What is the problem?
The problem is that in the opinion of the company Fun-Play BV their target market is too small. The company wants to expand their target market by developing a toy that can be used on water. The toy must be able to be moved in and on water. The product needs to have a driving mechanism and a transportation system that the user eventually could use to get acquainted with the technical aspect of the system. A potential problem is that the product is supposed to attract a target group from 7 - 11 years. Therefore the design should communicate to this target group.

What are the goals?
The goal is to design a product that is suitable for kids between 7 - 11 years and addresses a certain play activity of this group. Next to that the product needs to move in or through water with help of a driving mechanism or other transportation system. Furthermore the product needs to be suitable for competition or game element.

What are the avoidable side effects?
Some effects that are created by this product have to be avoided. Next to pollution that the production causes, effects of the user have to be taken into account, such as noise created by the users. Also the space that the product will occupy in public spaces, which in turn can create problems by not leaving enough space for i.e. storage.

Which ways of action are available in the beginning?
There are a number of conditions that need to be agreed on before solving the problem. For this product only the following materials can be used: metal, wood and plastics. The deadline needs to be met in 14 weeks.

What Is a Problem Definition?
What is a problem? What does a problem definition (see figure 2.13) consist of, and how do goals and objectives fit in? A problem always has to do with dissatisfaction about a certain situation. However, satisfaction is a relative concept, so problems are also of a relative nature. A big problem for one person may not be a problem at all for someone else.

An expected situation in the future does not have to be accepted. You can try to do something about it, by acting now. For defining a problem this implies that it is not sufficient to describe the existing state. Therefore, we speak consciously of the situation that someone is or is not satisfied with. As a result, a description of the situation is a description of a state plus the relevant causal model(s), including the assumed patterns of behaviour of the people and organisations involved. A situation is only a problem if the problem-owner wants to do something about it. This implies that a situation must be conceivable that is more desirable than the present one: the goal situation. The existing situation, however, can also be formulated in such a manner that a problem does arise.

When Can You Use a Problem Definition?
A problem definition is usually set up at the end of the problem analysis phase.
**How to Use a Problem Definition?**

**Starting Point**
The starting point of a problem definition is the information gathered in the problem analysis stage. The different aspects surrounding the design problem have been analysed and should be taken into account in the problem definition.

**Expected Outcome**
A structured description of the design problem, with the goal of creating an explicit statement on the problem and possibly the direction of idea generation. Also, a problem definition clearly written down provides a shared understanding of the problem and its relevant aspects.

**Possible Procedure**
Answering the following questions will help to create a problem definition:

1. What is the problem?
2. Who has the problem?
3. What are the goals?
4. What are the side-effects to be avoided?
5. Which actions are admissible?

**Tips and Concerns**
- When analysing problems there is always a tension between the ‘current situation’ and the ‘desired situation’. By explicitly mentioning these different situations you are able to discuss the relevance of it with other people involved in your project.
- Make a hierarchy of problems; start with a big one and by thinking of causes and effects, divide this problem into smaller ones. Use post-its to make a problem tree.
- A problem can also be reformulated in an opportunity or ‘driver’. Doing this will help you to become active and inspired.

**References and Further Reading**
Checklist for Generating Requirements

What Is a Checklist for Generating Requirements?
Checklists for Generating Requirements are lists of questions that you can ask yourself when creating a design specification (list of requirements) (see also ‘Design Specification (Criteria)’ in this section). Checklists ensure that you adopt a systematic approach to the creation of the programme of requirements. The most important thing is not to forget a particular requirement, meaning that we have to arrive at a complete collection of requirements.

You can create a programme of requirements by taking into account three points of view (see also ‘Design Specification (Criteria)’ in this section): (1) the stakeholders, (2) the aspects involved, and (3) the product life cycle. You can take these different points of view into account when generating requirements, and some provide explicit, clear-cut checklists (for example Pugh). Other points of view, for example the process tree, are not checklists by definition.

The Stakeholders
The aims and preferences of people set the requirements for a new product. Who are the people affected by the new product, what interests do they have, what do they decide on, and what information can they provide? Important stakeholders are the company, its (future) customers, suppliers, transport companies, wholesale and retail trade, consumer organisations, and legislators. An example of a checklist to distinguish relevant stakeholders can be found in Jones (1982).

Aspects Involved in Product Design
There are checklists of aspects which usually play a role in the assessment of a product. By aspects we mean such general issues as performance, environment, maintenance, aesthetics and appearance, materials, and packaging among others. Such checklists have been drafted by Hubka and Eder (1988), Pahl and Beitz (1984), and Pugh (1990) - see the example in figure 2.14.

Product Process Tree
The process tree of a product (see ‘Process Tree’ in this section) provides a third viewpoint to arrive at a complete specification. Between its origination and disposal, a product goes through several processes, such as manufacturing, assembly, distribution, installation, operation, maintenance, use, reuse and disposal. Each of these processes comes with certain requirements and wishes for the new product. You become aware of these requirements by making a process tree.
When Can You Use a Checklist for Generating Requirements?
Checklists are useful when devising a first list of requirements (see 'Design Specification (Criteria)' in this section), at the end of the analysis stage in the design process.

How to Use a Checklist for Generating Requirements?
Starting Point
The starting point of using checklists is formed by the information found in the analysis of the design problem, the context of the design problem etc.

Expected Outcome
The outcome of using checklists for generating requirements is a first list of requirements, which contains redundant requirements.

Possible Procedure
1. Search for the appropriate checklist.
2. Use the checklist to generate as many requirements as possible.
3. Work systematically through the checklist. Do not skip any of the points on the checklist.
4. Follow the procedure indicated in section 2.1.11.

Tips and Concerns
- Use more than one checklist; checklists complement each other.
- More practical guidelines for developing design requirements can be found in: Cross, N. (1989) Engineering Design Methods, Chichester: Wiley.

References and Further Reading
What Is a Design Vision?

According to the description in the Dutch dictionary ‘van Dale’ vision means ‘The way in which someone judges, considers matters (or things), consideration, view, opinion’. A vision in the context of product design provides us with a personal, inspiring image of a new future situation created by a designer or a group of designers and/or other professionals. This new future situation may directly concern the new product itself (features, functions etc.), but also the domain and context within which the product will be used, the user(s), the usage (or interaction) of the user(s) with the product, the business or other aspects related to the product design. A design vision includes: (1) an insight into or understanding of the product-user-interaction-context system; (2) a view on the essence of the problem: “which values are to be fulfilled?”; and (3) a general idea or direction about the kind of solutions to be expected.

A strong, convincing vision is often well-founded by arguments based on theories and facts, and is often communicated effectively by using images, text and other presentation techniques. A design vision should be sharable and inspiring. As it is the result of the use of theories, facts and arguments, it should be an ‘objective’ interpretation.

When Can You Make a Design Vision?

An explicit vision on the product (to be designed) supports you, the designer, during your search for ideas and the final design. It provides a design direction and thus helps you steer the product design process. This process is supported by many aspects that are influenced by factors such as the opinions of clients, users, team members, producers etc. Therefore a vision (on something - to be specified) should be created in an early stage of the design process.

How to Make a Design Vision?

Starting Point
The starting point of a design vision is a personal vision on the design problem.

Expected Outcome
The expected outcome is a written statement of a design vision or design philosophy.

Possible Procedure
A design vision usually does not ‘come out of thin air’ but is a result of thorough analyses, creative thoughts and personal experiences in design, as well as experience of life in general. The elective course ViP of the master courses provides a specific approach for it (see also section 1.6). A vision development approach is also incorporated in the 2nd year of the Bachelor course ‘Fuzzy Front End’ and Strategic Product Innovation.
What Is a Design Specification?
The Design Specification consists of a number of requirements (see figure 2.15). The design of a product is ‘good’ in so far as it complies with the stated requirements. A requirement is an objective that any design alternative must meet. The programme of requirements is thus a list of objectives, or goals. Goals are images of intended situations, and consequently requirements are statements about the intended situations of the design alternative. Design alternatives should comply optimally with the requirements; an alternative which does not comply with one or more of the requirements is a bad alternative and cannot be chosen. Many requirements are specific; they apply to a particular product, a specific use, and a specific group of users. There are also requirements with a wider scope, as they are the result of an agreement within a certain branch of industry or an area of activity. Such a requirement is called a standard. To some extent, a designer is free to choose requirements; standards, however, are imposed by an external authority.

When Can You Make a Design Specification?
Normally, a design specification is constructed during the problem analysis, the result being some finished list of requirements. However, a design specification is never really complete. During a design project, even during the conceptual designing stages, new requirements are frequently found because of some new perspective on the design problem. Therefore, a design specification should be constantly updated and changed.

How to Make a Design Specification?
Starting Point
The starting point for making a design specification is formed by the analyses that take place during the stage of problem analysis.

Expected Outcome
The outcome is a structured list of requirements and standards. Programmes consisting of 40 or 50 requirements are not uncommon.

Distribution:
2.01 The electrical home scissors should be efficiently transported from producer to wholesale and/or small shops
2.02 The electrical home scissors be efficiently transported from wholesale or small shops to the consumer
2.03 The product may not be damaged during transportation and storage
2.04 The packaged product needs to be stackable
2.05 The displayed product should clearly communicate its function and possibilities

Use:
3.01 The product can be carried and hand-held
3.02 The electrical home scissors have to be ready for use in 1 minute, preferably without use of any extra tool
3.03 The method of assembly of parts needs to be clear
3.04 The use of the electrical home scissors needs to be clear
3.05 Possible use restrictions of the electrical home scissors need to be clear
3.06 The operation of the product needs to be clear
3.07 The product needs to be operated standing and seated.
3.08 The product needs to be able to be used with one hand left and right handed
3.09 The product needs to resist a fall of 0.8m
3.10 The product may not damage the environment in which the product will be used
3.11 The product has to be designed in such a way that it will not harm users
3.12 The electrical home scissors need to be able to be cleaned with a wet tissue
3.13 Adjustments should be done by the user
3.14 The electrical home scissors need to be able to be repaired at a repair service

Example of a Design Specification (Criteria) (from student report)
Possible Procedure

1. List as many requirements as possible. Roozenburg and Eekels state that in order to arrive at a complete design specification, different points of view can be taken into account (see ‘Checklists for Generating Requirements’ in this section). Choose one, or several, of these points of views (stakeholders, aspects, or process tree) to help generate requirements. You can also use checklists, for example Pugh’s checklist (see figure 2.14).

2. Make a distinction between hard and soft requirements (i.e. between quantifiable requirements and wishes).

3. Eliminate requirements which are in fact similar or which do not discriminate between design alternatives.

4. Identify whether there is a hierarchy in requirements. Distinguish between lower-level requirements and higher-level requirements.

5. Put requirements into practice: determine the variables of requirements in terms of observable or quantifiable characteristics.

6. Make sure that the programme of requirements fulfils the following conditions:
   a. each requirement must be valid
   b. the set of requirements must be as complete as possible
   c. the requirements must be operational
   d. the set of requirements must be non-redundant
   e. the set of requirements must be concise
   f. The requirements must be practicable.

Tips and Concerns

• Be careful: do not make the possibilities for your design too limited by defining too many requirements.
• Distinguish between measurable requirements and non-measurable requirements.
• Give your requirements numbers in order to be able to refer to them.

References and Further Reading


Watch interview with Oscar Toetenel (MMID) via the OpenCourseWare version of this guide: http://ocw.tudelft.nl