kinds of meat to a uniform thickness. Through surface enhancement and uniform appearance, the pieces of meat are visually more appealing. Uniform thickness also provides an equal and shorter cooking time, causing less weight loss, and the tenderness and juiciness of the meat products are enhanced. The device should be suitable for both fresh and frozen meats.

The manufacturer designed and built a device that consisted of a large, stainless steel case in which three impactors in one row crushed passing

pieces of meat on a conveyor belt. The endless conveyor belt, powered by two metal rollers, was supported by a plate to be able to provide the necessary reaction force.

When tested, the product appeared not be working properly because the meat already got stuck to the first impactor. The manufacturer had not noticed that in a traditional operation, the butcher would wipe the knife on the meat after each blow. The use of a separate shielding cellophane solved this problem. The manufacturer then started thinking a little further. The butcher uses only one knife, so why use three impactors? He built a second device: again a stainless steel case, but this time with only one impactor and a conveyor belt with a cellophane-covered track. This device was not working properly either: the sticking problem was solved, but the belt had to be stopped at every blow and then started again. That was not really convenient. The manufacturer thought about it some more. The cut pieces of meat were transported between two moving conveyor belts in a small and handy device. The angle between the conveyor belts could be adjusted so that the desired thickness of the schnitzel was naturally realized through the transport.

In cooperation with a sales agent who supervised the sale and distribution of the schnitzel crusher, these machines have become a success, but the design and construction agency realized that the trial and error approach had cost more time and additional resources. As a consequence, the conclusion was that they no longer wanted to continue to work this way. Over the years many designs have been added, with different capacity, length and height. Each machine is built from the standard to customer specific options; where necessary, the machine is built completely customized. The latter applies for example to a tandem design that was intended to be used overseas. This crusher is built entirely to customer needs and is manufactured in such a way that the capacity of the machine is increased twice. Meanwhile, these machines are used worldwide in eighteen countries, and in many meat processing production lines (see figure 1.12).

FIGURE 1.12 Schnitzel crusher



Source: RVS Montfoort, 2012

The food processing industry needs many machines that often must be designed in a specific context and for a specific use. If you look on the Internet, you will see that several Dutch companies make similar machines for the food processing industry.

Example 1.1 shows that it can be very important to adopt a systematic and thoughtful approach to developing a design task. It is also important to find the right balance between applying a systematic method and handling it practically. The systematic approach gains should not cause much unnecessary work; you should always remain critical and wonder in your situation if all the steps of a particular method are really necessary. Unfortunately, you will only learn to estimate this in the course of the years. It is therefore recommended, especially in the beginning, to entirely follow the systematic approach you have chosen. Later, you can estimate, based on your experience, what you should and should not do. The main thing is that there is a healthy balance between simplicity and completeness. Sometimes this goes wrong; a designer can go to extremes. In his inaugural address on designing biomedical products, Professor Verkerke wonderfully described how designers sometimes lose sight of purpose and simplicity. See example 1.2 (Verkerke, 2005).

Balance between
simplicity and
completeness

EXAMPLE 1.2

A pen to write with in zero gravity

When the Americans and the Russians went into space together for the first time, the atmosphere was remarkably open. As colleagues they had a lot of experiences to share. For example, the Americans explained one of the problems that they had had: writing in the space. After all, a normal ballpoint pen works only if there is gravity. Fortunately, the American said with pride that the NASA engineers had achieved a great alternative after only one year, the Fisher Space Pen. A built-in micro-pump mechanism pushes the ink to the pen point, under all circumstances (figure 1.13). The Russians agreed that they also had this problem. Their engineering firm already had the solution after one day: a pencil. As you can see, product design is not a single event. Sometimes you develop a wonderful solution, but it might not be the best or simplest. This happens both in space and on earth

But further research reveals something different: the story is not true. The Americans first used pencils, like the Russians, but abandoned the idea because broken pencil points and the resulting graphite material when writing in a weightless environment may pose a serious threat to equipment and astronauts. And, the solution was not devised by the designers of NASA: a private company was used that had independently developed a ballpoint pen, without financial support from NASA. It was purchased for a small fee by NASA. Later, the Russians also abandoned pencils and bought the same pens as the Americans.

FIGURE 1.13 Space pen



Source: Fisher Space Pen

In short, the story is different, but the approach remains the same: do proper research first for the need to see if there isn't already an appropriate solution on the market that you might use or improve. Only if this is not the case, you can start your designing process. Designers tend to keep the research brief and want to design right away. They prefer to think in solutions, but it is important to first consider if the new need for a new design is not a false need, and whether the requirements imposed by client fit the identified need.

Summary

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- ▶ Design is originally an individual process aimed at indicating solutions to serve a need, using available resources and in compliance with standards of physical and social nature.
 - ▶ Design develops into an overall process where the multi-functional team is central to the success of an organization or enterprise.
 - ▶ Design is essential for innovation and creating economic value.
 - ▶ The increasing social problems such as resource scarcity, energy issues, environmental issues, security and health care lead to a complexity of design tasks.
 - ▶ Designers are expected to contribute to solutions in the area of tension between growing demand and desire on the one hand and the end of the growth and the depletion of natural resources on the other.
 - ▶ With the ever shorter life span of products the time to design is increasingly shortened, an unsuccessful design is increasingly risky for the survival of an organization or enterprise.
 - ▶ In order to increase the probability of success, a designer may use all the help he can get. Therefore, design methods are developed that can actually be used.
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