The art of making a design specification.

Introduction

The quality of a design, product or service is a reflection of the quality of the design specification. The design specification is therefore the DNA of a design.

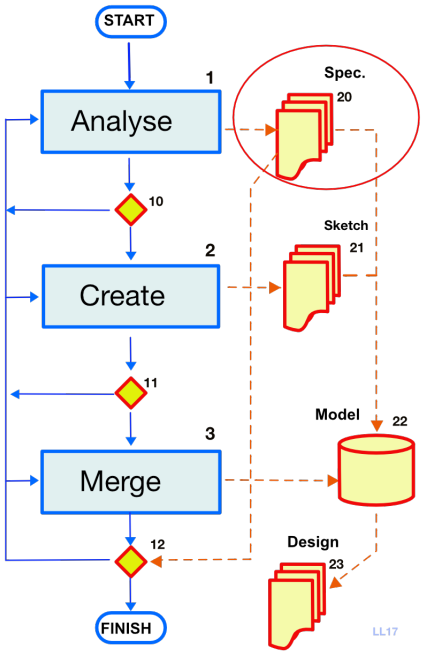
The purpose of this writing is to underline the importance of the design specification. Two examples of a design specification are given.

A design specification is a document where a product is development accordantly. A design specification is the basis of the design. In business the specification is a list of items, intended as a contract between the client and the contractor. The design specification as described here is not the contract specification. It can serve as a basis for making the contract specification. The drawing[1] as an example is the realization of the specification. Each professional discipline has its own way to make a (design)specification. This description is based on the specification, which is used in the process to design a (new)product or (new)service.

The design process.

Before looking to the requirement of the design specification we look at the place and the functie in the design process. Designing is the translation of (design)characteristics into a product or service. The design is a result of a complex process. There are various methods to translate a design specification into the product or service. Almost all of these methods are based on dividing the problem into a partial pieces. A solution is then sought for the individual pieces. Then all partial solutions are merged. If the validation relative to the design specification is negative, the process starts again. The design process consists of the following process steps[2]:

1. Orientation.
2. Analysis.
3. **Specification**[3].
4. Ideation.
5. Marketing.
6. Concept design.
7. Prototyping.
8. Production / industrialisation.
9. Market introduction.
10. Service.
11. End of life.



The phases follow each other in the design process. The design process is dynamic and repetitive, many phases will overlap and can be traversed in parallel. The outcome of a later phase can be such that earlier phases should be reviewed. It is often the case that the

[1] The drawing is a (standardized) exact description of the product in many fields. It is the realization of the (design) specification
[2] The order of the process steps may deviate from the specified order in certain circumstances.
[3] Sometimes the design specification is called the Design brief, Product design specification or 'red book'.

provision of service and the withdrawal of the product or service from the market are not included in the project plan.

Short description of the design process stages.

Ad 1. **Orientation**.
In the orientation phase, insight must be obtained. It is a phase in which all kinds of issues are examined which are listed later in the design specification. Often it concerns answers to the following questions: How big is the market? What are the developments and the trends? Who are the end users? Are there competitive products? What are the legal standards and requirements? Who are the stakeholder?

Ad 2. **Analysis**.
In the analysis phase, the data obtained in the orientation phase is analyzed. After the analysis, the results are included in the design specification.

Ad 3. **Specification**.
The data obtained from the previous phases are made presentable in the form of a design specification. Making a design specification is a repetitive process. Phases 1 and 2 are completed several times. Usually the conclusion of the design specification phase is a milestone[4] in the design project.

Ad 4. **Ideation**.
This is the phase in which the designer looks for an ordering principle and a form of which he or she assumes that it fits the design specification. In the development of ideas many creativity techniques are applied *(TRIZ, brainstorming, Analogies, Morphological thinking etc.)*. Next, the result is tested against the design specification. The design specification does not mention how the creation process should proceed. This is left to the craftsmanship of the designer.

Ad 5. **Marketing**.
The marketing phase is characterized by the planned preparation of "the market". The introduction of the product or service. The design specification expresses all wishes and requirements of the stakeholder. There was intensive (preliminary) consultation with them during the preparation. Preparations for the marketing phase are usually started at a fairly early stage. This phase runs like a red thread through the entire project.

Ad 6. **Concept design**.
A concept design is not yet a finished design. A concept is usually an incomplete definition of the design. The aim of a concept design is to obtain statements about the idea, the character and the solution direction. It expresses the rationale behind a design, it gives direction to the design choices and at the same time excludes variants. It organizes the design choices. The concept design allows communication with all stakeholders. Often the design specification is too abstract to serve as a communication tool. This phase is often used in the design process to obtain 'commitment' from the stakeholder.

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[4] The design specification is an abstraction of the reality. This makes it impossible to describe everything. This is clearly expressed in the two examples given. Additions and changes during the next stages of the design process are very likely. The design specification must be sufficient to continue with the next phase.

Ad 7. **Prototyping**.
Prototypes[5] are produced depending on the importance of the design. The purpose of a prototype is to test the functioning of the design. It can also serve as preparation for the production phase.

Ad 8. **Production / industrialisation**.
The production phase consists of arranging the production process needed to make the product of service. The definition of the product and the process of making the product of service are two different things. Usually they are also carried out by various professional disciplines. The design specification also take into account the manufacturability of the product of service.

Ad 9. **Market introduction**.
In this phase the delivery of the product or service starts. All planning activities come together here. It is a turning point from preparation to realization.

Ad 10. **Service.**
Depending on the type of product a ‘service’ is provided. Often, due to ignorance beforehand, too little attention is paid in the early phase. If all goes well, the design specification takes into account the requirements and wishes with regard to the 'service' of the product.

Ad 11. **End of live**.
As with almost everything a product or service also puts an end to its lifespan. The product or service may be out of date or just worn out. The design specification takes into account requirements for the disassembly process or the requirements for the type of materials by determining the life span[6].

Core of the design process.
The core of the design process is, in several iteration (repetition) steps, realizing the 'what'. Characterizing for these steps is going from abstract to concrete. The 'what' is the product specification in the design process. The 'how' to realize this is left to the knowledge and expertise of the designer. Usually the different phases are carried out by different people in the design process.

Role design specification in design process.

- The function (role) of a design specification in the design process is to define the design characteristics.
- The design specification is the outcome of the orientation and analyse phase.

The communication function of the design specification.
The function of the design specification is to communicate the design characteristics to the designer(s). The communication process consists of transferring information from the author(s) of the design specification to the designer(s).

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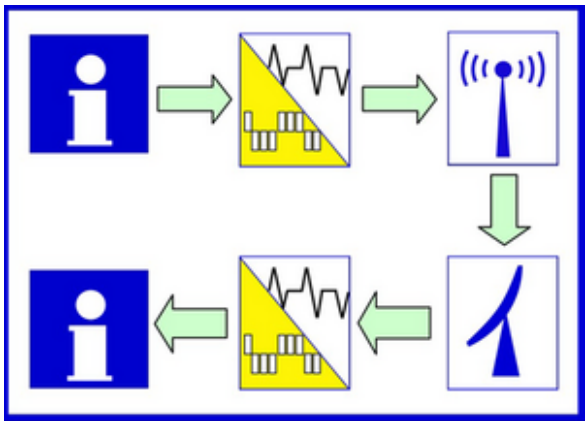
[5] It is also possible virtual prototypes are made.
[6] Depending on the type of product, a capital surcharge for the product decomposition is added at the market introduction. A kind of environmental tax.

Communication[7] is a process in which one tries to transfer a certain concept from one imagination framework *(the sender or the source in which it is manufactured)* to another *(the recipient)* by means of information which, according to agreement, refers to that concept.[8]



In the communication process, the following matters, **information**, **(de) coding** methods and **sending** and **receiving** processes are important.

Before going into detail we first have to look at the target group. Who is the receiver? The designer? The designer can be the same person who made the design specification or it can be a colleague. If the author of the design specification and the designer are the same, then the communication process is usually much more concentrated. After all, the (de)coding processes in the communication process are of the same person. Often there is the chance of 'over-simplification' in the use of the (de)coding processes. It may be that the author of the design specification no longer knows what he or she meant after some time. If the designer is a colleague, then he has the same educational background. The design process is usually divided over different persons. In addition, if the author of the product specification and the designer have a different educational background and another mother tongue, this is the 'worst case' with which the communication must be taken into account.

Requirements design specification.

•Simple.
A design specification must be as simple as possible. The simpler the information, the more likely it is to succeed communication. Often quantity is confused with quality. Most people do not read, they scan the information in search of something. This is called 'chunking'[9]. The chunking method teaches that **bold printed words**, VARIATIONS IN FONTS and colors, the use of chapters and lists and only one idea per paragraph, start with the conclusion and a half word are sufficient to ensure that information is better. This also applies to design specifications. They are not read they are scanned in search of something.

•Trustworthy.
A design specification must be reliable. After all, it is 'the document'. It is 'the law' in the design process. If the author of the design specification is not sure about a certain aspect, he or she can (must) include this uncertainty in the design specification. For the designer, it is important to know whether something is an assumption or a fact. One of the simple methods to make information reliable is to use information only once in a document. When changing is often forgotten to adjust the double information.

•Stakeholders.
All interests of all 'stakeholders' must be addressed in the design specification. A stakeholder is an interested party in the design outcome. It may be that not all interests of all involved parties are known when writing the design specification. It is then usual to include this

[7] from Latin *commūnicāre*, meaning "to share"
[8] https://en.wikipedia.org/wiki/Communication
[9] https://en.wikipedia.org/wiki/Chunking_(psychology)

uncertainty in the design specification. Knowing in the design process that is not yet known can be very important.

•Presentable.
The design specification must be presentable in one way or another. Usually the design specification is presented in the form of a text document. The (company) intranet is increasingly being used. Other forms of presentation, such as prototypes, mock-ups and virtual models, are also used. The advantage of these non-language presentation forms is that the language, as a complex communication tool with a high chance of miscommunication, is eliminated.

•Field of vision, purpose and marked.
Description of the field of view, intended purpose and the market will give the designer a good frame of reference. It is important to pay a lot of attention to the introduction of the design specification. Quantitative matters such as production numbers, market size and sales price are also determined in the introduction. By describing the viewpoints, the designer is given a lot more information than would be possible when only listing requirements in the design specification.

•Function.
The design specification must describe the function[10] of the product or service. A function is an abstract concept that describes a state change. The function of a light bulb is to illuminate the environment. By describing the function, the role or goal that has something within a whole is clarified. It forces the author of the design specification to think about the design. Often, the auteur of a design specification already have a biased picture (model[11]) of what the product or service should look like. By naming the function, distance is taken from the biased image (model) of the design.

• Requirements and wishes.
The design specification provides a summary of all requirements and wishes. A description of the requirement or wish can be in or explicit. An example of an implicit description is: the color must be white. An explicit description is: the color may not be white. Implicitly excludes one or more possibilities. An explicit description excludes only one possibility. The design specification must make a distinction between a 'hard' and a 'soft' requirement. A strict requirement is a requirement that is verifiable. A soft requirement is not verifiable and is also called a wish. Identifying the difference in hard and soft requirements is important because not all requirements are equally tough. Sometimes it is necessary to resolve a contradiction [12] between requirements. It is important to know which requirements are 'hard' and which requirements are 'soft'. An example of a hard requirement is: it must be able to contain a load of 100 kg. An example of a soft requirement or wish is: it must be safe. If the concept of safe definition is defined and measurable, the 'soft' requirement becomes a 'hard requirement' requirement.

Final state.

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[10] https://en.wikipedia.org/wiki/Function

[11] A model is a simplified representation, description or imitation of reality. As a general rule, the simpler the model the more enlightening it is. However, if the model is too simple, there is a chance that the model can not provide the explanation. See https://en.wikipedia.org/wiki/Model

[12] https://en.wikipedia.org/wiki/Contradiction See for solving the contradiction the TRIZZ method. https://en.wikipedia.org/wiki/TRIZ

The design specification must describe the final state of the product or service. The 'how' is left to the professional competence of the designer. Describing how a product or service comes about is often complex and time-consuming. After all, coming up with solutions is the professional competence of the designer. It also prevents the design specification from being too comprehensive and therefore too complex. After all, the human mind can only contain a limited number of things.

Unique document.
Indication of a **revision** and / or **date** and a **change index**. In order to increase the reliability of the design specification, it must be known by whom and when it is made. It should also be taken into account that during the design the specification can change.

Concepts.
By including in the design specification which concepts (or principles) have been investigated, the designer is prevented from reinventing the wheel[13]. Similar products can also be a good source of information for the design specification.

The goal in drafting a design specification is to be 'solution-free' as much as possible. The solution is not prescribed. It is prescribed to which the solution must comply. Setting up the design specification in this way prevents the design specification from being a brake for finding creative new solutions. A specification is not equal to the solution. A requirement or wish only indicates the direction of the solution.

[13] It is possible (very often is this the case) that the product is already on the market.

Example design specification

The example of a design specification of a match. By taking a product that already exists, you can zoom in on the 'quality'[14] of the design specification.

Specification: fire making tool[15]. Revision 1. LL 17[16]

Description[17]

When cooking food and when lighting the stove, fire is needed. This design specification describes the frameworks of such a 'fire-making tool'. It is estimated that, with a sales price (target) of xx €, the market for such an instrument of xxxx[18] is.

http://commons.wikimedia.org/wiki/Image:Matchstick_Lighter.jpg

Function

1. Making fire.
2. Food removal between the teeth.
3. ……[19]

Requirement

1. No self-ignite (-20 +40 gr.C / 5 -99% RV)[20]
2. Igniting must be done at a defined location (safety). *[Location TBD[21]]*
3. Burning time > 1/2 min.
4. Ergonomic (user 95% F en M)
5. ??[22] Meet the legal requirements. Machine directive CE marking (98/37 / EEC)
6. Reliable (6-sigma)
7. …….

Environment

1. Use in a dry environment with a relative humidity of max. 95%[23].
2. The whole world[24].
3. ……

Wish

1. Environmentally friendly.
2. Childproof.
3. Transportable (pocket size).
4. No external energy required.
5. ……

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[14] Quality indicates whether it matches what the designer expects.

[15] 'Fire-making-tool' is a naming that describes exactly the **function.** The name of the design specification (or the project) is the 'peg' to which all information is linked, a good name is essential.

[16] Indication of the revision (or date) and statements (initials) of the author or reviser of the design specification. It is a living document that is subject to many changes.

[17] By briefly describing the background, the reader of the design specification is given a frame of reference.

[18] In the context of this example, the market potential and the market price have not been examined.

[19] By indicating '……' it is communicated that the design specifications are never finished. It is a 'living' document.

[20] Conditions under which the product must comply with the requirement. Although it is described in a cryptic manner, the person skilled in the art understands that this means a temperature and an air humidity range. By describing it in this way, the design specification is kept simple and compact.

[21] TBD To be discussed. meaning; Must be determined further.

[22] Because it is not certain whether this is the case? is mentioned.

[23] The selected maximum relative humidity means the fire-making tool must not be able to work in a liquid.

[24] This definition may have been taken too far. If it turns out that a restriction is necessary for the realization of the design, this requirement may possibly be revised. Before reviewing this requirement, the consequences must be investigated. It may be that specific information about this is necessary when placing the product to be marketed.

Concepts[25] [code] *? =not investigated / R = rejected / X probably usable.*

1. [R] Wood impregneer with sulphur / To flammable.(E1)
2. [R]Hydrogen gas onto a platinum sponge .(Döbereiner's lamp[26])./ To flammable. (E1)
3. [R] Wood with white phosphorus (strike-anywhere matches) / To flammable. (E1)
4. [R] Wood with sulphur and Potassium chlorate / Too environmentally unfriendly (W1)
5. [R] Wood with iron - phosphorus compound.
6. [?] Gas with flint roll.
7. [R] Gasoline with flint.
8. [R] Gas with piezo element.
9. [?] Capacitor with laser.
10. …..

Another example of a design specification is the 'information point'. Such a product or service does not exist (yet). Here we zoom in on the problems that arise when making a design specification of something that does not exist yet.

Specification: information point. Revision 1. LL 17

Description

When traveling, there is often a need for a diversity of information. As an example, the information need to find a hotel for a place to sleep or finding another means of transport. In this design specification the diversity of the information request is taken as the starting point. It is estimated that the market for such an instrument is highly dependent on how the financing is realized. Further (market) research is therefore necessary in this respect.

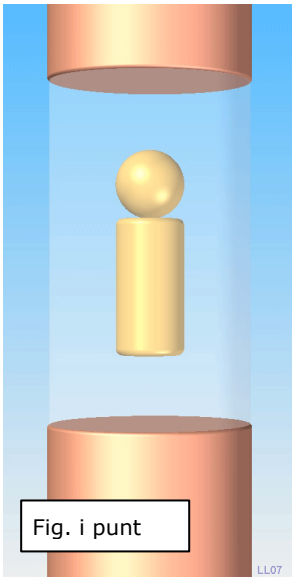

Fig. i punt

Functie

1. Providing, on request an answer (=information) to a question asked.
2. Giving personal advertising messages. (Earnings model)
3. .....

R**equirement**

1. Communicate, on request, with a person (in writing and sound) in all EU languages.
2. Ergonomically suitable for 95% F +M population.
3. Suitable for wheelchair users.
4. ……

Environment

1. Use in an urban outdoor environment. In Europe.[27]
2. .....

Wish

1. Robust[28]
2. Childproof
3. As many icons as possible.
4. As much room for advertising as possible. (easier to market)
5. ……..

Concepts [code] *? =not investigated / R = rejected / X probably usable.*

1. [V] LCD screen in a column / not robust enough (W1)
2. [X] Projector on a surface.
3. [?] 3D Hologram.
4. ……..

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[25] Description from an existing or invested concept. By including this in the specification, the designer is prevented to reinventing the wheel.

[26] https://en.wikipedia.org/wiki/Döbereiner%27s_lamp

[27] This requirement largely determines the product. The environment combined with the function. As an extreme example; suppose the environment was the moon. What would the product look like?

[28] No exact verifiable requirement can be given to the term robust, this requirement is included in the wish column. By adopting an assumption, after studying the wish can be converted is a verifiable requirement.

If this design specification is compared with the existing 'match' specification then it appears that it takes a lot of energy *(research and analysis)* to write a good specification of something that does not yet exist.

Conclusion
The quality of the design, product or service is always a reflection of the quality of the design specification. The 80-20 rule, the Pareto principle, also applies here. In order to (get) a good quality design, 80% of the energy needs to be invested in the design specification.

Given the impact, the design specification is the DNA of the design.

Making a design specification is a profession. A profession that can be learned.

Comments of any kind are always welcome.

Laurens van Lieshout

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[29] Advancing insight has also been applied in this document. This also happens in writing the design specification. In practice it appears that the requirements are regularly adjusted during the design. If properly documented and consulted with the 'stakeholders' this is not a problem. It would rather be a sign on the wall if this did not happen.