# Ecodesign of Electronic Devices

## UNIT 4: Design concept for electronic devices

Funded by the Erasmus+ Programme of the European Union

Ecoinnovation Skills for European Designers, Project number: 562573-EPP-1-2015-1-SI-EPPKA2-SSA.

# General approaches and concepts of designing electronic devices

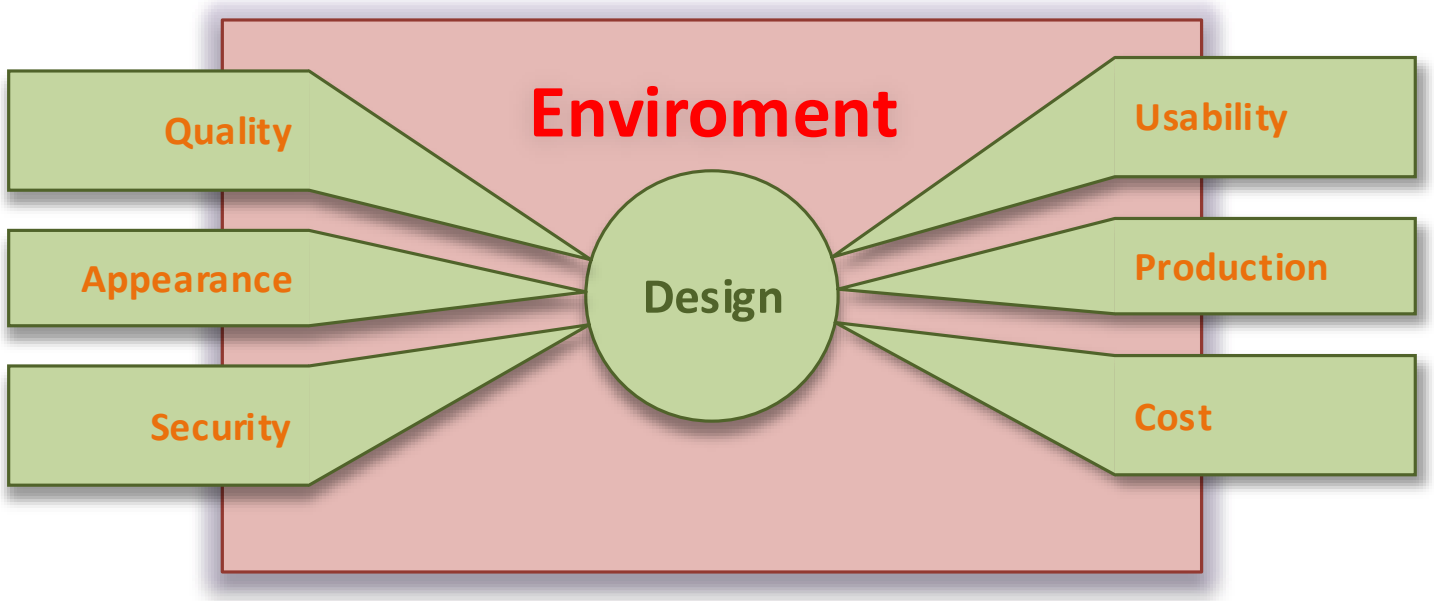
- The design of electronic devices is a complex process that requires a lot of preliminary preparation and analysis. One of the preparations is also to take into account the environmental aspects of the process of design, production, and operational efficiency of the device.
- The aim of the ecological design is to redesign the already existing device or to design a new concept that takes into account the aspect of the product's sustainability and functionality. In many cases, the re-design of the device is more common practice for many companies, since this involves lower risk and easier introduction of the new product to the market.
- The process of the product begins with the acquisition of materials and the processing of raw materials. The following cycles cover the production, distribution, use and disposal or recycling of the product. Various environmental and social issues arise in all of the above phases, which are included and adequately addressed during the design.



Funded by the
Erasmus+ Programme
of the European Union

# General approaches and concepts of designing electronic devices

- Product design process:

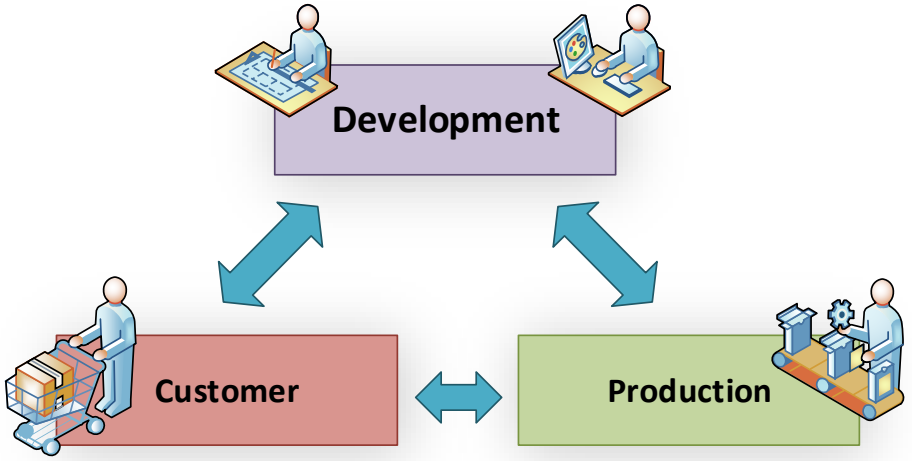





Funded by the
Erasmus+ Programme
of the European Union

# General approaches and concepts of designing electronic devices

- When developing an electronic product, three stakeholders are involved:
  - The first group expresses the desire to develop a product and presents the problems that need to be solved.
  - The second group adopts the design and elaborates the required solution.
  - The third group adopts and proposes the proposed solution.

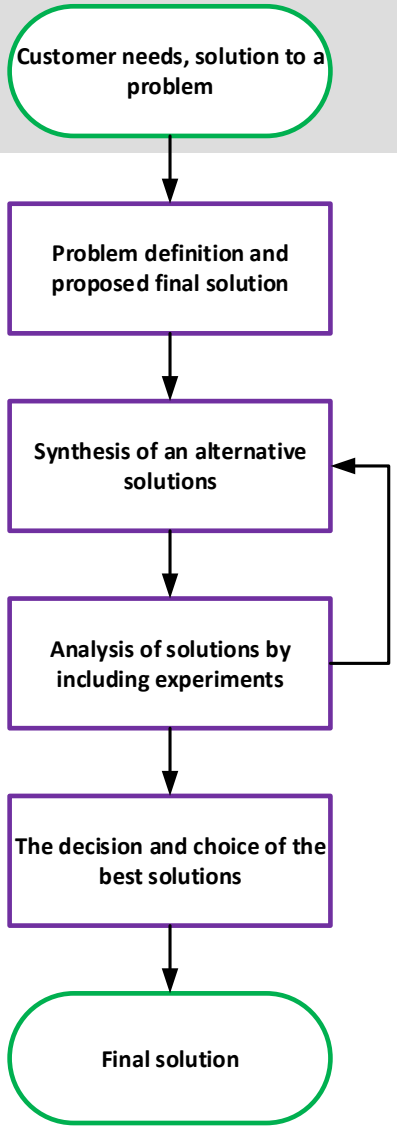





Funded by the
Erasmus+ Programme
of the European Union

# Design process

- Most design problems are very complex so that the final result can not be accurately predicted. In order to achieve the goal it is very important that the planner tackles the problem solving methodically and in separate phases.
- The planning process begins with expressed needs and possible problems and symptoms.
- The planner presents his expressed wishes in the form of definitions, possible problems and predicts the final outcome.
- In this initial stage, it is very important that the planner, when setting the definitions and the expected final outcome, takes into account environmental aspects, both in solving the problem and in the final outcome.






Funded by the Erasmus+ Programme of the European Union

# Design process

- What should the device be based on ecological principles?
  - Ecological devices should not be of lesser quality or less effective.
  - Ecological devices must be better than competitors.
  - The device must meet environmental standards.
  - The device must include advanced features.
  - The device must be effective.



Funded by the
Erasmus+ Programme
of the European Union

# Methodology for high-quality device design

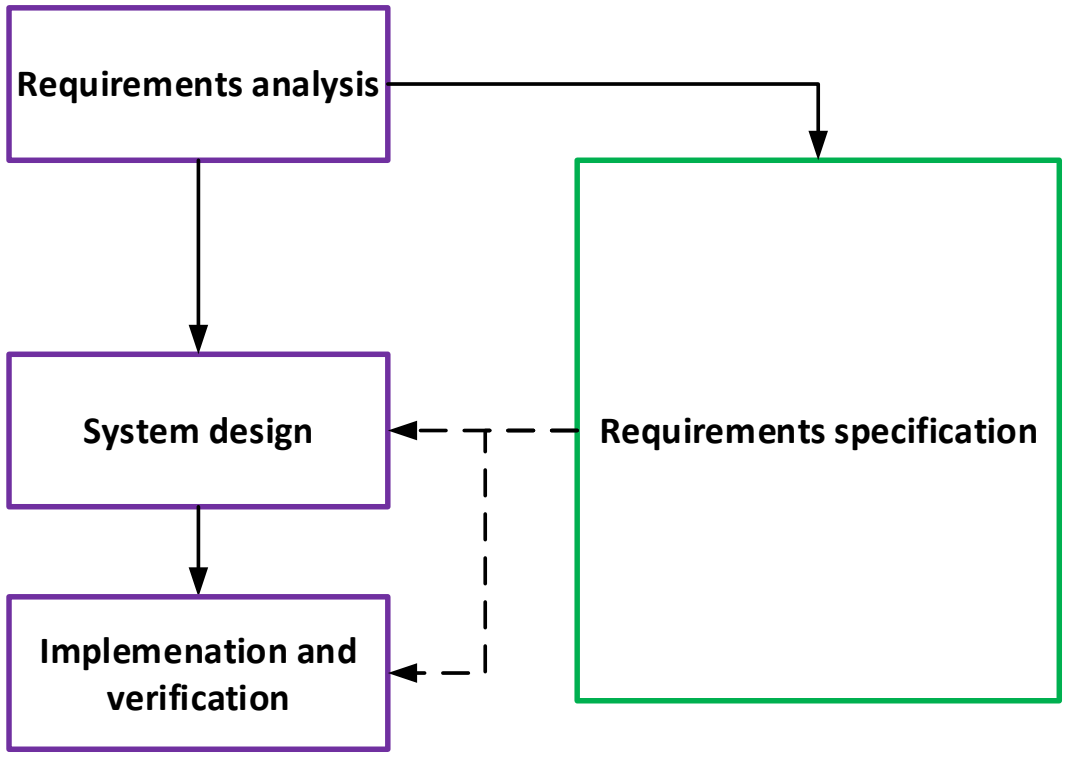
- All devices and items can be evaluated based on their qualities or price on the given rating scale. Unfortunately, there are no criteria for measuring design quality and its methodology.
- For quality ecodesign, it is very important that the product meets high environmental standards both in production as well as in use and removal. In many cases, we face a dilemma between efficiency and saving when designing highly ecological devices.
- Higher quality products also mean higher brand confidence and market expansion.
- Market analysis is crucial. The consumer market is very diverse and perceptible for various products, and this offers many opportunities for the production of new devices and solutions.
- In the industrial environment, trust in the brand and the quality of products, which is more important than the price of the device, plays a very important role.




Funded by the
Erasmus+ Programme
of the European Union

# Analysis and requirements specification

- The specification of requirements is the first step towards designing the device and represents the destination of the journey with given answers, What is the problem we are solving with the design of the device! "Or otherwise" What is the purpose of designing. "
- The specification of requirements offers an answer to other critical questions: "How can anyone involved in the design process know what has been done?" Thus, the specification of the requirements sets the criteria for verification if the design meets the set objectives.
- It also works like an early control filtered front that eliminates those designing procedures that are too ambitious against others, have conflicting goals, solve unfeasible or persistent problems, or otherwise they are doomed to failure.



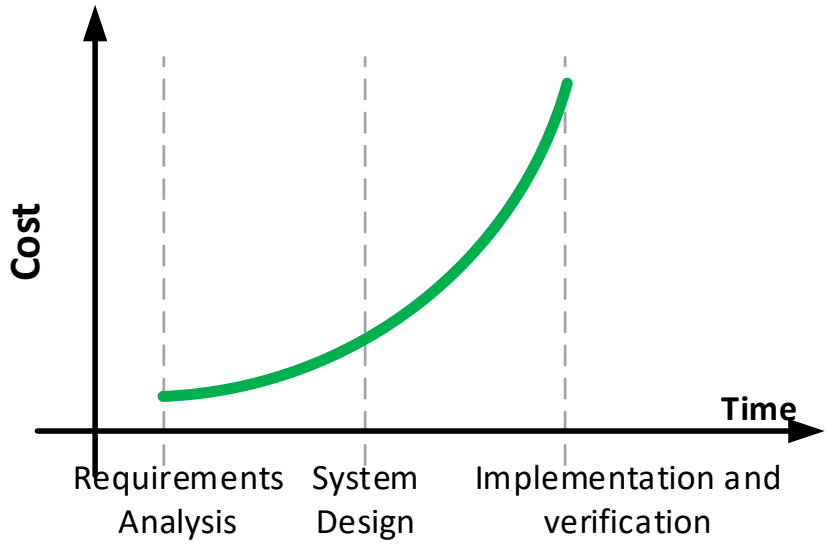



Funded by the Erasmus+ Programme of the European Union

# Analysis and requirements specification

- Recognition of conceptual approaches at an early stage of design, which will have a poor success or negligible market share in the future, will have a positive impact on the company's business or company.
- Likewise, the process of determining requirements is difficult in part because analytical skills are also needed, which are to a large extent different from classical engineering subjects taught in schools.

  - Cost of the design process :






Funded by the Erasmus+ Programme of the European Union

# Determining and outlining requirements specification

- At this point in the planning process, the emphasis is on a customer who needs a solution to the problem.
- The objective is to clarify, define and define the design criteria, which should be specified in the specification of the requirements.
- In doing so, it is essential that the decisions are made in cooperation with the client or the client.
- All proposals and possible alternatives provided must be defined in terms of maximizing consistency with the design process and must be very clear and precise.
- Regardless of who the customer is, the designer must be ready to act as a consultant, a mentor, an expert and a diligent listener. This is a complex task, so it is usually assigned to the most experienced and senior engineers in the design team.




Funded by the
Erasmus+ Programme
of the European Union

# Determining and outlining requirements specification

- There are two scenarios in the development of the specifications specification.
  - The first scenario is called an informed party. In this case, the client consists of several individuals, such as; company director, operators, engineers, etc ..
  - The second scenario is an uninformed party, which represents a complete opposition to the informed party. The term uninformed party means that the specification of requirements must explore the unexplored area and constitutes a brand new product.



Funded by the
Erasmus+ Programme
of the European Union

# Determining and outlining requirements specification

- Comparison of both scenarios:

| | Informed buyer | Uninformed buyer |
|---|---|---|
| **Knowledge of the buyer's problem** | A deep understanding of the problem and clear development expectations. | Weak understanding of the problem, without experience from the field. |
| **Available information** | Immediately available information:<br>• customers<br>• competitors<br>• equipment supplier<br>• similar solutions<br>• publications, books | Limited information. Devices do not exist on the market. No similar solution or approach to solving the same problem. |
| **Development of the requirements specification** | Relatively simple with slight effort and costs. | Relatively high demands for effort and costs. Additional res earch on potential users and cost evaluation are often needed. |
| **Probability of transition to the next phase of development** | Relatively high transfer coefficient to the next development phase with minimal risk. | Relatively low transfer coefficient to the next phase. Risks are related to |



Funded by the Erasmus+ Programme of the European Union

# Two-step approach to developing functional specifications with ecological factors

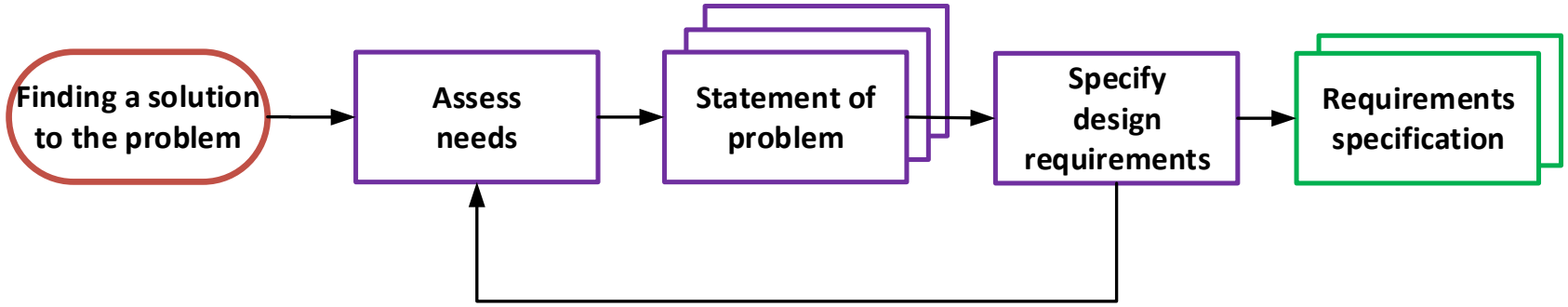
- The task of the functional requirements planner is not to propose alternative solutions or to reject certain approaches, nor to analytical calculations of parameters, but to propose an optimal solution.
- The optimal solution means a compromise between the given criteria. The given criteria can be the functionality of the device, the appearance of the device, the technical solutions, the technology used, the price of the final solution and the cost of producing the device.
- The specification of requirements also includes the proposed materials, the location of the device, the logistics-suppliers of raw materials, a high recyclability rate and the lowest carbon footprint.



Funded by the
Erasmus+ Programme
of the European Union

# Two-step approach to developing functional specifications with ecological factors

- The picture shows the development of a functional specification, which is divided into two stages.
  - The first phase evaluates the needs of the client and the customer and sets the next step in assessing the needs that we need to solve. This report must be carried out in the subscriber's language, which usually means that it does not contain technical, professional terms, and should be as easy as possible and understandable as easily as possible.
  - The second phase involves a more detailed report on the problem by adding further details on possible concrete solutions. The report contains a technical language and is intended for the engineering team and developers. This second phase also sets the criteria for assessing the acceptability of the model.

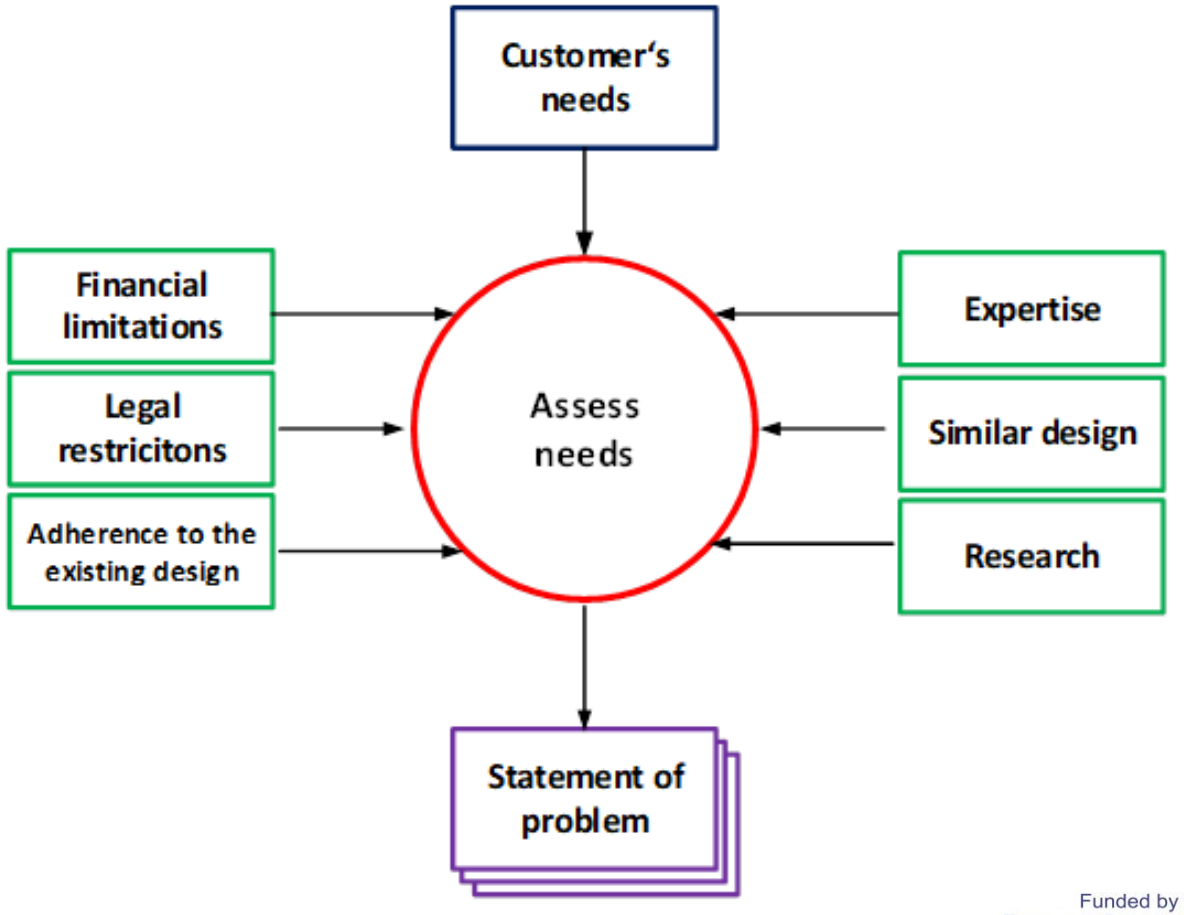





Funded by the Erasmus+ Programme of the European Union

# Evaluation of realistic circumstances in device development and design

- Before we present the specification of the functional requirements in more detail, we stop for a moment in the assessment of the real circumstances in which the design of the device begins.
- All these restrictions should be recognized as early as possible and should be stated in the functional requirements at the outset, where they will be discussed in further stages of development.






Funded by the Erasmus+ Programme of the European Union

# Evaluation of realistic circumstances in device development and design

- **Experience:** Sources experienced are accumulated largely within the development team.
- **Similar solutions:** Examples of similar designing are sometimes also a competitive demonstration of the way in which the design takes place or how the others have dealt with a similar problem.
- **Research:** A fundamental part of the research is the basic research of the needs of users and the financial market.
- **Financial constraints:** The financial capacity or willingness of the client is a very obvious limitation in the design of the device.
- **Legal constraints:** Apart from technical and financial constraints, laws and political influence can also limit the development of the device.
- **Considering production capacity:** Generally, the design of the device is associated with modification in order to improve the properties of an existing device. A brand new product must also be included in pre-existing product lines.



Funded by the
Erasmus+ Programme
of the European Union

# Analysis of customer needs and determining the problem

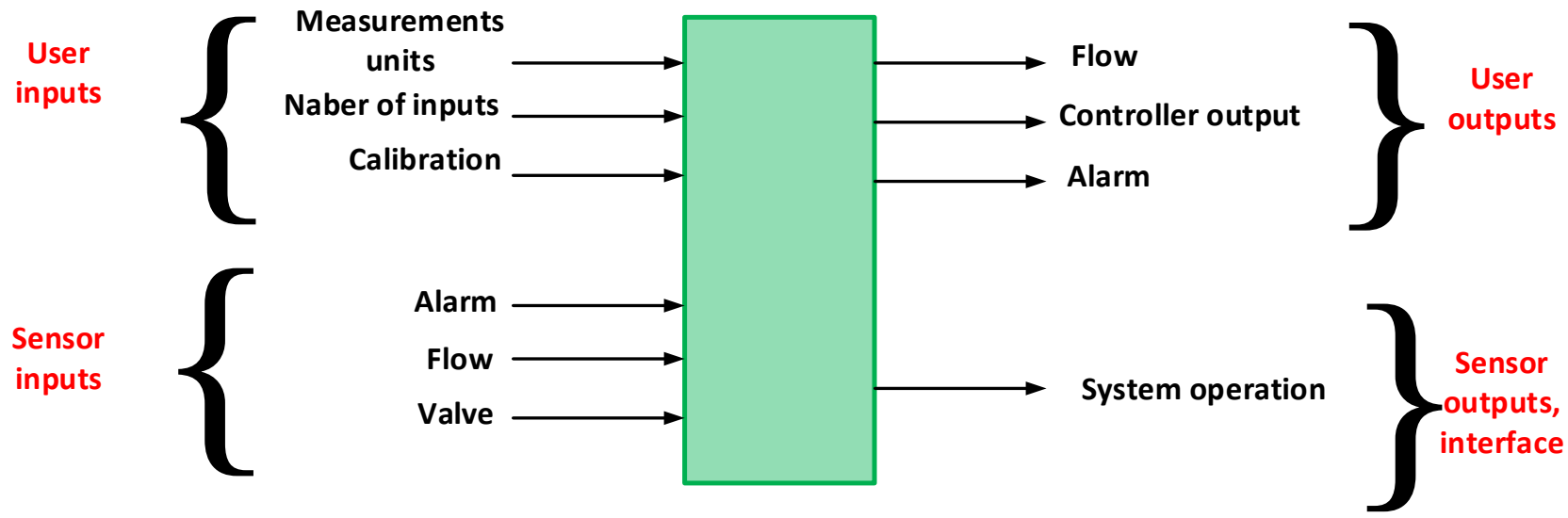
- The definition of the problem must include the following aspects.
  - **No technical aspects:** The problem must be presented in the subscriber's language, which means that it does not contain unnecessary professional and jargon expressions.
  - **No quantification:** Specifications like; size, quantity, price need not be presented in numerical form. Needs can be presented qualitatively.
  - **Definitive aspects:** To the fullest extent, the definition of the problem must cover all aspects and problems that the designer may encounter during the design of the device.
  - **Determined aspects:** The definition of the problem is subjective and must be in line with the precise quantitative specification of the requirements. Often it is possible that clients' wishes are included in the quantitative specifications specification.



Funded by the
Erasmus+ Programme
of the European Union

# Input-output analysis

- The design problem is conceptually presented as a function block with given inputs and outputs. Such a presentation of the problem is that the founder has a clear overview of what problems need to be solved during the design and what the design is intended for.
- Input / Output Diagram for the flow controller of the measuring device.






Funded by the Erasmus+ Programme of the European Union

# Research of design attributes

- Researching the design attributes can help to reveal additional project needs. It makes sense to split attributes into functional rather than functional requirements.
- With the research of attributes, the inventor discovers possible planning procedures. This triggers a new wave of questions about the design needs.

| Functional requirements | |
|---|---|
| **Standard functions** | Which standards does the product have to fulfill?<br>If the product has to fulfill multiple standards, are these standards set in production, trade or at the customer? |
| **Advanced functions** | Which new functionalities does the product need in addition to the existing ones?<br>Which functionalities does the product have to have to compete with the competitors?<br>Do we need any new functionalities?<br>Can the functionalities be categorized as needed and do they depend on the final device price? |

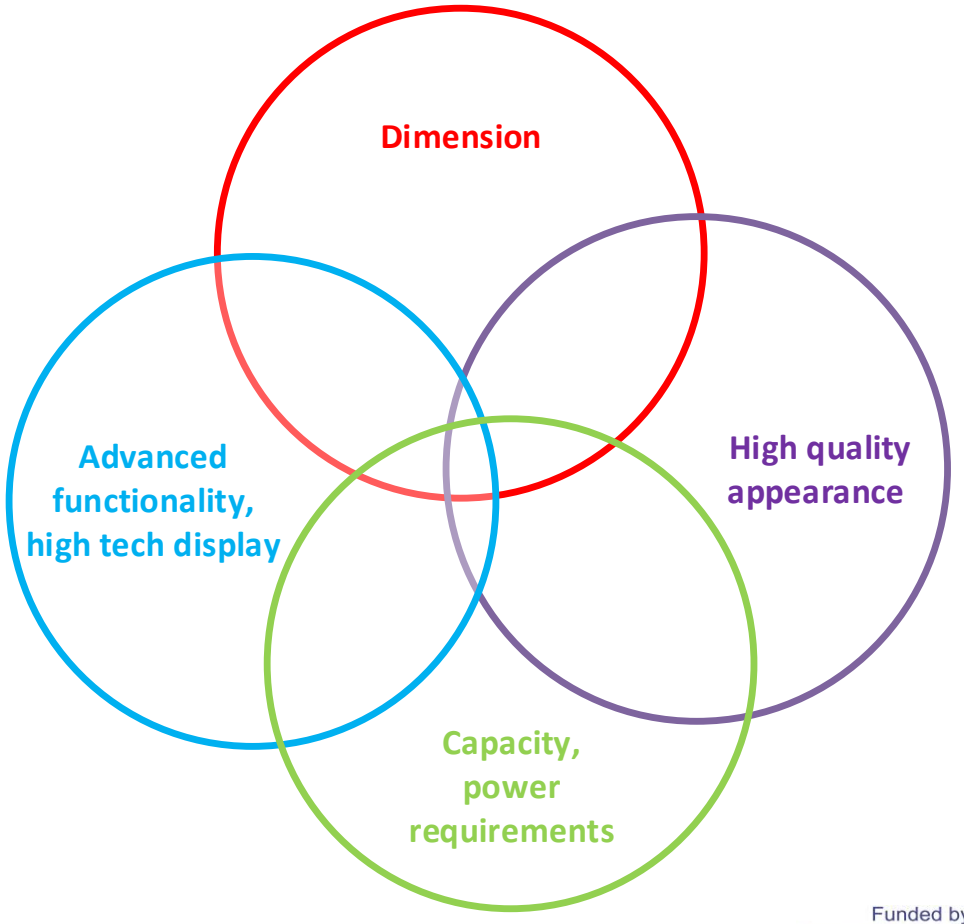
| Non-functional requirements | |
|---|---|
| **User interface** | Will we use new appearance? |
| **Packaging** | Wil sizing and weight stay the same?<br>What are the competitors' plans?<br>What are the environmental factors? |
| **Battery** | Does the battery need to be upgraded to offer higher autonomy and charging time? |
| **Production** | Where can we manufacture the device and what environmental effects will this process cause?<br>Which production techniques and testing will be used? |



Funded by the Erasmus+ Programme of the European Union

# Determination and recognizing of conflict situations

- In many cases, when designing a product, we encounter conflict situations, especially if there are some non-overlapping between the requirements of the client and the designer.
- A classic conflict arises between price, capacity and time of performance. Often, the customer expects a higher capacity, additional functionality, minimum price and minimum execution time.

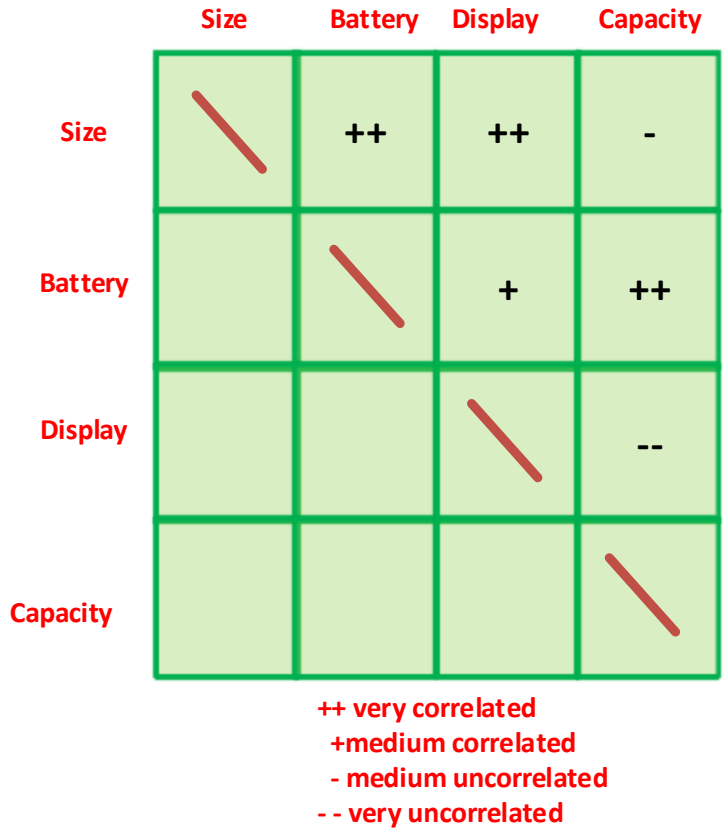





Funded by the Erasmus+ Programme of the European Union

# Determination and recognizing of conflict situations

- An example is the design of a mobile phone where the conflict arises between functional and non-functional requirements. Dani primer; packing requires smaller devices, higher capacity requires greater battery capacity, which at the same time means greater weight and dimensions of the device. The conflict can remain unresolved until technological progress improves battery performance, which can then lead to a price rise conflict.






Funded by the
Erasmus+ Programme
of the European Union

# Preparation of user instructions draft

- Each electronic device must also contain instructions for the user. As with all design methods, the draft instructions also require the user and the client to design the planning needs and requirements.
- The drafting of the instructions leads to new questions about planning needs. It is very convenient if the draft is made together with a subscriber who has previous experience with a similar device.

**Product overview**

**Installation**

1. Flow sensor
2. Linear valve
3. Linear valves control
4. Microcontroller
5. Communication interface
6. Charging

**First launch**

1. Sensor arrangement
2. Calibration
3. Testing
4. Device connection

**Operating**

1. Choosing matrix system
2. Obtaining data
3. Alarms
4. User interface
5. Management launch
6. Communication

**Maintenance**

1. Standard maintenance
2. Troubleshooting



Funded by the Erasmus+ Programme of the European Union

# Functional specification

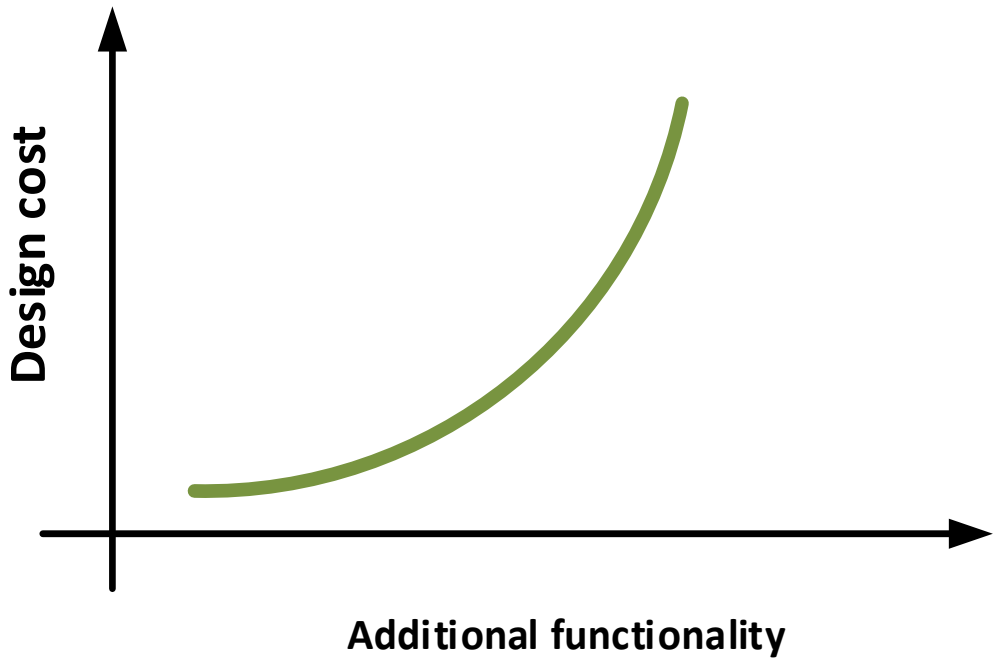
- Converting problem analysis into functional specification is a one-to-one translation. Vaska's design requirements have been translated into a functional specification. A good analysis of the design problem enables a complete and consistent translation into a functional specification.
- When translating requests, the designer resists his expertise and experience. It is not to be expected that the planner is an expert in all areas of development. Therefore, there are three different approaches to translating problem analysis into a functional specification.
  - **External expert:** Such resources include external experts, industry standards, and other sources such as; books, magazines and textbooks. In some cases, external experts appear as consultants or external assistants.
  - **Analysis of similar systems:** The term reverse engineering is a common approach to describe this approach. It often has a negative connotation because it is associated with theft of ideas and plagiarism. The fact is that most of the concepts are based on the design that was done before.
  - **Conducting tests or experiments:** A number of experimental tests are required to determine the battery charge time. The designer must make many tests of different types of batteries and different manufacturers in order to statistically determine the filling properties.



Funded by the
Erasmus+ Programme
of the European Union

# Excessive requirements

- In an analysis of needs, it is important that we determine and analyze real customer's needs. When analysis of need is converted to requirements specification, it is crucial that we get closer to the needs and requirements of the customer as much as possible. The specification must not be too ambitious or too inaccurate.
- Usually, the customers have a mindset that small additions to the device do not increase development price to the extent that it would be too expensive, especially when it is software. Although device price does not increase significantly due to additional hardware components, it is important to consider that design costs do increase.

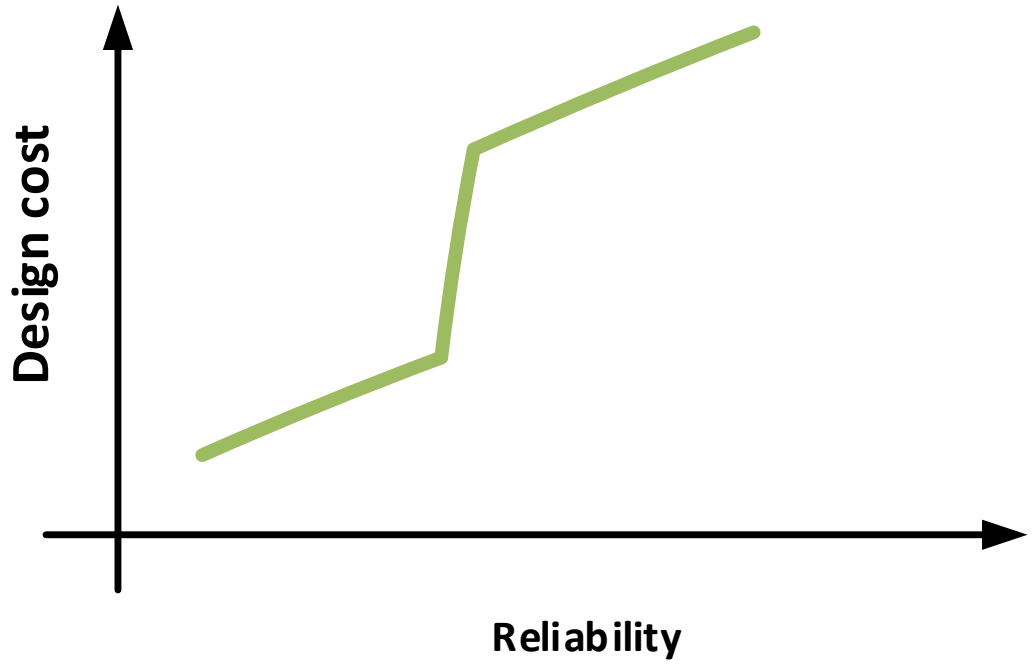





Funded by the
Erasmus+ Programme
of the European Union

# Excessive requirements

- Design costs are increased not only due to additional designer's work, but also due to additional project management, documentation, and device testing.
- Too strict or too loose specifications can also drastically increase design costs. Due to improper specification, there is not enough maneuvering space for additional adjustments or, contrary, there is too much space, and consequently, the choice is too undefined and not optimal.
- Too high requirements for device reliability also influence price. In image 15 that present price growth due to reliability is visible a dividing between a drastic increase and moderate growth of development costs.






Funded by the
Erasmus+ Programme
of the European Union