



Module S10

»Product Life Cycle and Usability«

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1. Introduction

When analysing the life cycle of a product and improving usability, several viewpoints must be taken into consideration. From a user's point of view, a good product is usable, functional, durable and easy to maintain. The user gives weight to his or her own values and attitudes – what is the symbolic meaning, message and status value of a product and a service to the user? Besides the selling price, environment-friendliness and ethicality are increasingly important to most consumers. The user may be provided with new kinds of concepts, in which the focus is not only on the product but also on related services. Development needs arise from different stages of the life cycle, and the need may also be brought up by the user/consumer.

An entrepreneur has to consider what kinds of overall concepts are suitable for the enterprise and what kinds of concepts help to improve the corporate image and the financial profitability. In its actual production, the enterprise has to find out about several matters, e.g. if it can manufacture a product with the existing machinery or should it have this done by an approved subcontractor. Are raw materials and other materials sufficiently available, is production environment-friendly, and a number of further questions. As regards marketing, the enterprise has to consider the suitability of new ideas for the current product range, marketing methods, competitive prices and the number and reachability of potential customers.

The “Product Life Cycle and Usability” module is linked to several other modules, such as B1 “Sustainable Development”. This module provides the basic module B1 with further information on the life cycle of a product. In particular, the user perspective is strongly featured in the Usability section, and this material is well complemented by the specific module S1 “Customer's Needs”. The marketing perspective must also be taken into consideration in all measures related to corporate development; therefore, the specific module S4 Marketing complements this module excellently.

2. Module description

This material focuses on design and usability methods suitable for different stages of the design/product development process. The entire life cycle of product comprises the stages of raw material treatment, manufacturing, transportation, marketing, use and disposal. By analysing the life cycle, design/product development aims at the design of entire life cycles instead of just products. Services related to the entity may outweigh the product. In this module, instructors are required to have a basic knowledge of sustainable development, life cycle design and usability. There is plenty of source material available on these topics, and it is advisable to get acquainted with it before the workshop. When training entrepreneurs, the instructor should also have personal entrepreneurial competence.

Part A focuses on life cycle thinking and discusses the basics of life cycle design. It includes sets of exercises with which the workshop participants can gradually increase the environment-friendliness of their enterprises' products and concepts. The exercise "Future-Oriented Product Life Cycle" (B1-C5) begins with an examination of various actors in different stages of the product life cycle. It provides the participants with a clear picture of the stages of the life cycle and motivates them to discuss and develop a more sustainable product life cycle. In the exercise "Life Cycle Checklist" (S10-A3), the life cycle is examined from the perspectives of needs, raw materials, production, distribution, use and disposal. It includes adaptable detailed questions in which the enterprise's products and concepts are examined through the current situation, through issues to be developed and through opportunities for change. This exercise deepens the preceding exercise also presented in the B1 module "Sustainable Development". In addition to the exercise, some qualitative and quantitative methods for analysing the life cycle are presented. Further information on these methods (MET matrix, eco-indicators and LCA software) is available in the sources mentioned below. Part A also aims to motivate enterprises to add services to the product life cycle and to design new innovative concepts for the environment-conscious consumers of the future. The PowerPoint presentation "Life Cycle Thinking" (S10-A1) can be used at workshops.

Part B focuses on the planning of usability testing. The exercise "Orientation to Usability" (S10-B2) aims to make participants interested in usability and to make them notice that even simple methods can reveal several things for the purpose of product and concept development. The grounds for selecting usability methods for different stages of product, product idea and concept development process are presented as a chart (S10-B3). It is useful to discuss the planning stages of usability testing with the participants at a workshop (S10-B4 and S10-B3). The PowerPoint presentation "Usability" (S10-B1) can be used at workshops.

Part C examines a number of different methods for testing usability. They are presented in general terms, as there is plenty of source material available on usability and various methods – also electronic sources on the internet. Two methods, observation and context mapping, are presented in more detail. Additional material is available for both of them: a model table for documenting observations (S10-C1) and for context mapping (S10-C2).

The module S10 “Product Life Cycle and Usability” comprises three parts.

Part A: Life cycle thinking

Part B: Usability

Part C: Methods for testing usability

3. Part A: Life cycle thinking

»Do not design products! Instead, design product life cycles that are compatible with sustainable development.«

(PRé Consultants)

Keywords: life cycle, sustainable design

This section deals with:

- What is life cycle design?
- Methods for life cycle design
- Added value brought by services

Life cycle design is a method in which the environment is taken into consideration in all stages of the life cycle. The main aim is to develop the compatibility of products and services with sustainable development by reducing the burden placed by the products on the environment throughout the life cycle, also taking account of other traditional product and customer demands, such as quality, safety, price, producibility, ergonomics, aesthetics and ethics.

The stages of a product life cycle can be divided into five sectors:

1. Raw materials
2. Manufacture of a product
3. Packing, transportation, marketing
4. Use, maintenance, updating and repair of a product
5. Recycling and disposal of a product

The use of natural resources should be minimised and the environmental load reduced during the life cycle. The aim is to achieve sustainable production and sustainable consumption. During the product life cycle, there are several actors, such as customers, subcontractors, financiers, partners and stakeholders. The basic module B1 includes an exercise in which the workshop participants discuss the life cycle of their products: Which actors participate in the life cycle of a product and in which stage? The exercise serves as an excellent orientation to the methods for analysing life cycle presented later on.

→ B1-C5 Future-Oriented Product Life Cycle

When designing product life cycles, the life of the product as well as the stages of use and disposal have to be taken into consideration. Usually, the aim is to maximise the life of the

product and to prolong the life cycle after the use, but also disposable products are needed for specific purposes. Be it a high-quality, classic piece of furniture or a pair of disposable medical gloves, the aim must be to minimise the environmental load reduced throughout the life cycle.

3.1 Life cycle design

Life cycle design aims to pay attention to and to minimise the environmental effects during the life cycle. In addition to the environmental effects, effects on ethics and labour policy also play a central role throughout the life cycle. During the product life cycle, there are several actors to be considered in overall planning. By analysing the life cycle, design/product development aims at designing entire life cycles instead of just products. Services related to the entity may outweigh the product. Development needs arise from different stages of the life cycle, and the need may also be brought up by the user/consumer.

The following list and table outline in general terms which environmental effects have to be taken into consideration throughout the life cycle.

Raw materials

- Optimised use of raw materials
- Saving of natural resources
- Use of renewable sources of energy
- Safeguarding the sufficiency of available natural resources
- Avoidance of harmful substances
- Minimisation and avoidance of emissions and waste

Manufacturing

- Minimisation of raw material, energy and water consumption
- Prevention and minimisation of generation of emissions and waste

Distribution

- Optimisation of packing and packing systems, avoidance of dispensable packing (transportation package/sales package), environment-friendly packing materials
- Use of optimally environment-friendly logistics (transportation distances, means of transport)

Use

- Increase in the durability and usability of products in terms of both technical and visual life
- Reduction/prevention of environmental effects during the use of a product

Disposal

- Designing products to be easily recyclable
- Designing products to be easily dismantled
- Designing products to be reused
- Consideration of the environment-friendliness of non-recyclable materials as waste

Need

- Do the product and the possible related services meet the social needs?
- What does the user really need, is there a corresponding product/service at the moment?
- Will the need change in the future, and how will this affect the development of the product and the services?
- Can the product be partly replaced with service?

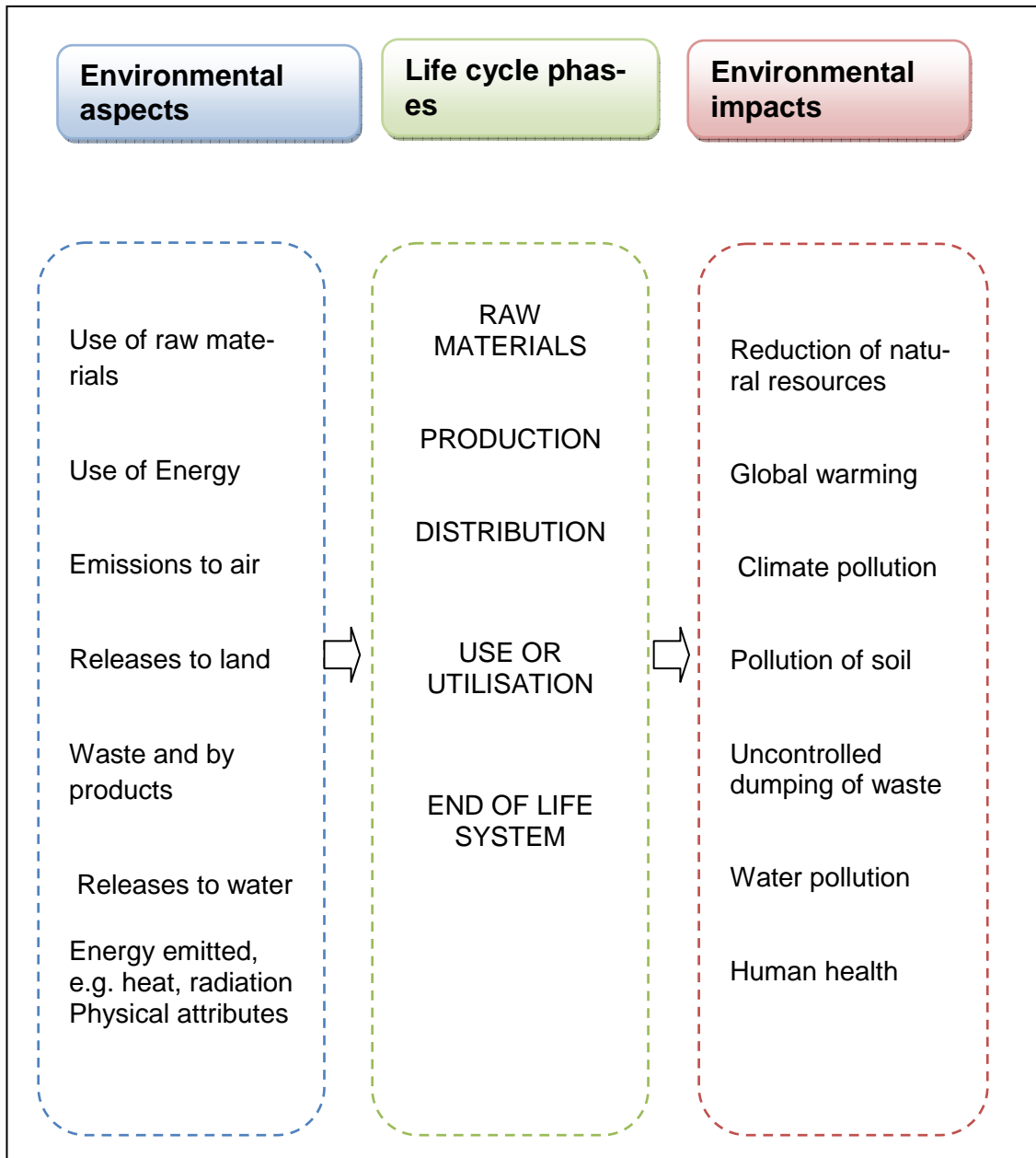


Chart 1: Environmental effects during a life cycle (source: Ecodesign Training Kit)

3.2 Methods applicable to life cycle design

Different stages of the life cycle can be analysed with qualitative or quantitative methods. Qualitative methods include the analysis of the life cycle by using the checklist for ecological design or the MET matrix, and they are best suited for the first analysis of an enterprise. Eco-indicator 99 and SimaPro software are examples of quantitative methods.

Checklist

Checklist is a simple and quick means that can be used together with any method. A prepared list of questions alone serves as a reminder of environmental aspects to be taken into consideration. The list will help to recognise strengths and weaknesses of environmental effects. However, it cannot be used for generating detailed quantitative information on the most significant environmental effects, nor for comparing the relative environmental impact of different factors with each other. Nevertheless, this method is an efficient introduction to ecological design because it encourages to think about environmental issues and to understand how important the optimisation of environmental aspects is. The use of a checklist is also the first step, after which other tools for environmental analysis (e.g. MET matrix or Eco-indicator 99) can be used.

→ S10-A1: Life Cycle Checklist

MET matrix

The MET matrix is also a relatively easy and quick analysis method. It is used for analysing environmental effects of input and output throughout the life cycle. It generates only limited quantitative information on the most significant environmental effects or the product itself. When using this method, environmental expertise is required or external experts need to be consulted. The MET matrix can be used prior to more extensive environmental analysis tools generating quantitative information (e.g. Eco-indicator 99, LCA software). Information is not necessarily available on all eco-indicators, in which case this method is suitable to replace the ones mentioned above.

In the MET matrix, the complex entity of environmental effects is divided into three categories: material (input and output), use of energy (input and output) and emissions that are toxic to the environment and humans (output).

In the MET matrix, the life cycle of a product is divided into five stages: production of material and parts, manufacture of product, transportation, use and – finally – recycling and disposal.

Transportation is indicated in the matrix with a single entry, which describes transport operations throughout the life cycle. More detailed instructions for the use of the MET matrix are available e.g. at <http://www.mindcom.fi/vihreakonsti/> (in Finnish) and more recent instructions at <http://www.learn-ecodesign.net> (in English).

Eco-indicator 99

Eco-indicator 99 is a method that is relatively easy to learn and use. It can be used for a quantitative assessment of environmental effects without separate software and without any additional experts. The method is based on eco-indicators; for example, performance indicators of different categories of environmental effects are combined and weighted in order to create a single indicator to describe the result of the life cycle assessment. Indicators can be used e.g. for comparing the environmental effects of different types of transport operations. Indicators are subject to further elaboration, and essential parts of the process may still be missing from them. The method is complicated to use for complex products because several indicators are required. If the most significant eco-indicators are not available, this method is not recommended. The use of the eco-indicators reduces the need for environmental experts; the method can also be used together with the MET matrix. A more detailed description of the method, including lists of eco-indicators and calculation tables, is included in the Ecodesign Training Kit material. The entire material is downloadable at <http://www.learn-ecodesign.net>.

LCA software

SimaPro and similar software facilitate the calculation of the environmental effects during a life cycle, as well as the comparison of matters and stages. Before using the software, it is advisable to assess the life cycle with qualitative methods, e.g. a checklist. This will make the method and the results attained more easily understandable.

The software may also be fairly expensive. It is possible to download a demo version of the SimaPro software before making a purchase. There are several versions of SimaPro for different kinds of enterprises and educational institutions.

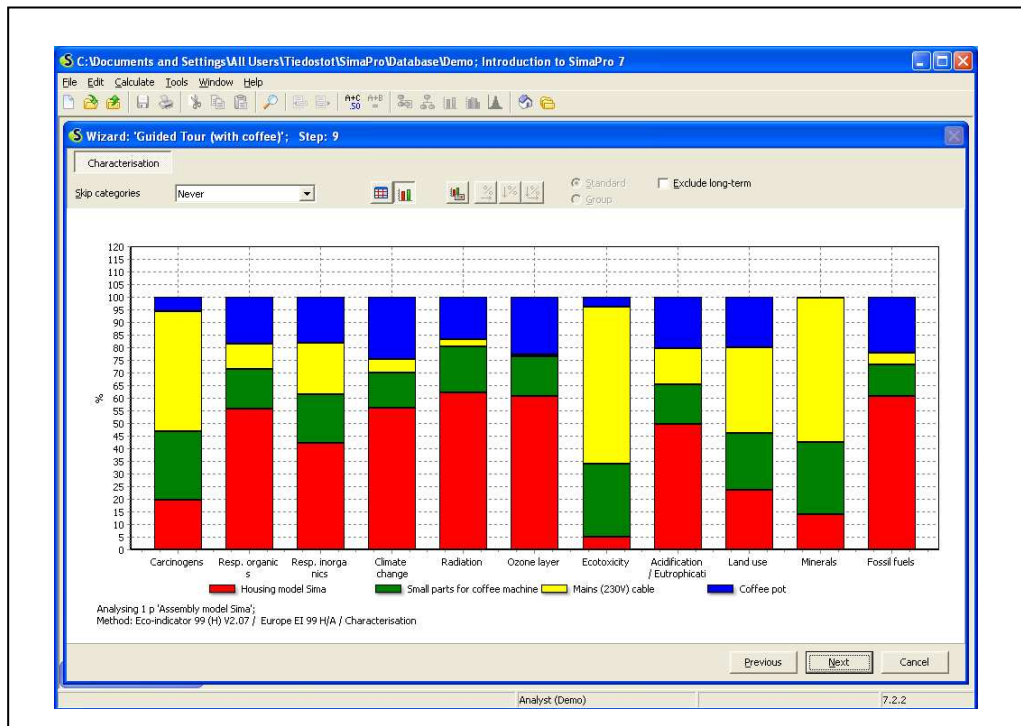


Figure 2: SimaPro software (source: PRé Consultants)

3.3 Product and service

The environmental load of a product can be reduced by adding services to the overall concept. When designing the product life cycle, it should be considered whether the product can be partly or even entirely replaced with service. The most important aspect of life cycle design is the combination of material products and immaterial services so that together they can meet the customers' needs optimally and provide high quality. In other words, in life cycle design it is important to find out about the customer's real needs and to offer/design products and services accordingly.

Adding new services increases the added value of the product; at its best, this will improve the entire corporate image. Typical services include repairs, maintenance and leasing. For example, customised services enable the provision of products and services only as needed. When the customer can influence the outcome of the product and service, customer satisfaction increases.

In many cases, essential success factors are similar:

- Creation of added value to the customers by improving quality, tailoring the product and service as necessary and enhancing comfort
- Creation of all-new functions or creation of new intelligent or unique combinations of old functions and concepts
- Addition of services – e.g. leasing or renting – lowers the customer's financial threshold for using the product and service
- Addition of services reduces the environmental load
- New ways of thinking may bring new kinds of innovations to the enterprise

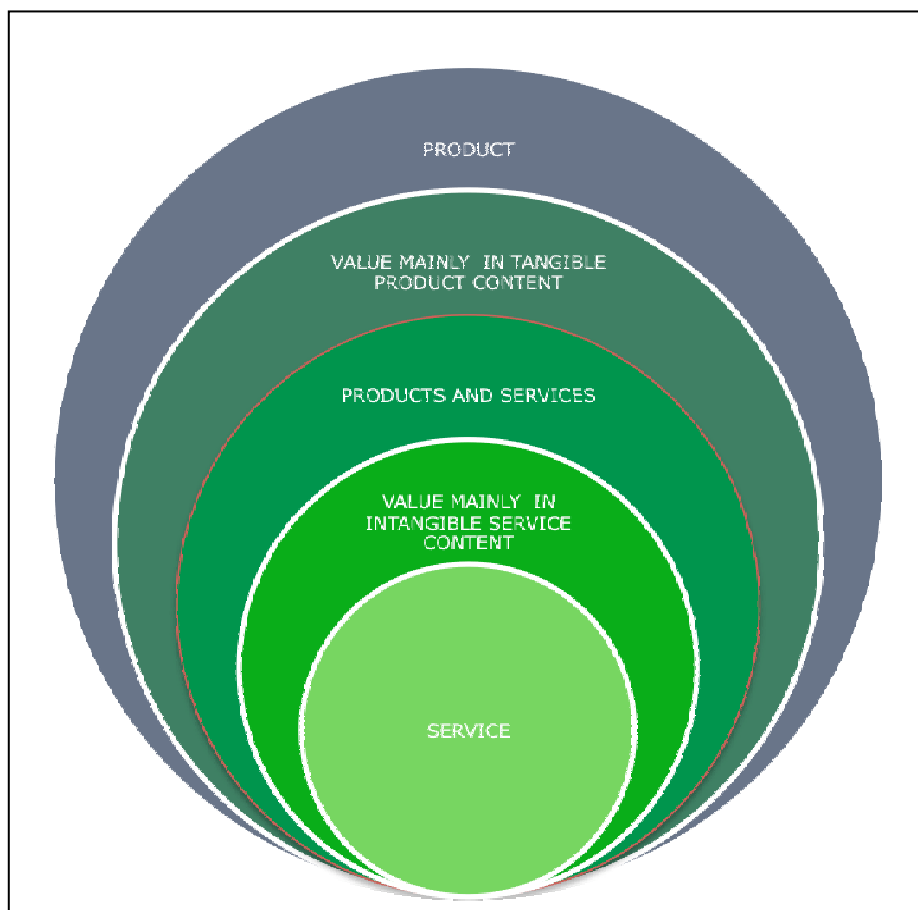


Figure 3: An increase in services reduces the environmental load (source: D4S)

4. Part B: Usability

Keywords: usability, usability testing

This section deals with:

- *Consideration of usability in the development of product ideas and concepts*
- *Planning and implementation of usability testing*
- *Selection of usability methods in different stages of the process*

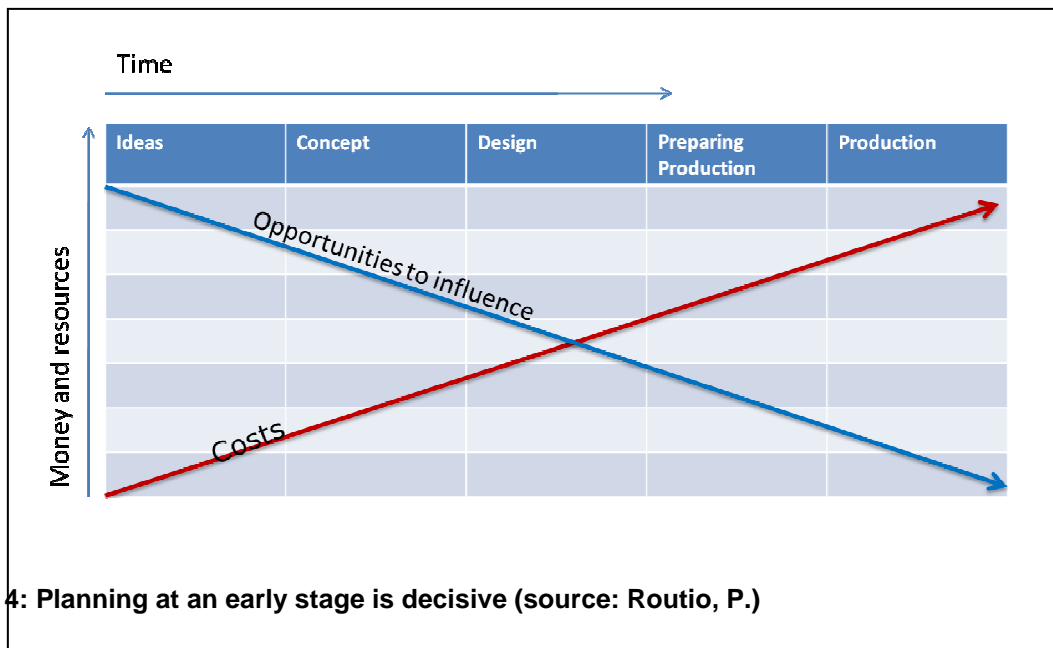
A good product is ergonomic, safe, of good quality, easy to use, aesthetic, ecological and ethical. Its design is pleasant to the user. The usability of a good product meets the needs, preferences and values of the consumer. The usability of the product increases its environment-friendliness. When a product is usable, the user does not need or want to get rid of it quickly. When there is no frequent need to buy a new product to replace the earlier one, the product is also more economical for the consumer.

Usability can be tested in different stages of the design process, with products, services or product ideas and concepts that are in different stages. Usability is preferably tested by involving users. The role of the user can take several forms: he or she can participate in the design/product development process as a team member or just reply to a survey. Usability can also be tested without users if users cannot be consulted due to the timetable or some other reason.

In recent decades, the customer's role has first moved from consuming to using, then from participating to adopting, and the current trend increasingly emphasises the role of the humans as participating designers. Social media speeds up this development; phenomena and issues are rapidly diffused to large target groups. Enterprises have to keep pace with this development and to stress increasingly the importance of the users' values and attitudes in their products and services. In the design process, it is economical to use methods that generate versatile information related to the perception of the products, are directly suited to the comprehensive and sensory character of design and help to take the values and attitudes of the users into consideration.

In particular, the actual stage in the product development process has an impact on the choice of methods to be considered useful. The best results are achieved at the beginning of the process when the overall concept is discussed. By making users part of the process at this early stage, a lot can be found out about the real need for the concept. Is there a need for the product alone, or would an all-new innovative concept with its possible new services

be a more profitable and also more environment-friendly option? By analysing the stages of the life cycle, the entity will be made more environment-friendly and often the production will also be more profitable. Planning at an early stage is particularly important because then it is possible to have the largest influence on the product development process and this is significantly more affordable than changes made later on. Chart 4 below illustrates how the costs of product design (indicated by the rising arrow) particularly at the beginning of the process are small when compared with the subsequent production costs. By contrast, the opportunities to influence will diminish.



4.1 Methods suitable for different stages of the life cycle of a product or service

In order to enhance usability, it is appropriate to look for the most suitable methods for each stage of the process, each user group, each planned use, each solution to the problems, as well as the timetable and the budget. It is important to choose methods whose results enable quick and easy applications in product development.

It is advisable to pay attention to usability even when the timetable and other resources do not allow more detailed usability testing. Usability can be analysed with minor measures, such as prepared checklists and user trips.

Chart 5 outlines the grounds for selecting different methods in general terms. More detailed descriptions of the methods are given in Part C: Methods for testing usability.

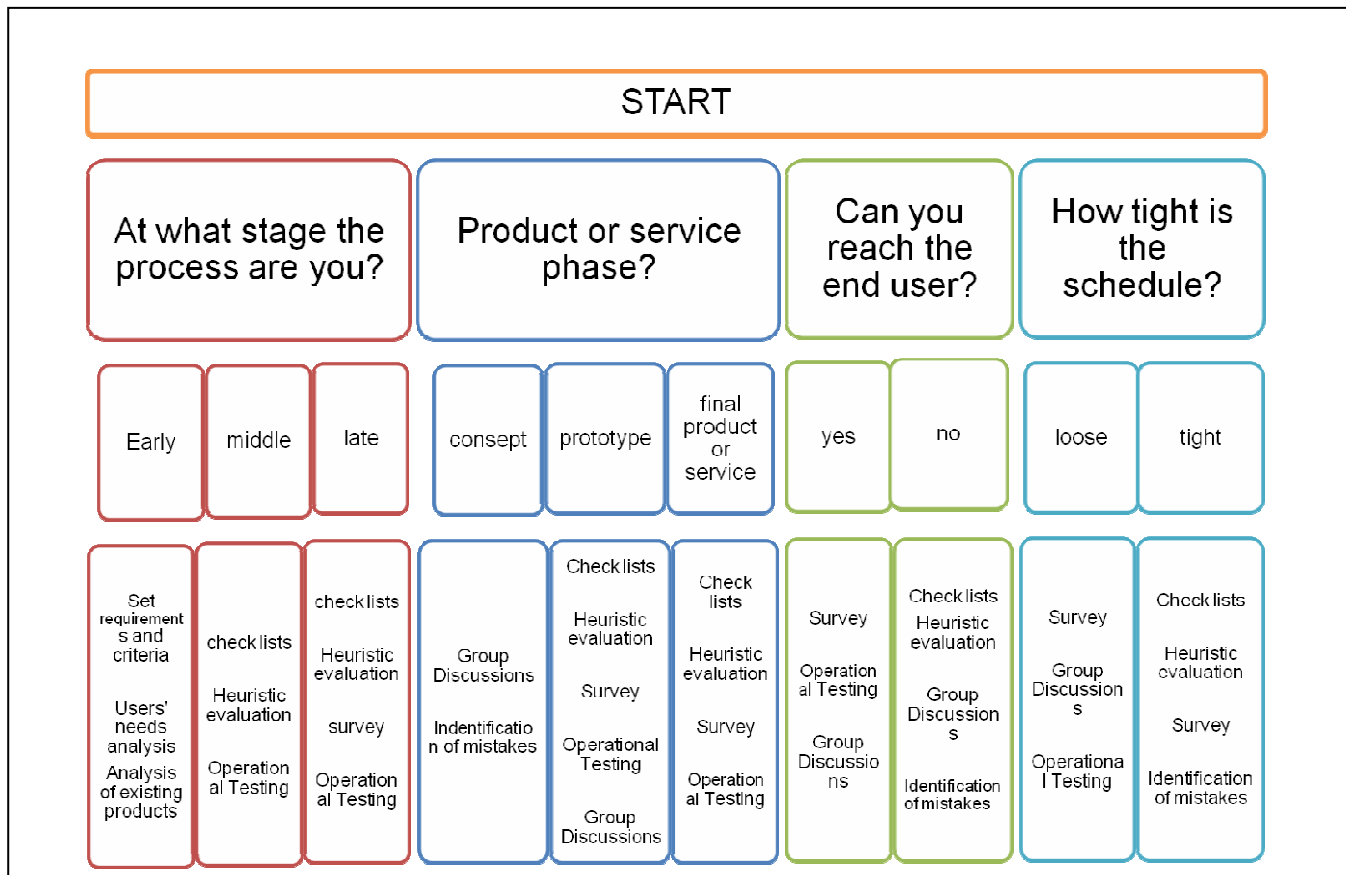


Chart 5: Selection of usability methods (sources: Stanton-Barber 1996, Kälviäinen, M. 2001)

→ S10-B2: Chart

Process stages and methods applicable to them

Early stage:

When determining the requirements, the criteria are analysed from different perspectives, i.e., what are the requirements placed on the product or service. Moreover, the entity must be examined for each stage of the life cycle separately. Various methods – such as context mapping – can be used for analysing the user needs. Users can be involved in the design process. When analysing existing products, a competitor analysis can be used. At the early stage, it is often useful to use observation too.

Middle stage:

It is advisable to compile a checklist of the criteria decided upon during the determination of the requirements. The list can be utilised in later stages of the process. In heuristic evaluation, external experts are used to assess the product and the service. Operational testing is applicable to products or services in various forms; for a user, a prototype or a scale model is the easiest to assess. Operational testing can be based on the method of e.g. observation or interviewing.

Late stage:

In addition to the above-mentioned methods, surveys can be used. Small-scale surveys can be carried out among the enterprise's own customers, who belong to the future target group of the product or service.

Form of product or service

Usability testing is applicable to products or services in the concept and prototype stage, or to finished products or services. In the concept stage, it is particularly important to pay attention to the way in which the ideas are presented to the users. An idea in the concept stage can be subject to a group discussion, which may involve the user. In the concept stage, assessments can be used and mistaken concepts can be eliminated.

A prototype can be tested e.g. by making observations and interviewing test users or carrying out a survey. External experts can be requested to assess the prototype, or the prototype can be examined in accordance with the prepared checklists. Similar methods are also suitable for assessing a finished product or service.

User involved or not?

The selection of the methods is influenced by the fact whether it is possible to involve users of the products and services. If the user cannot for any reason be involved in the usability testing, assessment will be carried out among the enterprise's own team and possibly external experts.

Timetable

The selection of the methods is also influenced by the tightness of the timetable. If the timetable is tight, actual users can only be involved with possible surveys.

4.2. Presentation of ideas in different stages of the life cycle

When a proposal for a plan is presented to persons who are not accustomed to the presentation techniques of designers, these “laymen” should react to it in the same way as to an actual item. In the concept stage, it is particularly important to pay attention to the way in which the ideas are presented to the users.

Presentation of a plan to be assessed

- Verbal descriptions
- Presentation of operations as a cartoon
- Operational charts
- Pictures and drawings
- Mock-ups i.e. three-dimensional constructs
- On-screen presentation of the plan
- Serviceable prototype

4.3. Selection and position of test users

When designing a product and service, a possible target group shall be determined. Optimally suitable users should be found from among this target group to test the usability of the product or service. In major enterprises or large development projects, a third party, newspaper advertisements or different kinds of registers can be used to find suitable users. In small enterprises, it is advisable to start looking for suitable users from among the enterprise's own clientele. Familiar customers may be motivated to develop products and services whose end users they possibly are.

The position of a user in a design process may be very different from his or her position in usability testing. Users may act as respondents to a survey only or as testers of products and services, or they may be member of the design team.

4.4. Planning and implementation of testing

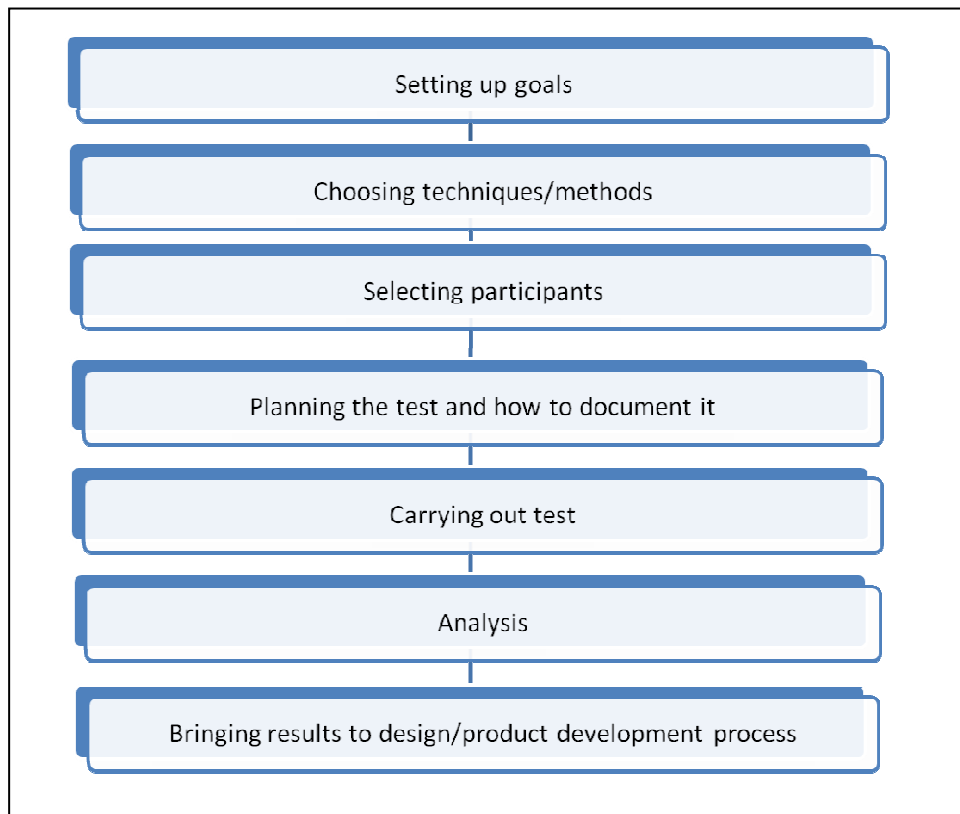


Chart 6: Stages of planning and implementation of usability testing (own source)

It is useful to discuss the planning stages of usability testing with the participants at a workshop. After determining the focus of development and the objectives, the participants select a suitable method. The grounds for selecting usability methods for different stages of product, product idea and concept development process are presented as a chart (S10-B3).

→ S10-B3: Chart on the Selection of the Usability Methods

→ S10-B4: Planning of Usability Testing

5. Part C: Methods for testing usability

Keywords: usability methods

This section deals with:

- Observation
- Co-creation
- Context mapping
- Surveys
- Interviews and discussions
- User trip
- Heuristic evaluation

Chart 5 in the previous chapter (p. 18) features the various stages of the design process and the methods applicable to each stage. The methods are classified according to whether the user can be involved in the testing of the methods. Some methods are suitable for both options, e.g. “user trip” that can be carried out when the user is involved or by the designer/expert alone. Group discussions can also be carried out accordingly. The methods are described in general terms. The methods are described in more detail in the source material, which is indicated in the list of references and in the additional material.

Observation

- can be carried out in different stages of usability development
- must be remembered as an important form of research, also prior to the beginning of the actual design process. It answers to the question: for which situations and for which functions is the product designed?
- An everyday observation situation is always complicated. However, it can be divided into parts, in which it is possible to examine and analyse the operational environment, operational stages, operational problems, operational development aspects etc.
- Observation serves to find out what is happening, but without interviews or the user's personal reporting, it is not possible to have an explanation for the causes or meanings of the operations (e.g. “I do it this way because I have certain personal qualities”).

= usually combined with an interview

Documentation:

- Notes, drafts, photographs and videotaping are important tools of observation since an observer cannot rely on his or her “eyes” only.

- An observing situation always requires planning in advance.
- Which tasks of the user are to be observed?
- To what is attention paid?
- An observer must be impartial!

→ S10-C1: Model Table for Using the Observation Method

Co-creation

- Users participate in product development as active members of the product development team.
- Users' creative efforts, drafts and prototypes, as well as products assembled from modules produced by the designers may serve as material on the basis of which the product design process will be advanced.
- Everybody is creative but everyone cannot become a designer. It depends on expertise, interest and creativity.
- It may be a better option to rely on a designer's creative work and production of models so that users may comment on them and make amendments on the basis of their needs.
- In co-creation, the researcher/designer should assume the role of a tutor who ensures the smooth progress of the workshop and supports all participants. This means encouraging the participants at their individual levels of creativity.
- Users can also be trained or advised to understand design-related factors in a better way. This way they can better participate in a product development project as true team members.

Context mapping

- Context mapping comprises several techniques with which the designers and researchers are in contact with users in order to find expressions and descriptions for user experiences.
- Users are provided with different tools and techniques of creative design. These include collage technique, drawing and construction of (scale) models. With these, they can express their needs, desires, dreams and opinions on situations where the product is used.

Collage technique

- compilation of plenty of different (descriptive) words (recommendation: 100 words)
- compilation of plenty of photographic material (various types of images, such as nature, city, different people of different ages, fantasy, products/objects, action etc. Pay also attention to different contexts, such as home, work, holiday, emotional etc.)
- The topics of the images must be balanced: positive/negative or concrete/abstract.
- The images must as ordinary as possible and the image quality as uniform as possible.
- Participants compile the words and images into a collage that they complement with their interpretations and stories.

Scale models

- Participants use suitable material to build scale models, which they describe with their story and interpretation. For example, modelling clay can be used for scale models.

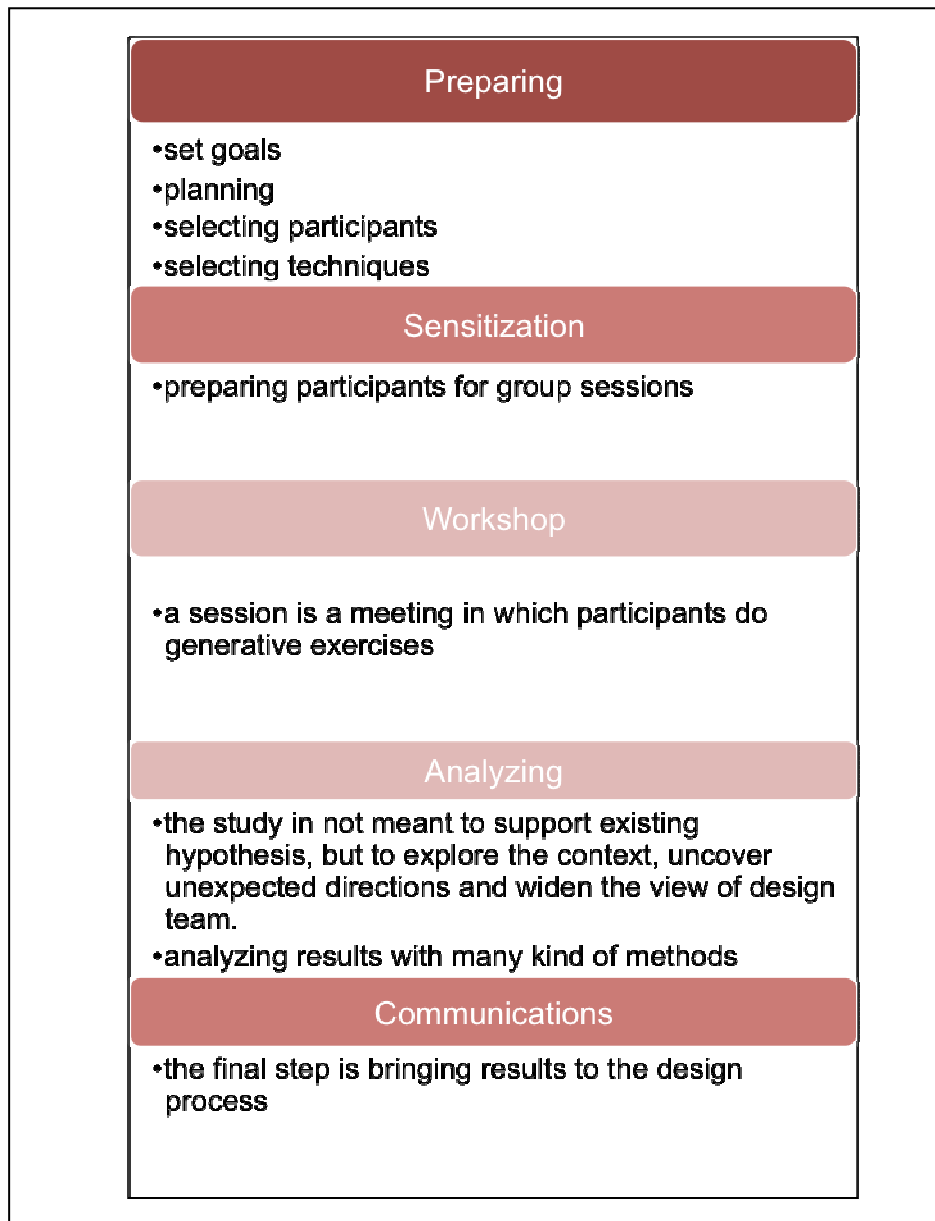


Chart 7: Stages of context mapping (source: Sleeswijk Visser, F. et al. 2005)

→ S10-C2: Context Mapping

Surveys

- Surveys usually generate only replies to the questions prepared in advance.
- A survey is useful and necessary when the users cannot be reached in any other way or when information is wanted from a large group of users.
- A survey is a quick method. Apart from postage and preparations, it is economical. It reaches a large number of respondents with relatively small costs.
- In order to acquire information needed in professional design tasks, visual surveys may also be necessary e.g. to clarify product qualities or visual features.

Interviews and discussions

Who is interviewed?

Experts: may provide necessary additional information and, for example, create visions of product development in the future.

Users: can approach their situation very analytically and describe how they experience it. A motivated user is usually willing to tell about his or her demands, situation, expectations etc.

User trip

- Walking through the different stages in the use of a product
- Designers, experts or users make a “trip” into the use of a product to be designed.
- May also be made in a real context of product use, in which case the impact of the context and the related environmental factors are taken into consideration.
- Analysis of usability-related experience and problematic features, evaluation of operational smoothness
- The method enables an empathetic relationship to the user's experiences so as to better identify with the user when developing the product requirements and the plan.

Heuristic evaluation

- Experts analyse the product independently in accordance with the principles and requirements placed on it.
- General usability principles are often used as tools for preparing the principles and requirements of usability analysis.

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Links

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7. Material

Part A: Life Cycle Thinking

S10-A1 Life Cycle Thinking (PPP)

S10-A2: B1-C4 Future-Oriented Product Life Cycle

S10-A3: Life Cycle Checklist

Part B: Usability

S10-B1: Usability (PPP)

S10-B2: Orientation to Usability

S10-B3: Chart on the Selection of the Usability Methods

S10-B4: Planning of Usability Testing

Part C: Methods for testing usability

S10-C1: Model Table for Using the Observation Method

S10-C2: Context mapping