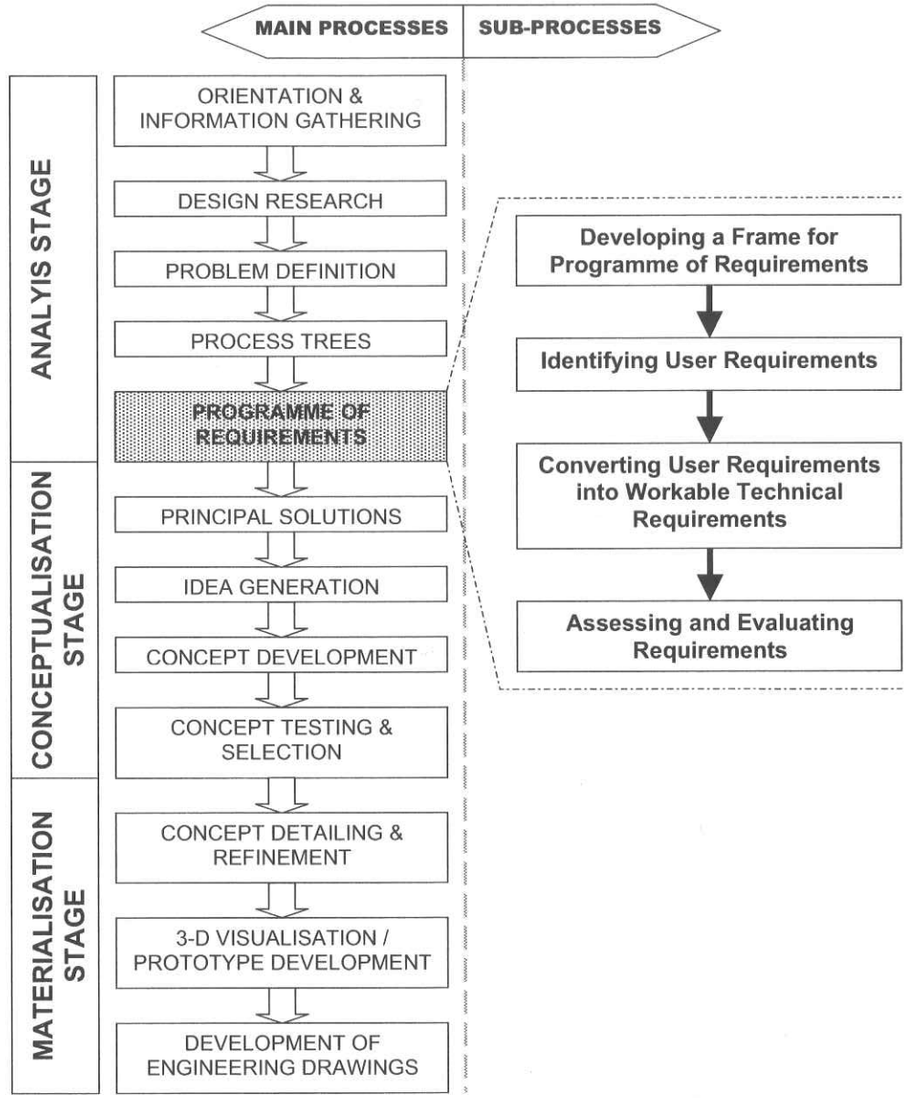
Main Process	Sub-Process, 1st Detailing	Sub-Process, 2nd Detailing	Problem Definition	Specifications/ Requirements
Use	• To bring inside the home	• To unpack • To assemble • To Position in environment	• Is the foldable chair easy to unpack? • Does it need assembly?	• The chair should be assembled by the user in not more than 3 major steps using added hand tools.
	• To make the chair ready for use		• How to unfold the chair for use?	• The chair should be unfolded in one action
	• To use the chair		• Who will sit on the chair? • Weight and Size of person? • Is it comfortable and safe?	• The chair should accommodate the P5-female – P95 male population range • The chair must me able withstand a vertical weight of at least 200kg. • The chair should be suitable for at least 1 hour continuous seating.
	• To store the foldable chair	• To fold the chair into storage position • To place it in a store room	• How to fold the chair? • Size of chairs? • How to store the chair(s) as efficient as possible, given a limited space?	• The chair should be folded in 1 action • When folded, at least 20 chairs should fit in an envelope of 1 x 1 x 1m
	• To repair the chair	• To bring the chair for repair. • To repair the chair oneself	• Is it worth bringing the chair for repair? • Should the chair be easily repaired by the user?	• The chairs must be easily repaired using basic hand tools, such as screwdrivers, pliers, etc.

Table 6.6; An example of the main process "Use" of a foldable chair

CHAPTER SEVEN

DEVELOPING A DETAILED PROGRAMME OF REQUIREMENTS



7.0 INTRODUCTION

A Programme of Requirements can be seen as list of specifications for the designer to visualise and materialise the design accordingly. This chapter discusses how a Programme of Requirements can be structured and formulated to a concrete level, where it can be directly applied for testing and evaluation of concepts.

7.1 WHAT IS A PROGRAMME OF REQUIREMENTS

At the end of the analysis stage, a well-defined "Programme of Requirements" or "List of Design Specifications" should accompany a "Detailed Problem Definition". A Programme of Requirements is a list of normative statements, concerning the properties of a 'to be designed' product, which sets limits to the solution space (Roozenburg & Eekels, 1995).

During the development of a Programme of Requirements, all data must be analysed and grouped in relation. The purpose of this is to provide a foundation for a good design solution, which meet user needs and requirements. However, it is premature to assume that a concrete Programme of Requirements is a passport to a good design solution. It only provides the designer with an evaluation and appraisal tool to make justified design amendments and decisions at subsequent stages of the design process.

From a design management perspective, it facilitates the distribution and monitoring of design task as well as it makes sure that the design process is still on the right track.

For a designer, who is aware of the design requirements, he or she will always refer and test his proposed solutions to these requirements. When necessary, adjustments to the requirements will be made accordingly. Unfortunately, he or she does not get all these requirements presented on a silver plate. He or she has to search for it, and formulate it in such a way that they can be used for testing.

The number of requirements will grow very fast, because many people are involved in the manufacturing, selling, use and disappearance of a product.

7.2 CLASSIFICATION OF PROGRAMME OF REQUIREMENTS

The Product Life Cycle, as illustrated by the "Process Trees", is one of the methods to structure the Programme of Requirements. All requirements can be

systematically classified under each of the sub-processes. In this way, you can easily refer back, identify missing and overly defined requirements, as well as make additions and exclusions, where necessary.

Other methods to classify requirements are according to:

- Key areas of Industrial Design; *Marketing, Technology, Ergonomics, Aesthetics and Ecology.*
- Main Problems, earlier identified in the Problem Definition

The choice is up to the designer which type of classification he or she prefers.

7.3 FORMULATING REQUIREMENTS

To start with an example, someone is asking you to design a handy suitcase.

> *The first question is: 'What is a handy suitcase'? 'It should be light and not be too big', is the answer'. Why? Is the next question. 'You must be able to bring it along in a plane, you cannot bring much weight into a plane, it should fit under the seat, that's why'.*

Requirements should be formulated in line with actions described in the Process Trees, to be classified under the sub-processes.

- Carrying a suitcase. . . . . .
- Putting things in. . . . . .
- Storing the suitcase in the airplane. . . . . ..

The last requirement: 'The suitcase must fit easily under the airplane seat' is too abstract. It should become more specific as follows: The suitcase must fit under the airplane seat, with an available space of 50 x 40 x15 cm. The measurement: 50 x 40 x 15 cm is specific. Now, we know that the suitcase should be smaller than the measurements. We measure our design, take the suitcase inside the plane, put it under the chair, and discuss with the client, how easy it went. In sequence, we have measured, perceived and discussed to say whether the suitcase met the requirement.

As a relationship exists between Concept Testing *(Chapter 11)* and Programme of Requirements, it is important to formulate the requirements as specific as possible. Only with a concrete Programme of Requirements, designers are able to determine and assess, as well as target the demanded quality for the design

Other examples of concrete requirements are: of lower cost than the competitor's product, lighter than the existing equipment, less than $S59,--, between 800 and 1200 mm, to be manufactured by hand and existing equipment,

This implies that the design should be detailed in such a way, that measurements, weights, prices and materials are known before testing.
A difficult problem is dealing with contradictive requirements. If such a case occurs, we have to analyse the requirements again and determine:

- Which requirements are essential and can not be compromised.
- Which requirements should be compromised.
- Which of the requirements to choose.

The most important thing is that contradictions between requirements must be solved.

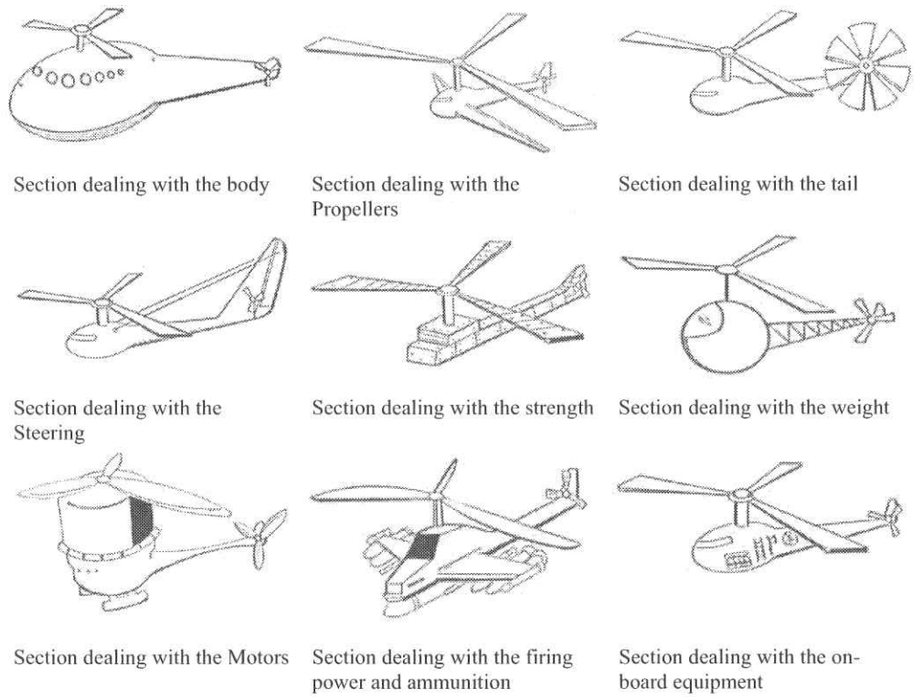


Figure 7.1; Contradictive requirements must lead to a compromise

7.4 FROM CONCEPT PROGRAMME OF REQUIREMENTS TO DETAILED PROGRAMME OF REQUIREMENTS

A Programme of Requirements cannot be developed in one step. It is an ongoing process. Dependent on the type and amount of information, one can sharpen the quality of the requirements. Usually, one has to adjust and correct the 'Concept Programme of Requirements', before it can be called a 'Concrete or Detailed Programme of Requirements'.

In the refinement and substantiation process of requirements, it is a challenge for the designer to convert general user needs into applicable technical requirements. A matrix can be useful to identify the relationship between each need and technical requirement. This matrix as applied in the example of a bicycle is a *"User Versus Technical Requirements Matrix"*.

Technical Requirements / ***User Requirements***	Material (Carbon fiber, titanium alloy, etc)	Painting Method (powder coat, spray, etc)	Tire Width	Frame Geometry	Rim Diameter	Suspension (fork suspension, full-sub, etc)	Handle Bar Shape (monkey, straight, etc)
Attractive		✓		✓			✓
Light Weight	✓					✓	
Easy to manoeuvre and control			✓				✓
Fast	✓		✓	✓	✓	✓	✓
Easy to maintain	✓						
Comfortable to ride	✓			✓	✓	✓	
Durable	✓			✓			
Cheap	✓	✓				✓	

The following example of a classroom desk illustrates the difference between a "Concept Programme of Requirements" and "Detailed Programme of Requirements".

Concept Programme of Requirements		*Detailed Programme of Requirements*
ERGONOMIC:		*ERGONOMIC:*
1. The desk must be able to be converted from conventional to PC based teaching		1. The desk must be able to be converted from conventional to PC based teaching **within 30 seconds without additional tools**
2. The desk system should be as compact as possible.		2. The desk system, when operational should not occupy an envelop of more than **1500 x 700 x 800 mm (LxWxD)**
3. There must be enough leg space for the user		3. There must be enough leg space for the **P95 Male** user
4. PC, keyboard and monitor within reach		4. PC, keyboard and monitor should fall within **the comfortable reach zone of P5-female when sitting and standing**
5. The system should be flexible in arrangement, which means suitable for classroom teaching		5. The system should be flexible in arrangement, which means suitable for classroom teaching
6. There must be sufficient walking space between the desks.		6. There must be sufficient walking space between the desks.
7. The furniture should be lightweight, easy to carry		7. The furniture should weigh less than **2.5kg** when transported

Table 7.2; Concept versus concrete / detailed programme of requirements

7.5 WHY MUST A PROGRAMME OF REQUIREMENTS BE SO DETAILED?

Where possible it is essential to incorporate minimum and / or maximum values into requirements. These values can be derived by having a closer look and elaborating further on the "Technical Requirements". During **Concept Testing and Selection**, these values will be used as a relative benchmark to evaluate the scores allocated to each individual concept.

The following example will show the importance of minimum and/or maximum values of requirements in relation to the allocation of scores:

Requirement: *The furniture should weigh less than **2.5kg** when transported.*

Rating: **1,** *(does not meet requirements at all)* – **5**, *(meets requirement very well)*

Performance of each of the three concepts, pertaining weight:

- *Concept A weighs 2.3kg*
- *Concept B weighs 3.5kg*
- *Concept C weighs 1.5kg*

If there was **no** maximum value of 2.5kg, the concepts may be rated as follows, according to their relative weights:

Concepts:	**Rating:**
• *Concept A weighs 2.3kg*	3
• *Concept B weighs 3.0kg*	2
• *Concept C weighs 1.5kg*	5

Adding a maximum value of 2.5, which is usually determined by research or detailed information gathering, conveys a serious message to the designer that surpassing this value may pose serious consequences for the quality of the design. Therefore, concept B will be "penalized" more severely, relative to concepts A and C. The updated rating may look as follows:

Concepts:	**Rating:**
• *Concept A weighs 2.3kg*	4
• *Concept B weighs 3.0kg*	1
• *Concept C weighs 1.5kg*	5

7.6 DETAILED PROBLEM DEFINITION VERSUS PROGRAMME OF REQUIREMENTS

Usually, a design brief in combination with existing knowledge should be sufficient to understand most of the design problems and accompanying requirements.

As it is most likely that not all problems have been investigated, it is necessary to take a more critical viewpoint towards the volume and complexity of the design problem. You will present your vision in an updated and more detailed Problem Definition.

In here, the most suitable combination of search fields, starting points and search directions will be recorded to solve the design problem. Of equal importance is the insight in the end stage of the design process. In advance, one has to determine the minimum requirements of the design, to be accepted by the consumer as well as by the user.

From the previous chapters, it should be clear that there are major differences between Problem Definition and Programme of Requirements. The first is a story written vision on the design problem; the second is a powerful summary of verified requirements.

Two examples below will clarify how Problem Definition and Programme of Requirements influence each other:

- In the Programme of Requirements, contradictive requirements are not allowed. In most cases, a compromise is sought, which will lead to new verified requirements. In the Problem Definition, one has to discover the roots of contradiction, and find out what has led to this compromise.
- When an unsolved problem is addressed in the Problem Definition, no requirements pertaining that problem area have been formulated yet, or no good solutions could be found in the conceptualisation stage to meet these requirements. In this case, we speak about under defined problems and unrealistic requirements. Considering the iterative nature of the design process, the design problem and requirements must be reformulated until an acceptable design solution can be foreseen.

In summary, a designer who has a clear view of the design problem and takes stock of the requirements increases his or her chances to succeed in designing a good product.

PART III: CONCEPTUALISATION