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Erasmus+ Programme Key Action 2 Cooperation Partnerships  
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*European Network for Additive Manufacturing in Industrial Design for Ukrainian Context*



# DESIGN METHODS AND TECHNIQUES

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## Examples of definitions from scientific literature:

**Design** = to organise resources in order to achieve an objective

**Design** = to generate the concept of a system, product or service

**Design** = to create, execute, or construct according to a plan for a given purpose

*Possible arguments between specialists:*

**Is a plan (methodology) really needed?**

- **YES**, the followers of structured thinking will say.
- **NO**, very creative people will say.





There are many **myths** regarding design and especially the design of successful products. One such myth was built around a product with an iconic design: **Juicy Salif**.



Squid



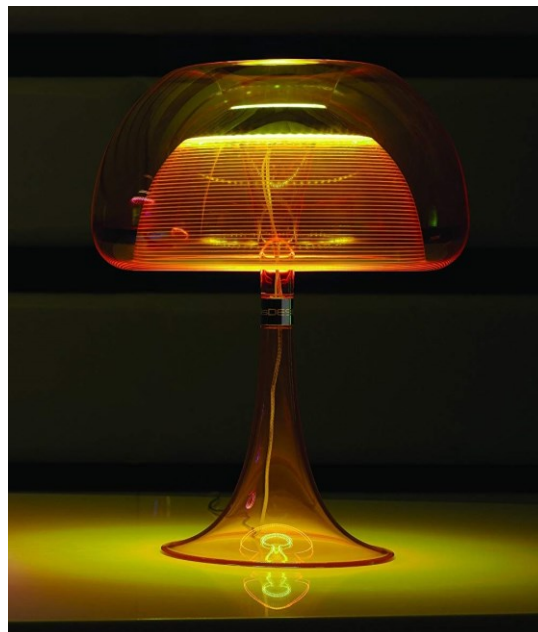
Juicy Salif



“Stained” napkin



From an etymological point of view, the word **design** comes from the Latin **designare**, respectively assigning the character of a sign to something. From this perspective, the name "industrial design" for product aesthetics is correct, because it conveys meanings.



Aurelia Lamp:

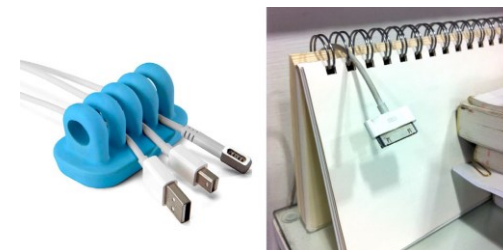
- luxurious
- high quality
- mysterious





## Approaches in designing / solving practical problems:

- **everyday design / design-by-use / non-intentional design**  
discovering simple solutions to design problems using resources at hand
- **silent design**  
it is specific to newly established companies, which have not yet hired a professional designer, and design decisions are taken by employees from other fields
- **professional design**  
the result of the activity of a designer or design team that covers every aspect of product development





Well-known rules, but which should still be mentioned:

- Representatives of **all relevant departments** participate in product design.
- The design process covers **simultaneously** (more or less) **all aspects** of the product (mechanical, electrical, ergonomics, aesthetics, etc.) and absolutely not sequentially (for example, first the mechanical part, then the electrical part...).
- The design starts with the **functional core** and then expands to the "outside".
- **Materials** and (operational and manufacturing) **technologies** should be used with maximum efficiency.





A product development framework should necessarily include the following aspects:

- Understanding the company's **objective**, overcoming the **ill-defined problems** and formulating the **design task**
- Correct **identification of the market segment** that will purchase the product
- In-depth understanding of the **needs, desires and expectations** of the considered market segment
- Formulation of the **value proposition** (vital and customer-aware problem that the proposed product / service solves)
- **Analysis of the competition** for an effective differentiation of product on the market
- Elaboration of the **product design specification**
- (Iteratively) generation and sorting of **concepts**
- **Concept selection** and embodiment design (for very complex products)
- **Detailed design**
- **Prototype testing** (including user appropriation)







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| Models                             | Establishing a need phase     |                             | Analysis of task phase             |                    | Conceptual design phase          |                                 | Embodiment design phase  |                                | Detailed design phase       |                  | Implementation phase            |  |                       |   |
|------------------------------------|-------------------------------|-----------------------------|------------------------------------|--------------------|----------------------------------|---------------------------------|--------------------------|--------------------------------|-----------------------------|------------------|---------------------------------|--|-----------------------|---|
| Booz et al. (1967)                 | X                             |                             | New product strategy development   |                    | Idea generation                  | Screening & evaluation          | Business analysis        |                                | Development                 |                  | Testing                         |  | Commercialisation     |   |
| Archer (1968)                      | X                             |                             | Programming   data collection      |                    | Analysis                         | Synthesis                       | Development              |                                | Communication               |                  | X                               |  |                       |   |
| Svensson (1974)                    | Need                          |                             | X                                  |                    | Concepts                         |                                 | Verification             |                                | Decisions                   |                  | X                               |  | Manufacture           |   |
| Wilson (1980)                      | Societal need                 |                             | Recognize & formalize              | FR's & constraints | Ideate and create                |                                 | Analyze and/or test      |                                | Product, prototype, process |                  | X                               |  |                       |   |
| Urban and Hauser (1980)            | Opportunity identification    |                             | Design                             |                    |                                  |                                 | Testing                  |                                |                             |                  | Introduction (launch)           |  | Life cycle management |   |
| VDI-2222 (1982)                    | X                             |                             | Planning                           |                    | Conceptual design                |                                 | Embodiment design        |                                | Detail design               |                  | X                               |  |                       |   |
| Hubka and Eder (1982)              | X                             |                             | X                                  |                    | Conceptual design                |                                 | Lay-out design           |                                | Detail design               |                  | X                               |  |                       |   |
| Crawford (1984)                    | X                             |                             | Strategic planning                 |                    | Concept generation               |                                 | Pre-technical evaluation |                                | Technical development       |                  | Commercialisation               |  |                       |   |
| Pahl and Beitz (1984)              | Task                          |                             | Clarification of task              |                    | Conceptual design                |                                 | Embodiment design        |                                | Detailed design             |                  | X                               |  |                       |   |
| French (1985)                      | Need                          |                             | Analysis of problem                |                    | Conceptual design                |                                 | Embodiment of schemes    |                                | Detailing                   |                  | X                               |  |                       |   |
| Ray (1985)                         | Recognise problem             |                             | Exploration of problem             | Define problem     | Search for alternative proposals |                                 | Predict outcome          | Test for feasible alternatives | Judge feasible alternatives | Specify solution | Implement                       |  |                       |   |
| Cooper (1986)                      | Ideation                      |                             | Preliminary investigation          |                    | Detailed investigation           |                                 | Development              | Testing & Validation           | X                           |                  | Full production & market launch |  |                       |   |
| Andreasen and Hein (1987)          | Recognition of need           |                             | Investigation of need              |                    | Product principle                |                                 | Product design           |                                | Production preparation      |                  | Execution                       |  |                       |   |
| Pugh (1991)                        | Market                        |                             | Specification                      |                    | Concept design                   |                                 |                          |                                | Detail design               |                  | Manufacture                     |  | Sell                  |   |
| Hales (1993)                       | Idea, need, proposal, brief   |                             | Task clarification                 |                    | Conceptual design                |                                 | Embodiment design        |                                | Detail design               |                  | X                               |  |                       |   |
| Baxter (1995)                      | Assess innovation opportunity |                             | Possible products                  |                    | Possible concepts                |                                 | Possible embodiments     |                                | Possible details            |                  | New product                     |  |                       |   |
| Ulrich and Eppinger (1995)         | X                             |                             | Strategic planning                 |                    | Concept development              |                                 | System-level design      |                                | Detail design               |                  | Testing & refinement            |  | Production ramp-up    |   |
| Ullman (1997)                      | Identify needs                | Plan for the design process | Develop engineering specifications |                    | Develop concept                  |                                 | Develop product          |                                |                             |                  | X                               |  |                       |   |
| BS7000 (1997)                      | Concept                       |                             |                                    | Feasibility        |                                  | Implementation (or realisation) |                          |                                |                             |                  |                                 |  | Termination           |   |
| Black (1999)                       | Brief/concept                 |                             | Review of 'state of the art'       |                    |                                  | Synthesis                       | Inspiration              | Experimentation                | Analysis / reflect          | Synthesis        | Decisions to constraints        |  | Output                | X |
| Cross (2000)                       | X                             |                             | Exploration                        |                    | Generation                       |                                 | Evaluation               |                                | Communication               |                  | X                               |  |                       |   |
| Design Council (2006)              | Discover                      |                             | Define                             |                    | Develop                          |                                 |                          | Deliver                        |                             |                  | X                               |  |                       |   |
| Industrial Innovation Process 2006 | Mission statement             |                             | Market research                    |                    | Ideas phase                      |                                 | Concept phase            |                                | Feasibility Phase           |                  | Pre production                  |  |                       |   |

## Design Phases

[Howard, T. J., Culley, S. J., & Dekoninck, E. (2008). *Describing the creative design process by the integration of engineering design and cognitive psychology literature*. Design studies, 29(2), 160-180]





| Models                       | Analysis phase                               |              |                                       |                 | Generation phase                 |              |                      | Evaluation phase                            | Communication / implementation phase             |                  |                   |
|------------------------------|--|--------------|---------------------------------------|-----------------|----------------------------------|--------------|----------------------|---|--|------------------|-------------------|
| Helmholtz (1826)             | Saturation                                   |              |                                       |                 | Incubation                       | Illumination |                      | X   | X  |                  |                   |
| Dewey (1910)                 | A felt difficulty                            |              | Definition and location of difficulty |                 | Develop some possible solutions  |              |                      | Implications of solutions through reasoning | Experience collaboration of conjectural solution |                  |                   |
| Wallas (1926)                | Preparation                                  |              |                                       |                 | Incubation                       | Illumination |                      | Verification                                | X  |                  |                   |
| Kris (1952)                  | X  |              |                                       |                 | Inspiration                      |              |                      | Elaboration                                 | Communication                                    |                  |                   |
| Polya (1957)                 | Understanding the problem                    |              | Devising a plan                       |                 | Carrying out the plan            |              |                      | Looking Back                                | X  |                  |                   |
| Guilford (1957)              | X  |              |                                       |                 | Divergence                       |              |                      | Convergence                                 | X  |                  |                   |
| Buhl (1960)                  | Recognition                                  | Definition   | Preparation                           | Analysis        | Synthesis                        |              |                      | Evaluation                                  | Presentation                                     |                  |                   |
| Osborn (1963)                | Fact-finding                                 |              |                                       |                 | Idea-finding                     |              |                      | Solution-finding                            | X  |                  |                   |
| Parnes (1967)                | Problem, challenge, opportunity              | Fact-finding |                                       | Problem-finding | Idea-finding                     |              |                      | Solution-finding                            | Acceptance-finding                               | Action           |                   |
| Jones (1970)                 | Divergent                                    |              |                                       |                 | Transformation                   |              |                      | Convergent                                  | X  |                  |                   |
|                              | Search for data                              |              | Understand the problem                |                 | Pattern finding                  |              | Flashes of insight   |   |  |                  |                   |
| Stein (1974)                 | X Fact-finding                               |              |                                       |                 | Hypothesis formulation           |              |                      | Hypothesis testing                          | Communication of results                         |                  |                   |
| Parnes (1981)                | Mess finding                                 |              |                                       | Problem-finding | Idea-finding                     |              |                      | Solution-finding                            | Acceptance-finding                               |                  |                   |
| Amabile (1983)               | Problem or task presentation                 |              | Preparation                           |                 | Response generation              |              |                      | Response validation                         | Outcome  |                  |                   |
| Barron and Harrington (1981) | X  |              |                                       |                 | Conception                       | Gestation    | Parturition          | X   | Bring up the baby                                |                  |                   |
| Isaksen et al. (1994)        | Constructing opportunities                   |              | Exploring data                        | Framing problem | Generating ideas                 |              |                      | Developing solutions                        | Building acceptance                              | Appraising tasks | Designing process |
| Couger et al. (1993)         | Opportunity, delineation, problem definition |              | Compiling information                 |                 | Generating ideas                 |              |                      | Evaluating, prioritising ideas              | Developing an implementation plan                |                  |                   |
| Shneiderman (2000)           | Collect                                      |              |                                       |                 | Create                           |              |                      | Donate (communicate)                        |  |                  |                   |
| Basadur et al. (2000)        | Problem finding                              | Fact finding | Problem defn.                         |                 | Idea finding                     |              |                      | Evaluate and select                         | Plan   | Acceptance       | Action            |
|                              |  |              |                                       |                 | Diverge – converge at each stage |              |                      |   |  |                  |                   |
| Kryssanov et al. (2001)      | Functional requirements                      |              | Structural requirements               |                 | Functional solutions             |              | Analogies, metaphors | Reinterpretation                            | X  |                  |                   |

## Creative Phases

[Howard, T. J., Culley, S. J., & Dekoninck, E. (2008). *Describing the creative design process by the integration of engineering design and cognitive psychology literature*. Design studies, 29(2), 160-180]



But it should be emphasized once again that **the process is not linear**, and each stage should be treated in-depth. It can be said that there are specialized methods and techniques that are suitable for each stage. Thus, someone can **classify** the design methods and techniques into four broad categories:

- documentation methods
- methods for increasing creativity
- auxiliary design methods
- actual design methods





## Documentation methods and techniques:

- competition analysis
- historical research
- collecting information from consumers (observing the product in use; questionnaire; interview; focus group; drawing / prototyping the ideal product)
- anthropological research
- sentence completion test
- user perceived value
- empathy diagram
- bio-mimicry (bionics)







## Methods to increase creativity:

- TRIZ
- brainstorming
- synectic method
- bisociation
- 6 thinking hats
- creative break
- creative challenge
- alternatives method
- layers method





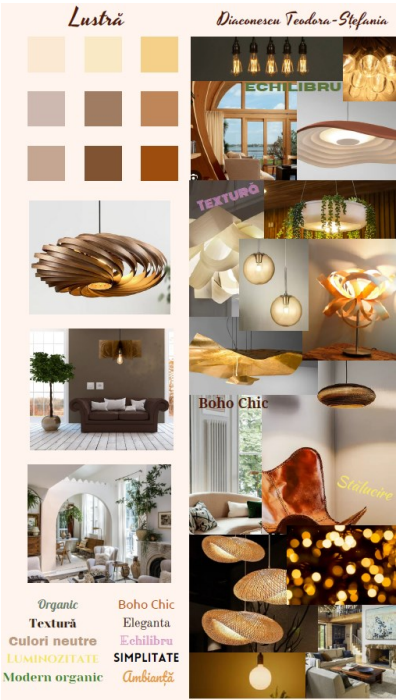
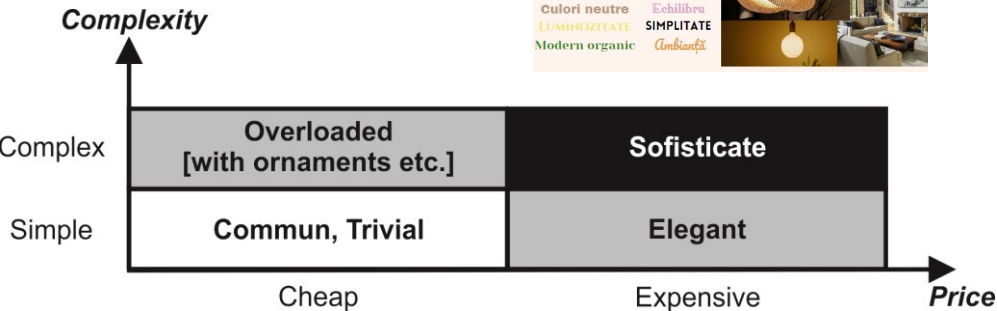
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# Auxiliary design methods and techniques:

- customer journey mapping
- character profiling
- scenario method
- mind map
- 9 windows technique
- cultural matrix
- mood board

|            | Past | Present | Future |
|------------|------|---------|--------|
| Road       |      |         |        |
| Automotive |      |         |        |
| Car body   |      |         |        |





## Actual design methods:

- Design Thinking
- User Experience Design / Interaction Design
- Participatory Design (CoDesign)
- Design for Behavioural Change
- Material Driven Design
- Design for Emotion



## Methods oriented to product aesthetics:

- Kansei method
- Morphological diagram
- Grammar of forms
- Designing product significance
- Product metaphor generation
- Design for product personality



## Design Thinking:

### Stages:

1. Understanding the problem /  
empathy with consumer
2. Definition
3. Ideation
4. Prototyping
5. Testing

### Characteristics:

- iterative experimentation;
- searching for a better and not necessarily perfect solution;
- allows finding revolutionary solutions, not just incrementally superior to others;
- search for novelty;
- ignoring the status quo;
- seeing and doing approach;
- focus on action.





## User Experience Design / Interaction Design

User Experience Design (UX Design) is the process of developing products that offer users a meaningful and relevant experience through the whole interaction involving observing, acquiring, using and appropriation.

Key Characteristics of User Experience Design:

- Empathy
- Strategy
- Usability
- Inclusivity
- Validation



## Participatory Design (CoDesign)

Participatory design is a design approach that:

- involves future users in all design stages, not only in the market research.
- imposes the consultation of all stakeholders associated to the product.
- requires the careful selection of the participants to the design process.
- ensure that all participants to the design process have a real say.
- all critical decisions are transparent.
- the whole design process is democratic.





## Design for Behavioural Change

This method philosophy is that the products, through the way or the context of use, determine the change in the consumers' attitude regarding harmful habits.

Harmful habits:

- driving on any occasion, even for short distances
- sedentary lifestyle
- food excess
- obtaining coffee from the machine in a single-use cup
- use of disposable glasses, cups, plates, cutlery made of any material (especially plastic)
- using a maximum and continuous flow of water when washing hands or teeth
- surfing the internet for hours out of boredom



## Design for Behavioural Change

In order to provide a pleasant conflicting feedback, a product should meet the following requirements:

- to be linked to an impulsive or automatic habit;
- to offer a much better alternative;
- to be used at the right time for attitude change;
- to disturb the user in some way so that he starts thinking.







## Material Driven Design

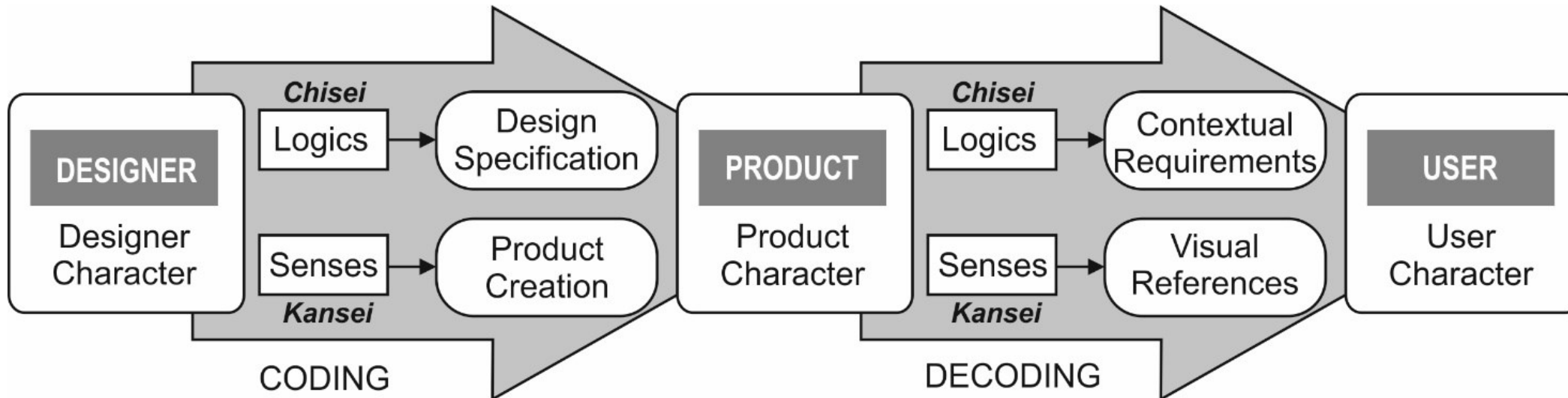
The materials-centred design methodology includes the following stages:

- understanding the material: technical, perceptual and semiotic characteristics
- creating a vision of the experience of using the material
- manifestation of material experience models
- designing with the material

| CHEERFUL   |   |
|--|---|
|   |   |
| <br><br> | <ul style="list-style-type: none"><li>▪ high-gloss</li><li>▪ light bright colours</li><li>▪ smooth</li><li>▪ warm</li></ul> <p>Sample:  plastic</p> |



## Kansei



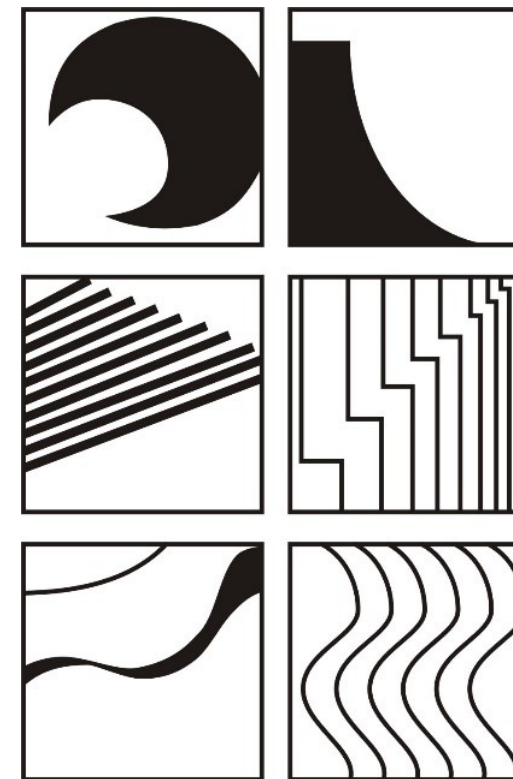
**Chisei** means intellectual knowledge.  
**Kansei** represents sensory knowledge.



## Kansei

### Kansei Stages:

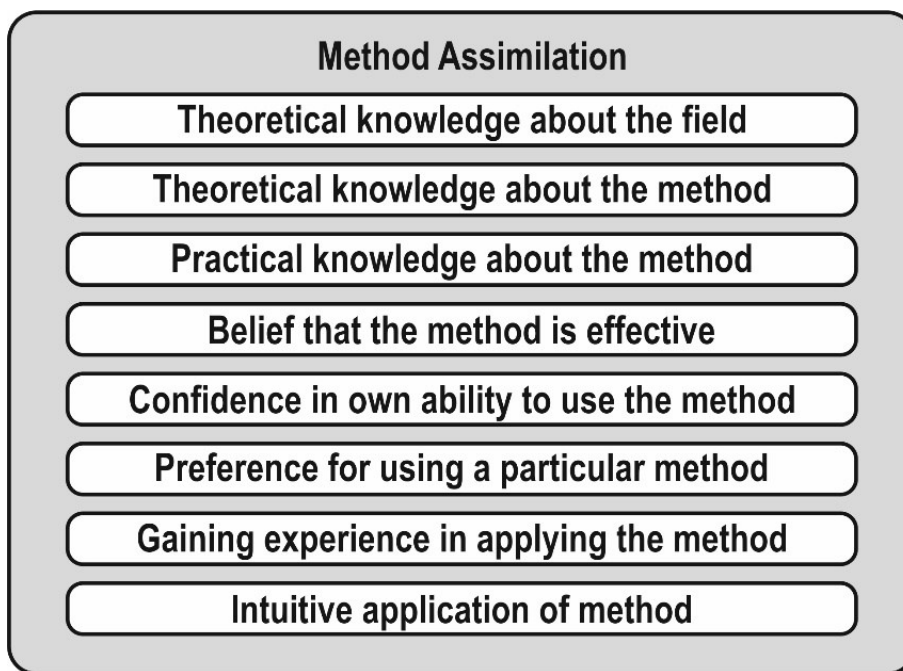
- collecting product images
- aesthetic transfiguration of product images into icon images
- establishing Kansei adjectives
- sorting icon images and Kansei adjectives
- establishing links between the icon images and Kansei adjectives
- analysis and decomposition of the shape
- synthesizing new shapes
- selection of the final shape





## Method Assimilation

Except for some simple techniques, the methods are not easy to apply and the designer needs to assimilate the method.







## Prototypes

A comprehensive classification is the following:

- **conceptual model** – simple expression of the idea of operation;
- **model for testing the principle of operation** – a model that only tests the basic idea of functioning;
- **non-functional model** ("visual") - model that only has the role of the designer and others to observe how the product will look in the end;
- **virtual model** – model made with a computer-aided design programme, and which can be tested virtually in different ways;
- **working prototype** – prototype that allows testing the functioning of the product;
- **ergonomic prototype** – prototype that allows testing how the user can use the product;
- **final prototype** – prototype that is almost identical to the final product in all respects.



## Prototypes

**Iterative prototyping** implies that a large part of the product development activities is dedicated to the development of prototypes and their testing. This strategy requires attention to application from two points of view:

- costs that can become high in the case of complex products
- need to design a system for assessment the contribution made by each prototype to the understanding, development and improvement of the product.

**Parallel prototyping** involves different teams (or individual designers) developing a prototype separately.





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*Thank you for  
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