DELFT DESIGN GUIDE

UNIVERSITY OF TECHNOLOGY / FACULTY OF INDUSTRIAL DESIGN ENGINEERING

PERSPECTIVES - MODELS - APPROACHES - METHODS

BISPUBLISHERS

Microcosm diagram of the mind designed by physician Robert Fludd, beginning 17th century; below an exploded view of a modular smartphone, beginning 21st century.

PREFACE

The Delft Design Guide originated from the need for a more comprehensive overview, deeper insight, and stronger assistance in choosing and understanding the right perspective while establishing the design goal, understanding theoretical models, and selecting appropriate approaches and methods that help with the actual development of products, services, and other manifestations of a creative process. We are truly pleased to know that the book is now used in many different places around the world, both in the educational institutions and in practice. The book has also helped in shaping a common image and language that contributes to the Delft design culture that has found its way around the world through this book. Additionally, the graphic design and layout of the book helped to make it an inspiring and accessible reference work, and for this we thank Yvo Zijlstra of Antenna-Men. As a result, the Delft Design Guide is currently used in various design disciplines and at different schools around the world. Thanks to one of our Chinese alumni, the Delft Design Guide has even been published in Chinese since 2014. Since 2015, there is also a Japanese version.

This is a completely revised Delft Design Guide. Like the first edition, published in 2013, this book once again offers a collection of perspectives, models, approaches, and methods that are used in the design education at TU Delft. The book offers a toolbox, an important asset for designers and it offers insight into the distinct Delft Design Thinking. We are proud that the Delft Design Guide is a project of co-creation and the result of a bottom-up approach, in which we created the content together with our many colleagues.

Our field is rapidly changing; after six years, we deemed that the time was ripe for a comprehensive review and renewal. The integration model of People, Technology, and Organisation is still central. The discipline is shifting from a focus on mostly physical products and individual users to a zoomed-out level in which products and individuals are part of a larger system. Non-physical designs, such as in services, and indirect users also play a role in that larger system. There is also more attention to the effect of design on people, the environment, and society: the raison d'être of design. Design therefore becomes increasingly complex and requires new or adapted working methods.

The new Delft Design Guide distinguishes itself from the previous edition on several points. First, more than one-third of this book consists of new content and pages. Second, this book is organised into a clearer structure with distinctive categories (perspectives, models, approaches, and methods). Third, some topics have been removed, whereas others have been merged. Finally, all subjects are improved and enriched with the 'mindset' component that explains the underlying values and principles.

We wish everyone good luck and an enjoyable learning experience with the new Delft Design Guide!

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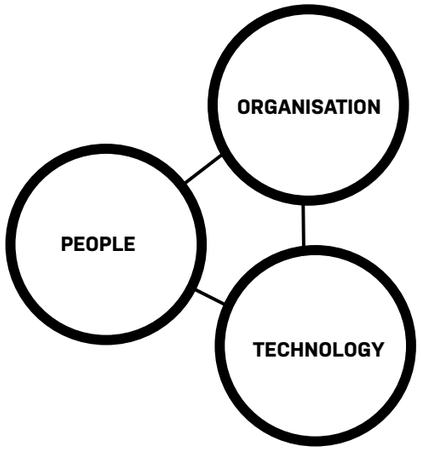

DELFT UNIVERSITY OF TECHNOLOGY
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ACKNOWLEDGMENTS This book could not have been written without the contributions and expertise, inspiration, and skills of design researchers and design educators and the support of the faculty management team. Our special thanks go to the contributors of this book who all worked as staff members, former staff members or students in the faculty of Industrial Design Engineering in Delft. The editors hope that the book will justify their dedicated work. Cheers!

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DELFT DESIGN GUIDE

PERSPECTIVES - MODELS - APPROACHES - METHODS

A guide to the Delft Design Guide

You have the completely revised and extended Delft Design Guide in your hands. This guide is meant for everyone that is - or aspires to be - a designer. It should help you to understand how a designer thinks, what a designer does and how this is done, the Delft way. The diversity of perspectives and methodologies presented in this guide shows that design is a rich field with many applications and a network of ways of working and tools to use. The Delft Design Guide offers you a set of perspectives, models, approaches, and methods that serve four distinct purposes.

First, to help you to diverge or converge in your design project in a structured way, identifying and selecting options to solve your design challenges. Second, to help you determine what information and knowledge to find and use to allow you to make decisions and progress the design process. Third, to document and communicate a way of working that helps others to participate and collaborate with you. Finally, to develop yourself as a designer with a strong identity and rich toolbox to tackle the challenges ahead!

BUILD A MINDSET

The domains and application areas that design contributes to are becoming increasingly complex and turbulent. For example, designing interventions that help bring about positive change in the healthcare system, or that change our relationship with the climate are immensely complex and require skills, creativity and thoughtful actions, and productive collaboration. The content of this book can help you in achieving impact, yet it is not enough on its own. Much of what is needed is embedded in the culture and values of our faculty, the missions of the design challenges we collectively work on, and can be identified in the principles of our way of working. In these we can see a strong common denominator that is what makes up the Delft designer. For example, we believe in being human-centric and evidence-based. We also believe in iteration and co-creation. Methodology provides the building blocks, yet you and the people working with design need to build a design mindset to bring these together into effective and meaningful ways of working. This is why we have added a section on mindset to each method in this new edition. These mindsets help you understand how and why a method can contribute to achieving a certain goal. Your first priority however, should always be to succeed in solving your design challenge and to have maximum impact for your cause.

BE REFLECTIVE

We see design as a goal-directed discipline aimed at creating change. This is not a new idea: Nobel Laureate Herbert Simon already wrote in 1996 in his book *The Sciences of the Artificial*: '*To design is to devise courses of action aimed at changing existing situations into preferred ones*'. Design is inherently uncertain and this can be traced back to the core elements in Simon's definition. Designers explore new and sometimes untrodden territories when they ask: *what would be a preferred situation?* They discover and define opportunities for innovation and improvement. They ask what would be meaningful and valuable for people in their context and dare to take a stance to steer innovation. Designers challenge the way tasks or problems are framed and formulated when they ask *what is problematic about the existing situation?* They will keep asking questions until they find root causes and core values that form the starting point for good design. Designers facilitate and drive the development of design solutions that can realise the *preferred situation when they ask: what courses of action will best realise the preferred situation and who should I involve to make it happen?* They make ideas and visions tangible

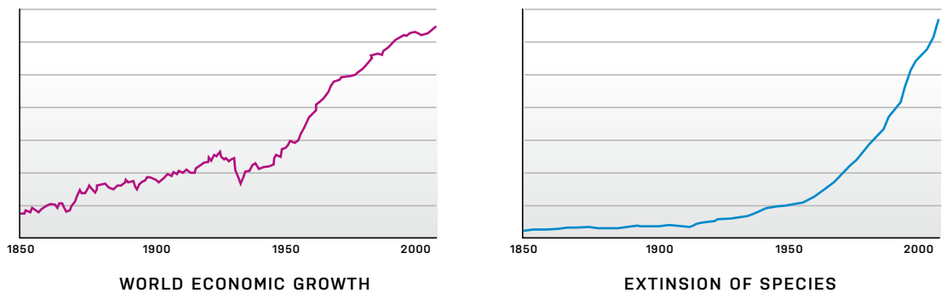
'Let us get used to looking at the world through the eyes of others.'

BRUNO MUNARI

PERSPECTIVES

Perspectives are descriptive in nature. That is, a perspective focuses on specific intended effects and qualities to strive for when doing design. For example, Design for Sustainability describes the intended effect of the design and explains its importance. Many perspectives are linked to an approach and/or one or more methods that help to achieve the desired effect when doing design.

The Māori tribes in New Zealand do not consider themselves masters of the universe but part of it. They fought a 140 year-long legal battle to grant the Whanganui River the same legal rights as a human being. They finally won the case in 2017 meaning that it would be treated as a living entity, as an indivisible whole, instead of treating it from the perspective of ownership and management. That perspective is not an anti-development, or anti-economic use of the river but one that begins with the view that a river is a living being, and then consider its future from that central belief. (wickimedia commons)



Graphs of economic growth are deeply political. They simplify and exclude a more troubling and complex reality. Apart from a few hiccups we've been moving upwards over the past hundred years. Moving up to no idea where. When seen against another graph, but this time that of species which have gone extinct in the same period, one realizes that this kind of progress can only be celebrated as a victory in isolation. (source: University of Idaho)

PERSPECTIVES

More-Than-Human Design

More-Than-Human Design considers the knowledge and behaviour of non-human entities – from plants to animals to intelligent things – and it aims to craft new capacities for meaning and action at the intersection of humans and non-humans.

WHAT & WHY? Through design, we are transforming the planet to meet user needs and desires. While it is reasonable to assume a beneficial intent to design, the consequences of design are not always positive and such consequences can range from climate change to resource depletion to surveillance capitalism. A more-than-human perspective acknowledges that humans are more than users: they are part of an ecosystem. Within this ecosystem, it is not exclusively humans who act and produce effects; in fact, plants, animals, and intelligent things can create new possibilities too.

MINDSET: More-Than-Human Design promotes the idea that to explore the futures we might face, we need to inquire what happens when we step out of an anthropocentric view of the world. Such an inquiry is necessary not because humans matter less but that society has largely become a sphere that threatens inclusion, diversity, and well-being due to the design ideal that humans are users of products to be consumed.

HOW? With a More-Than-Human Design approach, you can experiment with ways to access and include the knowledge and behaviour of non-human entities in design work. In doing so, the method contributes to the development of a next generation of co-design methods. Non-human perspectives are the 'views' of plants, animals, or intelligent things, namely what they can 'see' and contribute to the understanding of a context. Such perspectives are usually included in the design process by means of multispecies ethnography and science and technology studies, and this can be realised with the aid of intelligent cameras, computational or bio-based sensors, and algorithms. It should be noted that this is not about how to see like a pigeon and how to empathise with the pigeon. It is about critically enhancing, complicating, and possibly challenging human blind spots and biases, specifically at the intersection of the data and trajectories that non-humans give access to and the theoretically informed analysis that humans bring to it.

An example in this guide is the Thing Ethnography approach, which can be applied when designing connected products that can sense data, exchange them, and autonomously act upon the data across decentralised computational networks. The aim of the method is to map the interdependencies of a product ecosystem and its potential societal impact. However, the methods in this guide that are originally developed for human-centred design could be extended to explore and articulate the knowledge and behaviour of animals, plants, and intelligent things as well.

TIPS & CONCERNS

The development of a design sensitivity to non-human scales and types of knowledge is a major challenge for designers using a More-Than-Human perspective.

For example, what does it mean to access the knowledge of a river that has existed and has played a role in a specific context for hundreds of years? What are the boundaries of the investigation? How can we map insights in a way that they can be discussed in multidisciplinary teams?

Develop skills for recognising, understanding, and making palpable the potential discomfort, tension, and compromise that is required to forge new alliances with non-human entities in design. How can animals be enlisted as participants without being harmed? What data can be collected and used with respect to people's privacy?

LIMITATIONS

Our understanding is inherently limited by what we humans know regarding the actions and behaviour of living and computational organisms. We can gather a lot from a More-Than-Human perspective, but this kind of consideration concerning the impact of design on the interplay between human and non-human systems is far from trivial.

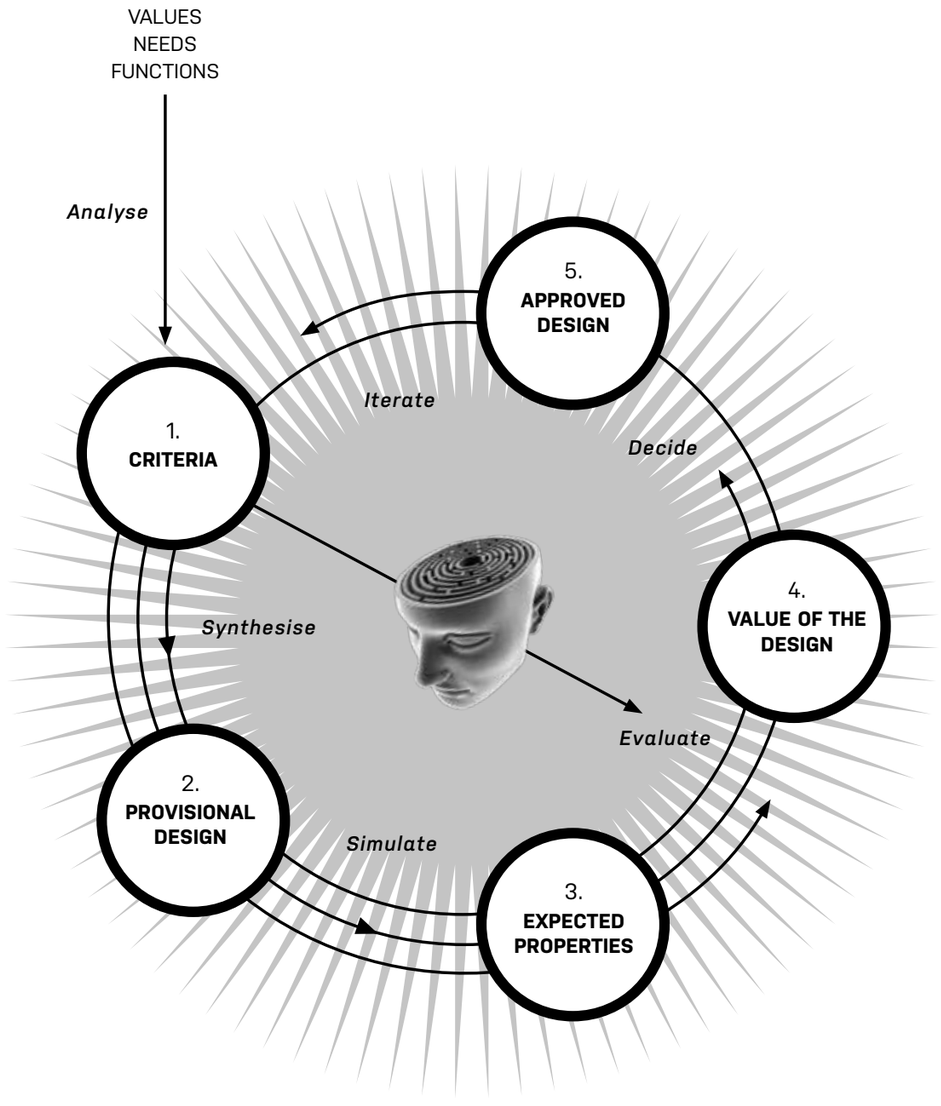
REFERENCES & FURTHER READING: Clarke, R., Heitlinger, S., Light, A., Forlano, L., Foth, M., & DiSalvo, C., 2019. More-Than-Human Participation: *Design for Sustainable Smart City Futures*. Interactions26 (3), 60-63. / DiSalvo C., & Lukens, J., 2011. *Nonanthropocentrism and the Nonhuman in Design: Possibilities for Designing New Forms of Engagement with and through Technology.* In M. Foth, L. Forlano, C. Satchell, & M. Gibbs (Eds.). *From Social Butterfly to Engaged Citizen.* Cambridge, MA: MIT Press. / Giaccardi, E. & Redström, J., Technology and More-than-Human Design. *Design Issues.*

'Have no fear of perfection -- you'll never reach it.'

SALVADOR DALI

MODELS

Models are descriptive in nature. That is, they describe how design happens. For example, the Basic Design Cycle describes how designers fundamentally think while designing. A model offers a generic description of design activity, often in a non-normative manner.



The basic building block of the design process is this circle of thought, action and decision. Designing is like a fractal: zooming in or out results in a similar image. Designing is an iterative process where you sometimes have to take a few steps back – 'back to the drawing board!' – in order to go a step forward later on. Being aware of the basic cycle that you are going through, up to a few times per minute, helps you as a designer to organise your thoughts and design activities. (After Roozenburg and Eekels, 1995)

Basic Design Cycle

The Basic Design Cycle is a model that represents the fundamental reasoning steps in the process of designing. It consists of a sequence of conscious reasoning steps that are repeated in empirical cycles. The knowledge of both the problem and the solution increases with each cycle.

WHAT & WHY? The model describes the different basic reasoning steps a designer goes through when solving a design problem purposefully and consciously. Theoretically, you can go through only a single cycle, but you usually perform many cycles across the various phases of any design process. The basic design cycle consists of five reasoning steps that are logically connected. Novice or naïve designers often tend to 'jump' over some of the steps, which might harm the quality of the design outcome. For example, one might immediately 'jump to solutions' when presented with a design brief, without thoroughly analysing the problem. This reasoning might result in a design that does not address the actual problem. Ideally, you spiral from problem to solution, from abstract to concrete, and from function to product geometry. This process is usually iterative, in which you sometimes have to take a few steps back – 'back to the drawing board!' – to go a step forward later on. You might also enter into the cycle at different steps, as long as you complete the cycle each time. Being aware of the basic cycle that you are going through on different resolution levels – from a cycle within the time span of a minute to cycles that span several weeks – helps you to organise your thoughts and design activities.

MINDSET: The Basic Design Cycle represents a fundamental cycle of reasoning that is inherent in conscious, purposeful design problem solving. This means that a designer who desires to do so needs to critically reflect on how his or her own thinking corresponds to basic reasoning logic.

HOW? The model describes five reasoning steps, each with its own purpose. As mentioned, these steps can happen, for example, in a span of a few seconds or over a period of weeks depending on the resolution level you take.

Analyse: In this step, you examine the aspects related to your design goal or a design problem. Overall, analytical reasoning yields information that informs your design criteria and eventually the requirements.

Synthesise: In this step, you generate possible solutions. Synthesis yields (elements of) design proposals that potentially offer valuable (parts of) solutions to the problem.

Simulate: In this step, you create imagined, digital, or physical representations of (elements of) design proposals. Simulation yields representations either in your mind or externalised with which you can evaluate their potential value.

Evaluate: In this step, you reason about the potential value of design proposals through their simulated representation. This happens in relation to design criteria. Evaluation produces an understanding of the current value of (an element of) your design proposal and informs design making.

Decide: In this step, you reason about the relative value of (an element of) your design proposal and you decide on how to proceed. Decision making informs the next cycles of design: whether to repeat a cycle, proceed to (an element of) your design proposal, or focus on other elements instead.

TIPS & CONCERNS

Do not confuse the five reasoning steps with the phases of a design process. The Basic Design Cycle is a model describing the fundamental reasoning steps and their relative logical order, which happen throughout any conscious, goal-directed design process.

This means that there is not one phase in which you synthesise, but that you must engage in synthesis throughout the design process.

When you 'get lost' in your ideas and thoughts, you might find it helpful to consider which step of the basic cycle you are in and identify which reasoning steps you might have missed that might get you back on track.

Discussion with others often helps in effectively doing these reflections.

LIMITATIONS

'Analyse' is the first step in this model, and this might suggest that it should also be your point of departure. However, that step is not necessarily your preferred point for starting your design cycle.

Depending on your preference, you can enter into the cycle at different points.

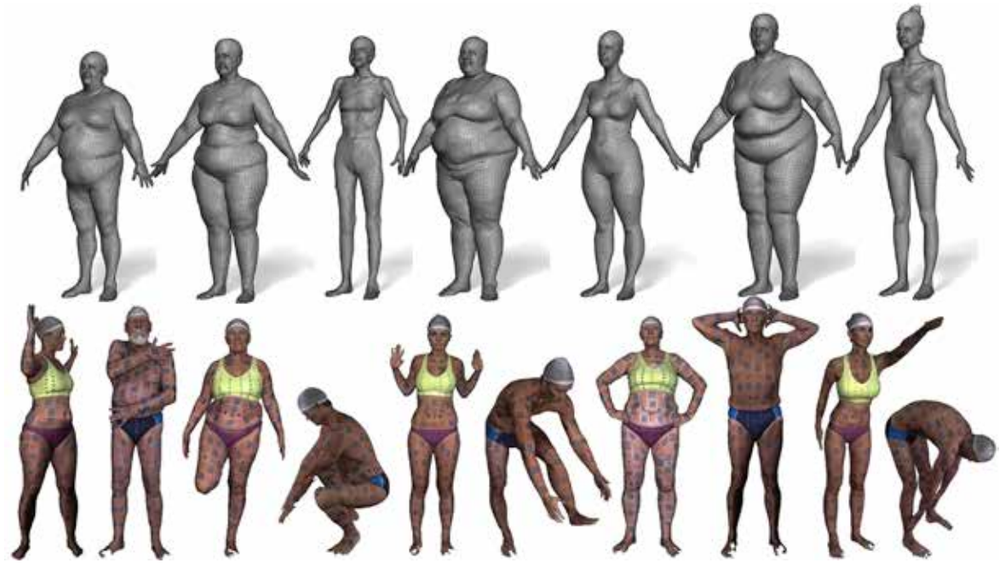
REFERENCES & FURTHER READING: Roozenburg, N.F.M. & Eekels, J., 1995. *Product Design: Fundamentals and Methods.* Chichester: John Wiley & Sons. / Roozenburg, N.F.M. & Eekels, J., 1998. *Product Ontwerpen: Structuur en Methoden.* 2nd ed. Utrecht: Lemma.

'Your work isn't a high stakes, nail-biting professional challenge. It's a form of play. Lighten up and have fun with it.'

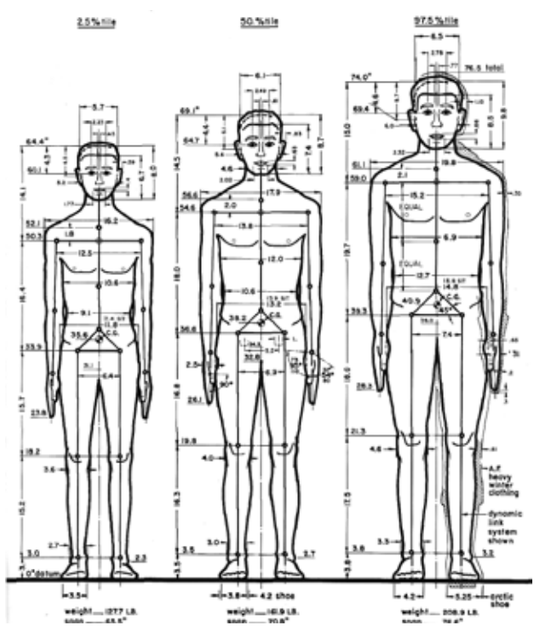
SOL LEWITT

APPROACHES

Approaches are prescriptive in nature. That is, they describe ways for how to go about a design activity. An approach offers a comprehensive process for design that spans across phases. Many approaches are linked in turn to a set of methods and tools that are appropriate to use in combination, for example, because they adhere to the same mindset as the overall approach.



The myth of designing for the 'average' person - since there are no people whose body dimensions are all at the 50th percentile. Body dimensions aren't linearly correlated so people with short arms don't necessarily have short legs. While the use of the 5th and 95th percentiles on one body dimension may exclude 10% of the population, the use of these on 13 dimensions actually can exclude 52% of the population.



Anthropometric Design

Anthropometric Design is an approach to be used through the design process to ensure the optimal fit of products to the people using them. Doing so will help you to design and make decisions on adjustability, size, and shape throughout the design process.

WHAT & WHY? The interior of a car, a train seat, an office chair, safety equipment, or a hand tool, should accommodate the variation in shape and size of the targeted users. As the average user in terms of size, weight and shape doesn't exist, designers need to gain insight into the variation within their target group with the help of statistical measures such as percentiles and correlations between different body measurements.

Using scientific databases that include anthropometric information requires demographics about the users, such as birthday, age, and gender, because human size, weight, and shape widely vary across populations. You also need to determine which anthropometric parameters are relevant for the design at hand. Therefore, you need to study the interaction between the human body and the product and describe how users will handle the product, in what postures, and which movements they possibly will make.

MINDSET: Be aware of your user group and be aware of who will be excluded by certain design decisions. Children are very different from adults and so are people who are disabled in any type or form. An important principle is to always aim to design for all within your user group; to practice inclusive design. On the other hand, a personalised design or a design made for a very limited user group might prove to be useful for a larger group of users. For example, an easy-to-open jar lid that is specifically designed for the elderley is easy to open for all. Such a well thought-out design strategy facilitates the comfortable, safe, and efficient use of products.

WHEN? Anthropometric data can be used in different stages of the design process, preferably right from the discovery phase because this ensures an optimal outcome, instead of trying to adjust the design at the end of the design process.

HOW? First the future user group is defined. Then decide whether a product should be one-size-fits-all, have a size system, be made adjustable, or be fully personalised. Depending if the additional costs and complexity are worth the gain in ergonomics. The method involves 5 steps:

Step 1: Define the target population, taking into account demographic variables as well as relevant abilities and disabilities. Describe the context of use: posture, movements, and sequence of movements; socio-cultural influences; artefacts (clothing, tools, equipment) and physical environment. Observing how similar products are used can be very helpful in this stage.

Step 2: Search for anthropometric data, for example, in the DINED database (dined.nl) or scientific papers. Consider representativeness (demographic variables), precision, and presentation type (1D, 2D, 3D). If no data are available, determine whether there is time and budget to perform measurements for the missing data; otherwise, make estimations (based on the correlation between known variables).

Step 3: When all the data have been collected, add allowances for worn garments and use of tools and equipment For example, stature +20mm for shoe sole thickness.

Step 4: Establish the anthropometric design guidelines. Prototypes are needed to evaluate the fit, comfort, force exertion, interaction during short use or prolonged use, and interaction with the environment while using the tool.

Step 5: The use of statistics and databases is a simplification of the reality; the proper evaluation of the final concept based on a mock-up is necessary. This process is often iterative, and a fifth step to search for additional anthropometric data could be necessary.

TIPS & CONCERNS

It is important to mention that the size, weight, and shape of the population in the world is continuously changing (secular trends) due to ageing, lack of nutrition, overeating, or sedentary lifestyle.

Why not design for P0.1–P99.9? The standard use of P5–P95 to define your target group will lead to the exclusion of 10% of the population per anthropometric variable.

The closer the product needs to fit on the body, the more important the knowledge about shape becomes. 3D scan data can be of great help.

Some industries have developed advanced software representations of humans (Digital Human Models).

LIMITATIONS

Many modern products and systems integrate both physical and non-physical elements such as services and digital interfaces, for which additional data are needed.

REFERENCES & FURTHER READING: Jellema, A., Galloin, E., Massé, B., Ruiter, I., Molenbroek, J., & Huysmans, T., 2019, 3D *Anthropometry In Ergonomic Product Design Education*. In I. Whitfield (Ed.), In proceedings of the 21th International Conference on Engineering and Product Design Education, Glasgow. / Lee, W., Molenbroek, J., Goto, L., Jellema, A., Song, Y., & Goossens, R., 2019. *Application of 3D scanning in design education.* In S. Scataglini, & G. Paul (Eds.), DHM and Posturography, (1st ed., pp. 721-731). Academic Press. / Robinette, K. & Hudson, J., 2006. *Anthropometry.* In G. Salvendi (Ed), Handbook of Human Factors and Ergonomics (3rd ed, pp. 322-339). John Wiley & Sons, Inc. / Verwulgen, S., Lacko, D., Vleugels, J., Vaes, K., Danckaers, F., De Bruyne, G., & Huysmans, T., 2018. A new data structure and workflow for using 3D anthropometry in the design of wearable products. *International Journal of Industrial Ergonomics*, 64, pp. 108-117.

'A bird is an instrument working according to mathematical law, which instrument it is within the capacity of men to reproduce with all it's movements.'

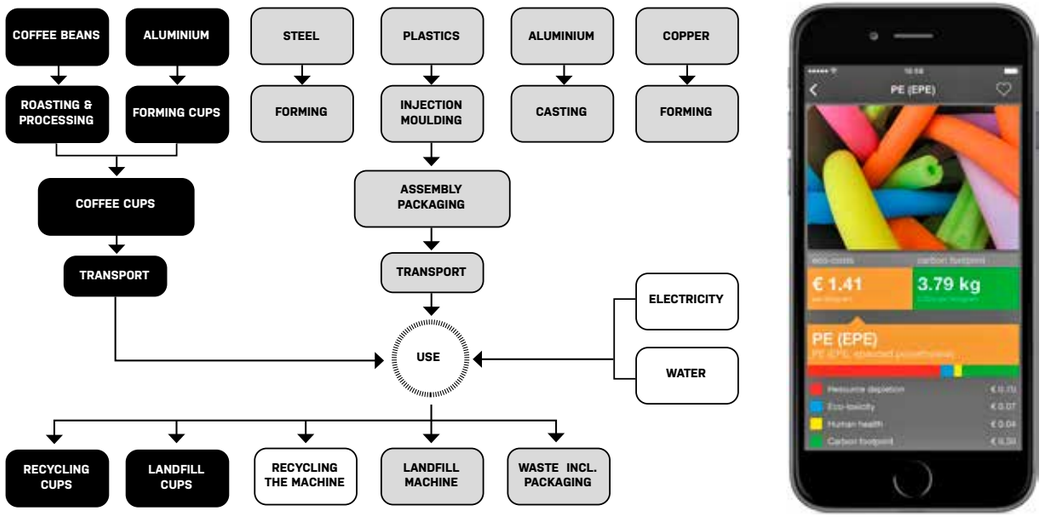
LEONARDO DA VINCI

METHODS DISCOVER

A method offers a specific process for a design activity that is predominantly used within a specific phase of design. In this guide, these methods are categorised into the phases of a design process. However, many methods can be used in several phases, and an overlap occurs in practice. The methods in this section help you to discover, explore, analyse, and understand your design domain.

Ocean Plastic® produces a range of premium materials for the sports, fashion and luxury industries made from intercepted and upcycled marine plastic debris. These materials replace virgin materials and allow for the implementation of a long-term strategy: Avoid, Intercept, Redesign

Each model is a simplification of a complex reality and as with all simplifications this means that the reality will be distorted in some way. The challenge for an LCA practitioner is to develop the model in such a way that the simplifications and distortions do not influence the results too much. The best way to deal with this problem is to carefully define the goal and scope of the LCA study.



With the Idemat Light app you can make a simple LCA calculation according to the Fast Track method, using the data and the selection method. You can open an LCA, and add materials and processes to it with the required quantities. You can even calculate the eco-costs of products with an Environmental Declaration. (idematapp.com)

Fast Track Life Cycle Analysis

A Fast Track Life Cycle Analysis (Fast Track LCA) is a method for determining the total eco-burden of a product, service, or product-service system over its entire life cycle. A Fast Track LCA can be carried out when there is a limited amount of time.

WHAT & WHY? The Fast Track LCA can give you a thorough and quantitative grasp of your design's environmental impact. This method is a powerful predictor of the environmental impact of different solutions. It helps you to:

- Find the environmental 'hotspots' of a product and lower its overall environmental burden.
- Compare different design and service solutions and thus make a substantiated choice for the product-service system design with the lowest environmental burden.
- Explore both the possibilities for making use of certain materials (such as recycled or renewable materials) and other sustainable options along the product life cycle.

MINDSET: Fast Track LCA is a very powerful tool for determining a product's environmental impact, but it needs to be used with caution. If you do not understand the scientific background of LCAs, you may misinterpret their outcomes, which can lead to misleading or wrong conclusions. Conducting an LCA requires an analytical mindset and a willingness to 'sweat the details'.

WHEN? You can use Fast Track LCA in the beginning of the Develop stage or earlier when analysing existing products.

HOW? You can express the eco-burden – emissions, materials depletion, and land use – in terms of a single-impact indicator using the Idemat database (www.ecocostsvalue.com), which includes over 6000 materials and processes. These tables make LCA comparable to normal cost calculations; it is then a matter of adding up the eco-burden.

Step 1: Establish the scope and the goal of your analysis.

Step 2: Establish a functional unit. Describe the main function or functionality of the product-service and a metric to measure this functionality of the product-service. Validate your metric by evaluating the current solution and an out-of-the-box solution.

Step 3: Establish the system and the system boundaries by describing which part of the life cycle is taken into account.

Step 4: Quantify the materials, and when applicable, quantify the use of energy or other resources during the use phase of the product service system. Collect data such as the weight and material use, energy and resources consumed during use. Determine the accuracy and relevance, and establish allocation rules and cut-off criteria.

Step 5: Quantify the transport involved for the components or for the complete product to be assembled and shipped to the consumer. Determine the routes and means of transport involved 1. for the components to the assembly factory; 2. for the assembled product to the distribution centre,; and 3. for the product's 'last mile' to the consumer.

Step 6: Calculate the total impact, the distribution of the impact over the different life cycle phases (material, production, transport, use, and end-of-life), and the distribution of impact over the different components or material groups.

Step 7: Interpret the results. Which parts of the life cycle are dominant in terms of eco-burden? How can you lower the eco-burden most effectively?

TIPS & CONCERNS:
Doing a Fast Track LCA is a modelling exercise. As with the saying 'garbage in equals garbage out', the same applies for LCA. Make sure you know how an LCA works and understand the significance of the outcomes.

You can also make an LCA from cradle-to-gate where only the production of the product is taken into account. This is when the product does not require any resources during the use phase.

It should always be combined with end-of-life data, since that has an important impact on the total eco-burden of a product life cycle.

If elements are missing, you need to make an educated guess by using comparable materials or production processes or find data from scientific literature. Never leave out a material because of missing data.

LIMITATIONS:
Fast Track LCA is helpful when assessing mature products. New and emerging products and processes may be more difficult to assess because of a lack of data.

An LCA's complexity is difficult to communicate, which may lead to an oversimplification of the results. LCA does not consider rebound and other social effects.

LCA should be applied throughout the design process rather than at the end.

REFERENCES & FURTHER READING: European Commission, Joint Research Centre, Institute for Environment and Sustainability 2010. *International Reference Life Cycle Data System Handbook: General guide for Life Cycle Assessment - Detailed Guidance*. 1st ed. Luxembourg: Publications Office of the European Union. / ISO, 2006. *ISO 14044 Environmental Management – Life cycle assessment – Principles and framework*. 2nd ed. Geneva: ISO. / ISO, 2006. ISO *14044 Environmental Management – Life cycle assessment – Requirements and guidelines*. Geneva: ISO.

'Mirrors would do well to reflect a little more before sending back images.'

JEAN COCKTEAU

METHODS DEFINE

The methods in this section help you to define and articulate a design problem, direction or goal. For example, the Persona method helps you to structure and communicate insights into your intended users and define the user group that you want to represent and empathise with during the remainder of a design project.

KEY PARTNERS	KEY ACTIVITIES	VALUE PROPOSITION	CUSTOMER RELATIONSHIPS	CUSTOMER SEGMENTS
• bicycle shop • sponsors • webprovider • mobile phone provider	• delivering packages on bicycles • maintenance • acquisition • administration • planning	• saving the customer's time by offering an ecofriendly, fast, cost-effective and reliable bicycle courier service • taking care of: internal mail, PO-box delivery, express delivery and one-day service	• face-to-face • telephone • e-mail • newsletter, • website	• anyone who needs packages and letters (max. 1 x 0.5 x 0.5 m and up to 50 kg) to be delivered quickly within a 15 km radius.
	KEY RESOURCES		CHANNELS	
	• workspace • personnel • smartphones • website • laptops • bicycles (+ trailers) • bags • cycling clothes • good physical condition		• Mouth-to-mouth • (social) media • telephone • pay online • couriers	

COST STRUCTURE		REVENUE STREAMS
• Workspace • personnel • bicycles + equipment • insurance	• maintenance • laptops • smartphones • website	• paying customers • shirt sponsoring

Example of a business model canvas filled in for a bicycle courier service. (After Osterwalder & Pigneur, 2010)

METHODS: DEFINE

Business Modelling

Business Modelling is a method for developing the reason to exist of our designs from a business point of view. The Business Model Canvas serves as a checklist to generate business ideas; it also structures, discusses, and evaluates these ideas on a conceptual level.

WHAT & WHY? Business Modelling enables you to see the economic relevance and context of the product or service that you are developing: What exactly is the added value of the product or service and for whom and how can you generate a revenue?

MINDSET: Business Modelling requires both an analytical and creative mindset, as well as an interest in how organisations 'get things done'. Discussion with other stakeholders, prioritisation, and reflection are needed to fill in the blank spots.

WHEN? Business Modelling with the Business Model Canvas as a tool can be used in various stages of the development process. In the idea generation phase, it can help you in completing ideas or in evaluating them. The same goes for the conceptual phase where you need to choose between several business concepts: Which concept can be expected to generate the required turnover or profit? Which concept will strengthen the company's competitive position? Making a perfectly detailed lamp might be your dream as a designer, but if it turns out to be affordable for a handful of buyers only, it might not make a lot of sense from a business point of view, even if it has a high profit margin.

HOW? The canvas, divided into nine areas, supports the method. Each area should be defined, and the relationship between these areas can be described using arrows and drawings. Preferably, the template should be printed on a large sheet of paper (minimum A3) so you can work on it with a team in a brainstorm-type setting. This stimulates analysis, discussion, and creativity in the group.

These nine key elements of the canvas should finally be 'aligned' so that you can create a well-defined product-service proposal, though not necessarily in this order. The nine key elements can be structured in four clusters:

Group 1 – Offering (reason to exist):
What do you offer and how is that different from the offers of competitors?
• Value Propositions

Group 2 – Infrastructure (internal):
What tasks and assets are important to deliver your Value Proposition?
• Key Activities
• Key Resources
• Key Partners

Group 3 – Customers (external):
• Customer segments
• Customer Relationship
• Channels:
  - Awareness: How do we raise awareness about our company's products and services?
  - Evaluation: How do we help customers evaluate our company's Value Proposition?
  - Purchase: How do we allow customers to purchase specific products and services?
  - Delivery: How do we deliver the product or service to customers?
  - After sales: How do we provide post-purchase customer support?

Group 4 – Finances (input-output):
What are the major costs and how are they covered?
• Cost Structure
• Revenue Streams

In a further stage, the external context of the business idea can be drawn up around the Canvas and more Canvases can be drafted to communicate the development of the new business over time.

TIPS & CONCERNS

Postpone criticism. New ideas and approaches should be welcomed, and if needed, adapt them in order to improve them.

If an idea is not realistic, change it. Or add a new idea to make it realistic. Often the trick is to turn the problem into a possibility.

When a business concept is chosen for further elaboration, draw a more detailed business plan.

This method focuses on the economic interest of organisations. You can also use it to identify social and environmental interests by adding categories to the canvas that you think are relevant, such as societal- or the environmental costs and benefits.

LIMITATIONS

Compared to a classic business plan, this Business Modelling method using the canvas represents a more conceptual level of thinking about new business development.

Ensure that the order and magnitude of the numbers are realistic enough. This could be a first step in working out several business ideas.

Do not try to put in exact numbers, such as the estimated turnover or running costs.

REFERENCES & FURTHER READING: Osterwalder, A. & Pigneur, Y., 2010. *Business Model Generation*. New Jersey: John Wiley & Sons Inc.

'It is important to use your hands, that is what distinguishes you from a cow or a computer operator.'

PAUL RAND

METHODS DEVELOP & DELIVER

The methods in this section help you to develop ideas and concepts and deliver them to stakeholders. For example, Brainstorming is a well-known method for generating ideas and weighted objectives to select ideas or concepts. Several methods for evaluating designs are available. For example, PrEmo assists in the evaluation of the emotional effect of a design.

Morphology is the study of the evolution of form. Morphology originates from the biological study of animals and their functional body parts. In the design process it is used to deconstruct an overall function in sub-functions and to generate innovative combinations.

SUB-FUNCTIONS

SUPPORT KART	*4 wheels A*	*4 wheels B*	*3 wheels A*	*3 wheels B*	*3 wheels C*		
PUT KART INTO MOTION	*Direct drive*	*Chain drive*	*Belt drive*	*Drive shaft*	*Crankshaft*		
STOP KART	*Disk brakes*	*Rim breaks*	*Tire breaks*	*Feet*	*Parachute*	*Anchor*	
CONTROL DIRECTION	*Central axis*	*Ackermann*					
SUPPORT DRIVER'S BODY	*Saddle*	*Chair*	*Plank*	*Cloth*			

Example of of a morphological chart for a pedal kart. In the left column the main functions are listed. On the right for each function all possible solutions are listed. The most promising combinations are selected to be used as starting points for further development.

METHODS: DEVELOP AND DELIVER

Morphological Chart

The Morphological Chart helps designers generate solutions in an analytical and systematic way. It is based on the deconstruction of the overall function of a product or service into sub-functions.

WHAT & WHY? The Morphological Chart is a matrix of sub-functions and solutions – also referred to as parameters and components. While functions are abstract, solutions are concrete, but they do not need to have a definite shape or size yet. The matrix enables to describe possible principal solutions by combining solutions for each sub-function.

MINDSET: Similar to methods such as Problem Definition, this approach is rather analytic, in that the deconstruction requires you to have a systematic and analytical way of working. Solutions for sub-functions need idea generation, so you also need a creative and free minds for this process.

WHEN? The Morphological Chart is useful at the beginning of the idea generation phase after some ideas have been sketched. A Function Analysis is used as a starting point to break down the overall product function into sub-functions. In most cases, a number of solutions to these sub-functions are already known, while others still need to be generated.

HOW? Start with a well-defined main function of the product or service and its sub-functions. These describe all the product characteristics needed to fulfill its function. Express these by an active verb and a measurable noun. For example, a teapot: receives water; it contains tea, and allows for holding and pouring tea in a cup. In a Morphological Chart, functions and sub-functions are independent and have no reference to material features. Through a careful selection and combination of a set of solutions, a 'principal solution' is formed.

Step 1: Formulate the main function of the product or service.

Step 2: Identify all the functions and sub-functions that are needed in the solution.

Step 3: Construct a matrix with these sub-functions as rows. For example, in designing a pedal cart, its sub-functions could be: put cart into motion; stop cart; control the direction and support the driver's body.

Step 4: Fill the rows with solutions for a particular parameter. Solutions can be found by analysing similar products or by thinking up new principles for these sub-functions. Use evaluation strategies to limit the number of principal solutions.

Step 5: Create solutions by combining one solution per row for each sub-function.

Step 6: Carefully analyse and evaluate all solutions with regard to the design requirements, and choose at least three principal solutions.

Step 7: Sketch possible ideas for the whole product based on each solution.

Step 8: Elaborate on a selection of the ideas by turning them into design proposals with more detail. For services, use methods such as roadmapping and scenarios to further detail the best service ideas.

TIPS & CONCERNS

A 10 x 10 matrix yields 10,000,000,000 solutions! To limit the number of options, analyse the rows critically and group the solutions together before making the combinations.

Use the design requirements to rank the solutions per sub-function in order of first and second preference.

Group the sub-functions in groups of decreasing importance. At first only evaluate the most important ones.

Choose one or more combinations of solutions for evaluation.

Draw all the solutions or components when you develop an idea or design proposal.

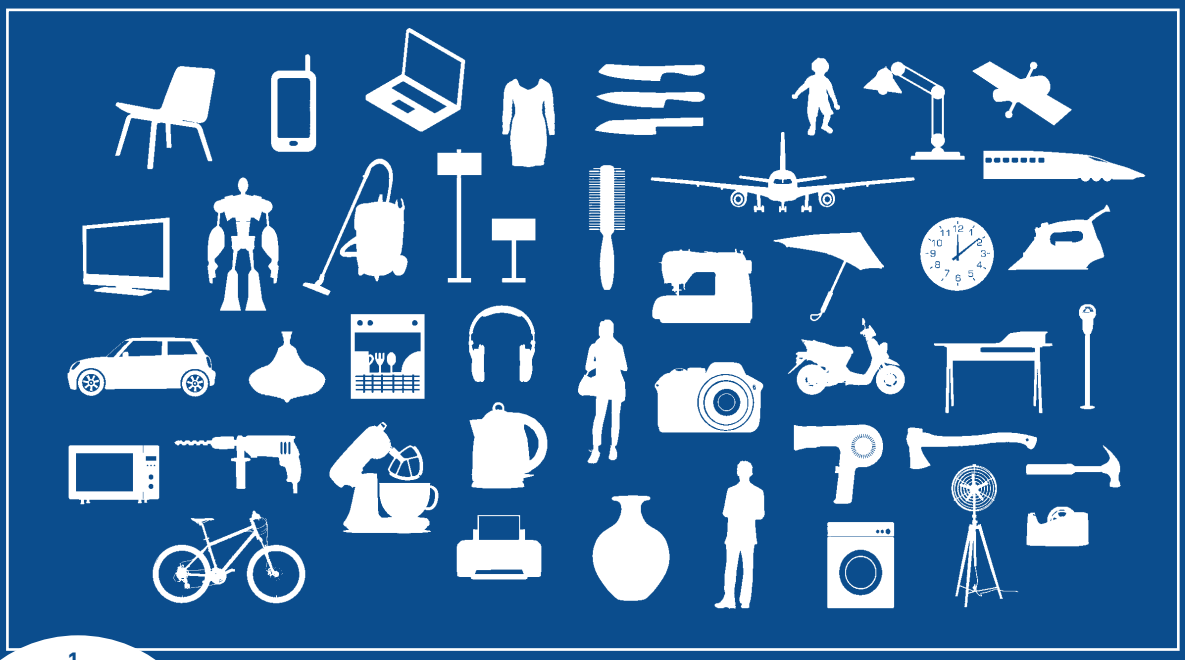
Challenge yourself by making counterintuitive combinations of solutions.

LIMITATIONS

This method is initially developed for design problems in the field of engineering design, but can also be applied to other design problems.

For service design, you need to have a very clear goal and a main function. Otherwise use less systematic methods.

REFERENCES & FURTHER READING: Heijne, K.G. & van der Meer, J.D., 2019. *Road map for creative problem solving techniques. Organizing and facilitating group sessions*.Amsterdam: Boom / Roozenburg, N.F.M. & Eekels, J., 1995. *Product Design: Fundamentals and Methods.* Utrecht: Lemma. / Cross, N., 1989. *Engineering Design Methods.* Chichester: Wiley. / Steen, M. Manschot, M. & Koning, N. (2011) Benefits of co-design in service design projects, *International Journal of Design,* Vol. 5(2) August 2011



The Delft Design Guide presents an overview of design perspectives, models, approaches, and design methods used in the Bachelor and Master curriculum at the faculty of Industrial Design Engineering in Delft.

Due to its complexity, designing requires a structured and systematic approach, as well as moments of heightened creativity. In this guide, you will find 11 perspectives on what design can do, 6 models that describe how design happens, 12 approaches that describe a comprehensive process for design that spans across phases, and around 68 purposeful and goal-oriented design methods. Some are unique to Delft, but many are more commonly known and widely used. They are all described in a practical one-page text, with illustrations and reading suggestions.

THE DELFT DESIGN GUIDE SERVES THREE GOALS

1. **DESIGN STUDENTS** can use it as a reference manual in their design projects, managing their personal development.
2. **DESIGN TUTORS** can use it as a reference manual to support students in their learning process.
3. **DESIGN PROFESSIONALS** can use this guide as a reference manual.

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