Methodical design explained

Insights into the methodical design process as it is applied in companies.

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Preface

How to develop a product?

Practice has shown that many participants in the design teams are not aware of the complete design process. The participants usually have a specialized task. Knowledge of the entire design process is lacking.

This book provides insight into the methodical design process as it is applied in companies.

Why this book?

As lead engineer and project leader I often had to explain to the team members what their role is in the design process. Also, the manufacters, the makers of the products, who were involved in the design at an early stage, had no idea of their role in the design process. Very little attention is paid to this in education and in the professional literature. Much attention is rightly given to the theory of design, however not how to put it in practice. I have written this book to share my many years of experience in this field.

“If you can’t explain it simply, you don’t know it well enough.” – Albert Einstein
I don’t know if this statement comes from Albert, but I like the idea. In the book I have tried to following this rule of thumb.

My thanks go to all the companies where I have had the pleasure of applying methodical design in practice. Due to, the various roles I have fulfilled as; (lead) engineer, group leader, architect, project leader, manager of the R&D department, and value engineer, I was able to get to the core understanding of the design process.

A special thanks goes to Dave Corben. He helped me with the linguistic aspects of the book.

Laurens van Lieshout
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1 Introduction

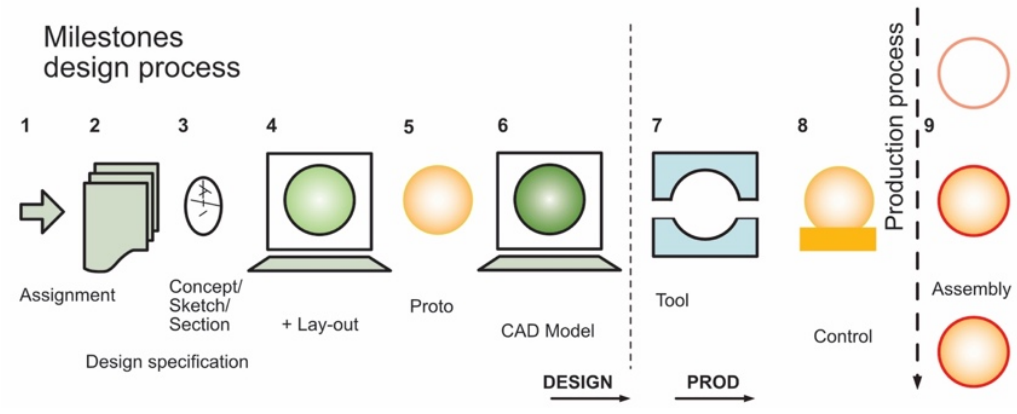
This book provides insight, from the assignment to the final production, of the methodical design process. It provides insight into how the design is realized in practice at companies. The methodologies described in this book may differ in detail from practice. However, in general, the methodologies are often the same. It is therefore wise to take note of the applied methods in your organization. With the knowledge gained in this book, it is easy to understand the applied methodologies and to apply them.

If you are proficient in operating a device, it is relatively easy to learn to operate a similar device. So, it is with the design process.

The target audience of this book are design team members; designers, specialists, project leaders, managers and of course the makers of the design. In order to transfer the knowledge effectively, a very simple example, a children's catapult, is included in the book. Using this example, the entire process from order to production is explained in understandable steps.

This book uses practical experience to share knowledge of how products are designed in a company.

This book provides insight into the methodical design process. Every good design is unique, but the method used is the same. The design process is divided into three main phases and nine milestone steps.



In this book, the order of the chapters, as it happens in design practice, is discussed.

The book can be used as a reference for methodical design.

To clarify the methodical design process in detail, a design example of a children's catapult is used in the book. The design starts with getting an order, an order to design a product and ends with the actual release of the design. All aspects, in the example used are discussed in detail. A very simple design was deliberately chosen. This makes it immediately clear to the reader of the book what the essence of the design process steps is.

After all, simplifying something usually contributes to understanding something.

A good design must also be makeable.
Much attention has therefore been paid in the book to the realization of a makeable design. From the creator's *(the manufacture's, the makers) point* of view, it's important to be involved in the design early on. How to realize this communication between the creators and the makers is discussed in detail in the book.

In university and higher vocational education, relatively little attention is paid to the practice of methodical design. The theory is of course discussed in this education, but the practice remains underexposed. This book is written from the practical knowledge gained in various large and small organizations. In this book, where possible, a reference is given to the theoretical underpinnings. Although this book is written for mechanical engineers, methodical design is also applicable to other disciplines.

For the upcoming designer, who wants to become more proficient in design, the advice is to ask for feedback from all design team members as soon as possible. Designing is a complex process. A process that you can only realize together with all stakeholders.

Use the knowledge and skills of everyone in and outside the design team. Ask if you don't understand something. **Everyone, if you ask, will want to help you.**

In the back of the attachment is a children's coat hanger case to make yourself. After all, one learns the design methodology best by doing it.

On behalf of the many team members in the many projects I have participated in, good luck in applying methodical design.

Designing is fun!

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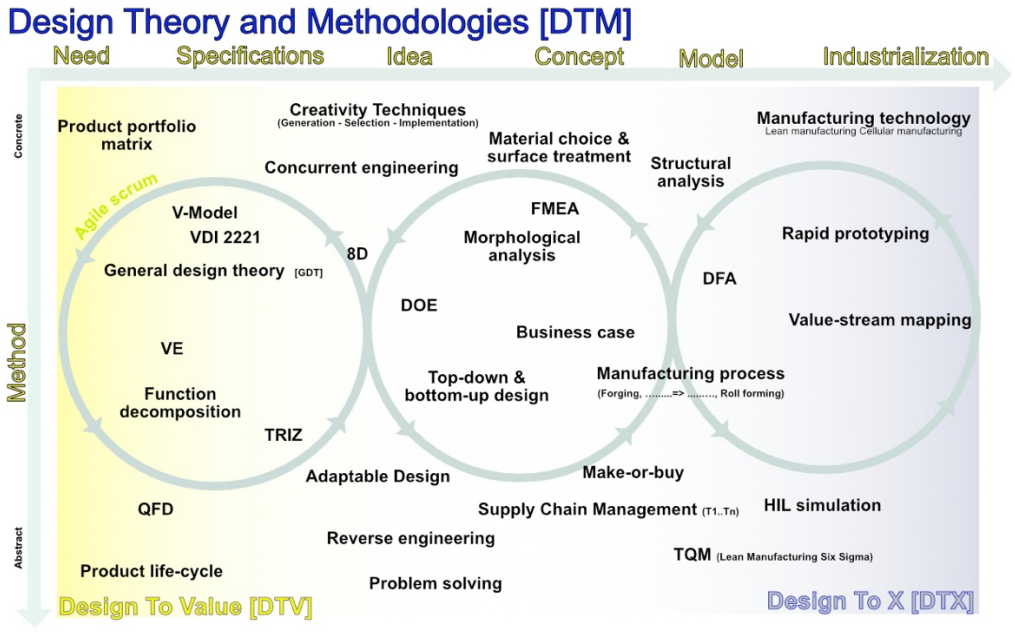


Overview methodologies

2 What is 'Methodical Design'

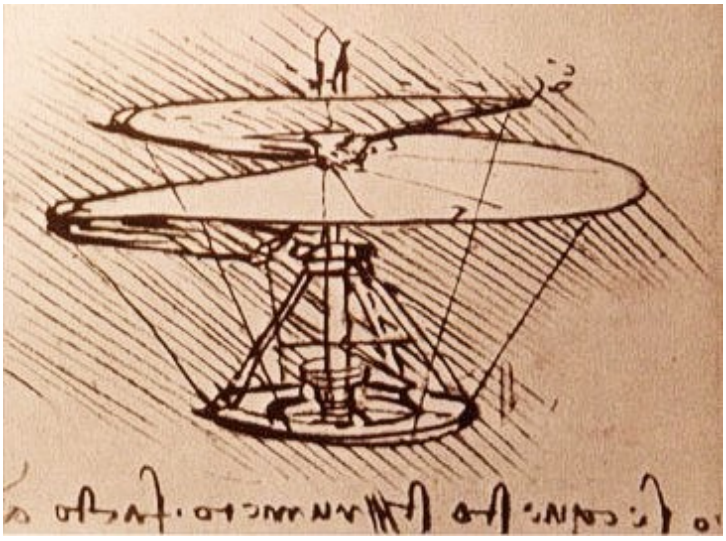
Methodical design is a way that gives control to the process when designing products and/or devices. In other words: following a methodology during design.

Methodical design is a structured way of solving problems by creating many possible solutions and by selecting the one best meeting the set requirements.

The characteristic of Methodical design is the mutual coherence and integration of the applied design tools.

What is a design?
A design is a description of something new or a description of something existing.
A design is therefore a description (projection or model) of the (future) reality.

What is designing?
Designing is the doing (the process) of creating a design.



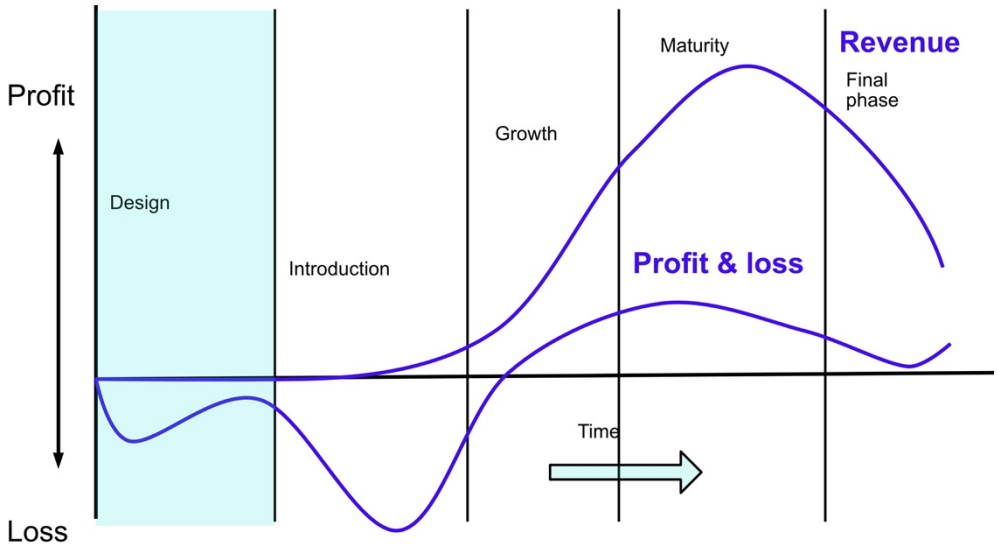
Example of a design made by Leonardo da Vinci

What is a process?
A process is a series or set of activities that interact to produce a result; it may occur once-only or be recurrent or periodic.

A process is a set of activities in which a product arises from one or more pre-existing materials or objects. In the time-ordered series of events, an input product is converted into an output product, whether intended or not. In other words; a process is the sequence of tasks that are performed to do something.

When baking a pancake, the process is first making the dough and then baking the pancakes.

2.1 Position of the design in the product life cycle



Product life cycle

Product life cycle business model
The economic life of a product differs per market segment. In general, a product life cycle consists of a product development, an introduction, a growth and a decline or end phase.

Design phase
In this phase, also called the **product design phase**, a company starts something new. This is also the phase in which you as a designer are usually involved. In this book, extensive attention is paid to this phase.

As you can see in the graph above, for a company the development process is a very large cost item *(the marked part).* That is why it is important that a high-quality design is realized. As an example, the following rule of thumb is used: Fixing an error in the design costs a certain amount of money. If this error is corrected in the introduction phase, it costs 10x as much. If, on the other hand, the error is discovered when the products and/or machines are already with the users, this costs the company 100 times as much. **Preventing a mistake cost nothing.** That is why it is important to design methodically.

Methodical design does not guarantee the prevention of errors or defects. However, the chance that they occur is very small.

For a full description of a company's product life cycle see Appendix: Position of the design in the product life cycle.

2.2 Advantages and disadvantages methodical design

Advantages of methodical design
The methodical design ensures that all aspects are addressed in the design. As a result, solutions are only used if they have been thoroughly investigated. A methodical approach during design ensures:

1. Transparent and comprehensible documentation of the design;
2. Prevents solutions from being seized too quickly;
3. Because all essential matters are considered, decisions can be taken easily.
4. That the chance of an effective design increases.

Disadvantages methodical design
As far as known, there are no disadvantages. Experienced designers are already unconsciously applying this method. The pitfall of the experienced designers is not fully recording the (decision) information. Reconstructing this information

afterwards is time-consuming and not challenging. Often this is omitted with all the consequences that entails.

Good documentation is ingrained in methodical design. A designer can be held accountable for his design, by the judge.

2.3 CE- marking

What is CE marking?
The CE mark has existed in its current form since 1993. Many European products bear this designation. The two letters stand for 'Conformité Européenne', which means 'in accordance with the EC directives'. It indicates that the product may be freely traded within the European Economic Area (EEA) because it meets the requirements of the EC directives. The manufacturer of a product actually affixes the marking and is responsible for the correct application of the EC directives. But many others also have to work with this CE marking. *(The CE marking pays extensive attention to this. This is not part of this book)*

Designers, traders, buyers, employers and users must always be aware **of the correct application of the requirements**.

On this site, https://eur-lex.europa.eu/browse/summaries.html, you will find an overview of EU directives.

The link can also be found in the External links at Wikipedia: https://nl.wikipedia.org/wiki/CE-markering

Example: A search for 'Toy'; (toys) provides, inter alia, the following Directive:
Directive 2009/48/EC on the safety of toys.

Please note! Multiple guidelines may apply. And there may be references to other guidelines listed.

A designer must include this in his or her specification. Reading and understanding an EC directive is not always easy, but it is necessary. It may be that reading and understanding a guideline takes a lot of time. The advice is to read a guideline in steps:

1. First determine whether your product or device must comply with this.

2. Then reading the summary and then searching specifically for requirements or limitations.

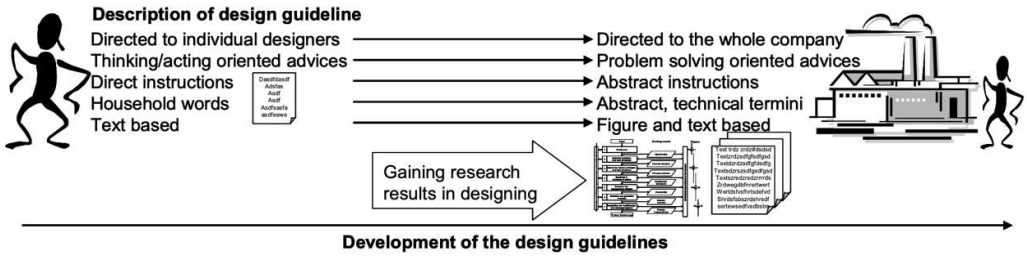
In countries outside the European Community, other requirements or guidelines often apply.

2.4 Overview of different design methods

2.4.1 History

In the past, design was a craft. A craft that you could learn from a master. By learning early at a young age, the design knowledge was transferred. The journeyman master system. In this way, the knowledge to build pyramids, cathedrals or bridges was passed on.

One of the first guidelines for inventions *(design)* was developed by Fritz Kesselring *[Kesselring, 1954].* In his book *'Technische Kompositionslehre'* he describes a guideline called *'Guideline for inventions'* based on his own practical experiences. His goal was to scientifically explain the design, the process of how you come up with something.



Development of the design guidelines

Visualization of the design