



# Applied aesthetics in biomimetic design - a guide

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This booklet is a result of our work in the special course  
“Applied aesthetics in biomimetic design” with supervision  
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## What is this booklet?

This booklet proposes seven methods that can be used to draw inspiration from nature when working with an industrial product.

Our focus will only be on biomimetics in industrial design. The methods described in this booklet lies within the industrial design area, on the border of art.

The scope with the booklet is to deliver tools to small design studios and students, which can use these systematically on a methodically basis in relation to getting aesthetic inspiration from nature.

The booklet is supported by a design case: A pendant for the living room, which illustrates the use of the seven methods, where a final concept of a pendant is presented as an outcome, after which the methods and process are evaluated.

## The motivation behind the project

What is biomimetics and how is it used?

"..biomimetics.. is the discipline of creating new objects with inspiration from nature." [6], furthermore, "Biomimetics as a scientific discipline needs to formulate theories that will explain the relations between nature and technology and develop methodologies that will facilitate the design process. Design is basically about creating new ideas and transforming them into physical or immaterial concepts. But the design activity will be different depending on the focus". [6]

There are different approaches within the biomimetic area. In the article "biomimicry –a useful tool for the industrial designer" [8] the authors Nina Louise Voldstad and Casper Boks gives examples on different types of biomicry products, and proposes a scale of biomimetics. "None of the examples are regarded as purely engineering or art, emphasizing that industrial design often lies in the middle of the two." [8]. There are both similarities and differences between the areas within biomimetics. "Roughly speaking the engineering designer are mostly focused on inspiration to new functional principles, like for example cleaning principles or principles for reduced flow resistance. The industrial designer on the other hand has focus on inspiration for aesthetics and geometric shape, like plant shapes and animal expressions." [7] "Search methodologies for mechanical principles are very different from retrieval tools for geometry and shape." [6]. Volstad and Boks emphasis that there is a lack of tools, in the design area of biomimetics. They mention tree different methods, describe their drawbacks, and propose "The card deck method". [8]. Another method,



which focuses on the functional analysis, is the “biocard” that has been presented for us in the course: 41070 Holistic design. The lack of concrete methods for aesthetic biomimetic and the existence of methods like the “card deck” and “bio card” [10] have been the reason for making, and inspiration for, this booklet.

### Industrial design & aesthetics

This booklet deals with the aesthetic values within the field of biomimetics. This section shortly covers the term aesthetics and our approach to aesthetic biomimetics.

Early scholars of beauty held the perspective that features like lines, proportion, shape, colour etc. were inherently attractive. Some schools, like Bauhaus, have tried to define the objective aesthetic principles; Symmetry, proximity, similarity, continuance, repetition and closure. Corzior suggests that there is no such thing as an objective aesthetic, that the notion is affected by individual factors. Coates suggests that both the subjective and the objective qualities are important. Gombric proposes, “delight lies between boredom and confusion”. [3] Coats suggest that subjective and objective qualities on both exists and that the product attractiveness stems from the balance between information (novelty and contrast) and concinnity (order and sense)[3]. It is our opinion that biomimetics is an ideal inspiration source when trying to balance a product between information and concinnity. Several of the booklet methods permit the incorporation of sensory attributes such as: proportion, shape, colour, material, surface and so forth. Other methods focus on symbolic attributes. The symbolic association in products may evoke; thoughts, feelings and associations. This gives an opportunity for the consumer to

communicate their identity, through the product [3].

### The methods

**The methods enables you to:** extract inspiration from nature in a systematic way and document the design process.

**The overall purpose with the methods is:** Document and inspire to generation of bio-inspired concepts.

**Bio-methods is:** An easy accessible and limitless source of inspiration.

**The methods can be used by:** Our methods are shaped for the individual designer, and does not require economics or memberships to existing databases. Thus making them suitable for students, free lancers and small design studios.

**How these methods are used:** The methods can be used independently of each other, or in a combination. They could be used as a supplement to other inspirational methods in the design process, or as the only one, as it is done in the “pendant for the living room” case.



The origin of the methods:

The development of the methods has been an iterative process between defining and testing the methods. The tests are performed internally. The methods are to be seen as a first draft and represent the first tentative steps towards a set of refined and thorough methods.

The different methods originate from various fields within the engineering and industrial design area. All methods have been modified in order to function as methods within the area of aesthetic biomimetic.

**Nature as product:** Is inspired by the “Vita Riis approach” [12] method used to analyse industrial design products.

**Action reaction:** Initially inspired by the “control volume” from fluid dynamics and “the sequence model” from participatory design. Both models are able to describe the change within an object.

**Split feelings:** Inspired by an assignment in industrial design 1, where the student has to design an artefact, which appearance radiates two feelings.

**Impressions on the spot:** Is inspired by the working paper “Product search through the use of semantic properties”, and a field trip to a park.

**Material board:** Is inspired by the styling mood board used in the DTU course: 41031- Industrial Design.

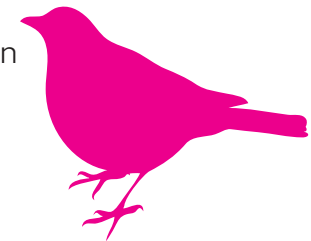
**Pattern of inspiration:** This method is a slightly modified method, inspired by the Morphological chart introduced in the book: Engineering Design Methods by Nigel Cross.

**Inspiration wheel:** Is inspired by VISCERAL HEDONIC RHETORIC by Cara Jayd Wrigley [Table 3: Visceral Rhetoric Coding Scheme and Figure 39: Visceral Hedonic Rhetoric Design Tool]



Word list:

In this booklet the term **Natural element**, is used to describe elements in nature, which can be used as an inspirational source. The natural element spans from minerals, plants, animals to natural phenomena in either water, space, air or on earth.

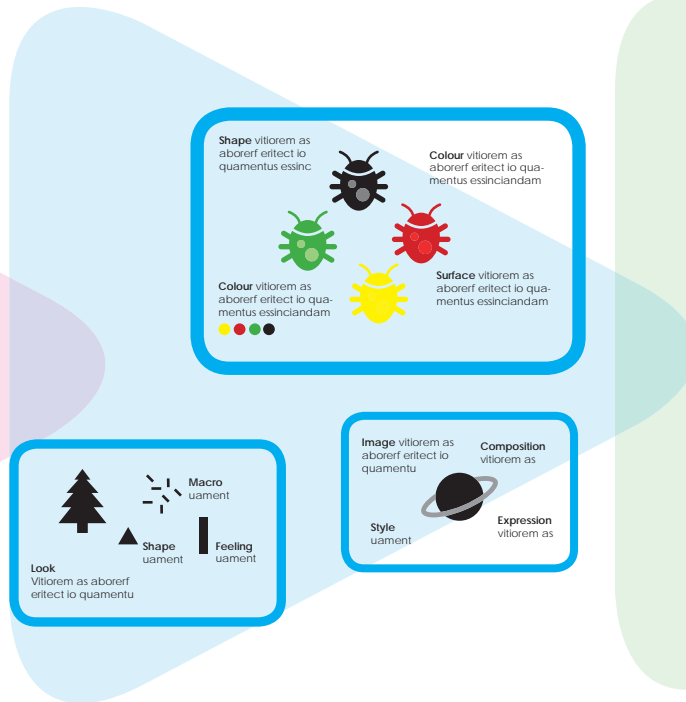


# From bio-inspiration to concepts



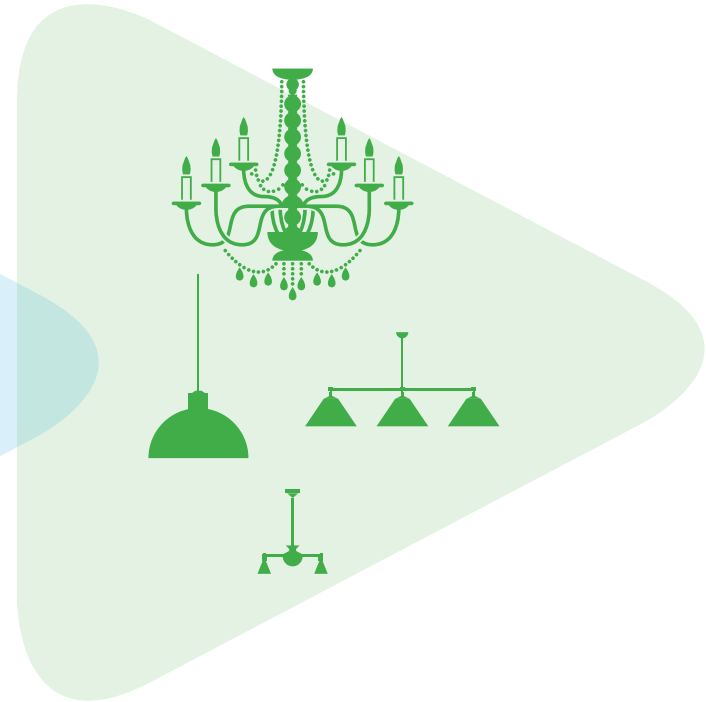
## Inspiration

Seeking inspiration from nature via museums, the internet and going out in nature.



## Documentation

Documenting the found inspiration with the use of 7 methods.



## Concepts

Generating concepts and variations based on the inspiration and documentation.

# Introduction to the 7 methods



## #1 Nature as a product

**Does:** Makes it possible to transfer the qualities of the natural element into design expressions.

**Gains:** Encourages you to analyse a natural element as a product.

### Step by step:

1. Analyse the natural element.
2. Document the analysis into a card with the natural element in the middle surrounded with categories around, explaining e.g. the composition of the natural element by describing properties like texture, style and expression, tactile, colours, shapes, composition.
3. Focus on several points from the explanation of the natural element.
4. Transform these points into concepts.

### Pros(+):

- Perceiving the natural element in another context.
- Takes sensory aspect into account.
- Decomposes the natural element into design characteristics.

### Cons(-):

- Demands the user to have prior knowledge about stylistic periods.
- Needs support from a historical walk-through's of style epochs.



**Tactile:** soft, rough and curly surface

**Style:** art nouveau

**Colours:** soft yellow, white and black

**Texture:** fragile and smooth

**Shapes:** round, oval, long

**Expression:** alluring, fragile, aggressive, light, elegant, feminine, symmetrical



**Composition:** stem, leaves, petals.

#1A A flower as a product

**Tactile:** rough and hard, soft and crisp.

**Style:** baroque and art nouveau

**Shapes:** rounded, long, plump.

**Colours:** green, brown and sand

**Texture:** structured, web, patches, frayed.

**Composition:** round root, patches leaves with long branching leaves

**Expression:** frisky, moose, soft explosion, point wise growth, unfolds, elegant.



#1B A antler fern as a product



## #2 Action reaction

**Does:** Makes you focus on the causal changes in nature.

**Gains:** Inspires to dynamic products.

### Step by step:

1. Find an object in nature that changes its appearance due to some form of action.
2. Copy/take photos before and after the action.
3. Document the reaction, as seen at right. Formulate the reaction with key words, get inspiration from e.g. change of structure, colour and a certain movement.
4. Transform the inspiration into concepts, which are consisting of partial principals of the reaction.

### Pros(+):

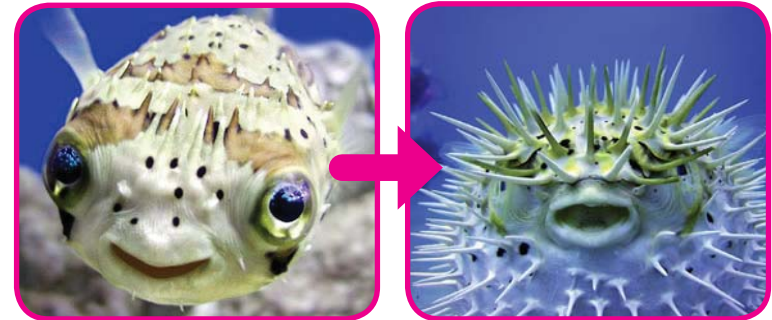
- Takes dynamics into account in the design process.
- Encourage the user to focus on a specific feature during the action/reaction.
- Fast method to use and document.

### Cons(-):

- The transformation can be hard to capture with a camera in nature because of the speed of action.



#2A Folding out, extending body, "explodes"



#2B Blows up, change of structure, smooth to pointy



#2C Reveals pattern, spreading, open-close



### #3 Split feelings

**Does:** Makes you focus on the details of the natural element and express the different feelings connected to this.

**Gains:** Challenges you to transfer different feeling to one natural element

#### Step by step:

1. Choose a natural element
2. Decompose the natural element into areas with opposite feelings, choose 3-5.
3. Describe the opposite feelings you perceive in these areas(at least two feeling per area).
4. With a focus on e.g. stable and mellow generate a concept, which radiates both feelings. This can e.g. be done by having a high focus on textures and the overall shape. Repeat this action for all the selected areas.

#### Pros(+):

- Capturing multiple feelings on one spot.
- Does not require special equipment.
- Easy accessible data.

#### Cons(-):

- Needs guidance from a list of feelings(appendix 1).



Aggressive,  
youthful



Fresh, slick



Stable,  
mellow



Quiet,  
lonely



Confused,  
energetic

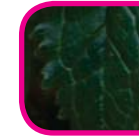
#3A Split feelings - rocks, leaves and cactus



Sensitive,  
strong



Light,  
mellow



Strong,  
brave



Spirited,  
devoted



Vain,  
defended

#3B Split feelings - rocks, leaves and cactus

## #4 Impressions on the spot

**Does:** Makes it possible to map expression in nature via pictures and text.

**Gains:** Gives you the opportunity to explore the expressions in one area of nature.

### Step by step:

1. Go out in the nature and choose one specific physical restricted spot.
2. Describe the overall expression on the spot by e.g. looking in all direction.
3. Take photos of individual expressions that support the main impression in the area, describe individual impressions.
4. Make sub categories and begin to map the different impressions.
5. Use the mapping loosely as an inspiration source for different concepts all named "the overall impression", in order to convey this.

### Pros(+):

- Maps impressions on spots in the nature.
- An quick way to get a visual and verbal overview of several impression and expressions in a restricted area.

### Cons(-):

- Easy to get distracted by other neighbouring spots.
- Difficult to write thoughts down and take pictures at the same time.



#4A Overall impression: Princess adventure



## #5 Inspiration boards

**Does:** Makes it possible to decompose an area of natural elements into surfaces, colours, materials and shapes of existing materials and products on separate collages.

**Gains:** A visual inspiration source during concept generation.

### Step by step:

1. Choose a category in nature e.g. beetles.
2. Document these on a board(3-5 relatives of 1 species).
3. Find existing materials and products(not similar to your case), which describes the appearance of the natural element and place these on four individual boards; surfaces, colours, materials and shapes.
4. Get an overall overview of the individual boards or select/combine specific features from the individual boards and generate a concept, which illustrate these and continue this.

### Pros(+):

- A strong visual tool in relation to decomposing natural elements within the same category.
- Stretches the inspiration space with existing products and materials.

### Cons(-):

- Knowledge of design is needed, as the user needs to know where to find existing products and materials containing the same features as the natural element.



## #6 Pattern of inspiration

**Does:** Makes it possible to collect and map “natural elements” into categories systematically. Afterwards it is possible to combine partial solutions into one concept.

**Gains:** Gives you the opportunity to collect different expressions of “natural elements” and combine these into concepts.

### Step by step:

1. Find or take photos that matches the different categories.
2. Place photos in table.
3. Combine one picture from each category, into a collective concept.
4. Create new combinations (repeat number 3)

### Pros(+):

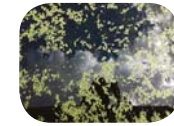
- Contributing in relation to mapping variants within the same field and get a visual overview.
- Takes design characteristics into account
- Possible to generate numerous of different concepts because of the quantity of possible paths between categories.

### Cons(-):

- The categories structure and surface can be hard to differ between.

### Categories

#### Surface



#### Shape



#### Colour



#### Structure



#6A Natural elements from Botanical Garden – CPH

## #7 Inspiration wheel

**Does:** Is an inspirational tool that allows you to combine industrial design methods and bio characteristics.

**Gains:** Inspires you into seeing nature within various different categories.

### Levels in the wheel:

**Level 1 - Micro, macro:** tells you whether you should focus on textures or full scale elements.

**Level 2 - Category of nature:** Decides if you should search for either minerals, plants, animals or natural phenomena.

**Level 3 - From earth to space:** It defines if you should focus on the category from level 2 in either water, space, air or on earth.

**Level 4 - Characteristics:** Sets your focus on a certain characteristic: Gender, colour, quality, texture, material, intrigued.

### Step by step:

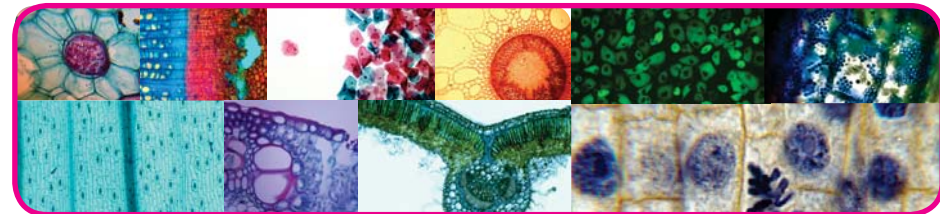
1. Spin the wheel.
2. Highlight the path of levels in the wheel.
3. From the four categories in the levels search on the web.
4. Document the search results in a board with pictures.
5. Create different concepts based on board and spin the wheel again and repeat the steps.

### Pros(+):

- Guides the user to new sources of inspiration
- A quick way to get inspiration through cyberspace.

### Cons(-):

- Some of the combination in the wheel will not work, as animals + space.



#7A Path: Macro -> Plants -> Earth -> Texture



#7B Path: Largest -> Mineral -> Earth -> Materials

# Conceptual ideas based on the 7 methods





#1A

#1B

#1 Nature as a product  
Even though the conceptual ideas are very different,  
it is clear that the overall look of the two plants have  
been transferred, in every single idea.



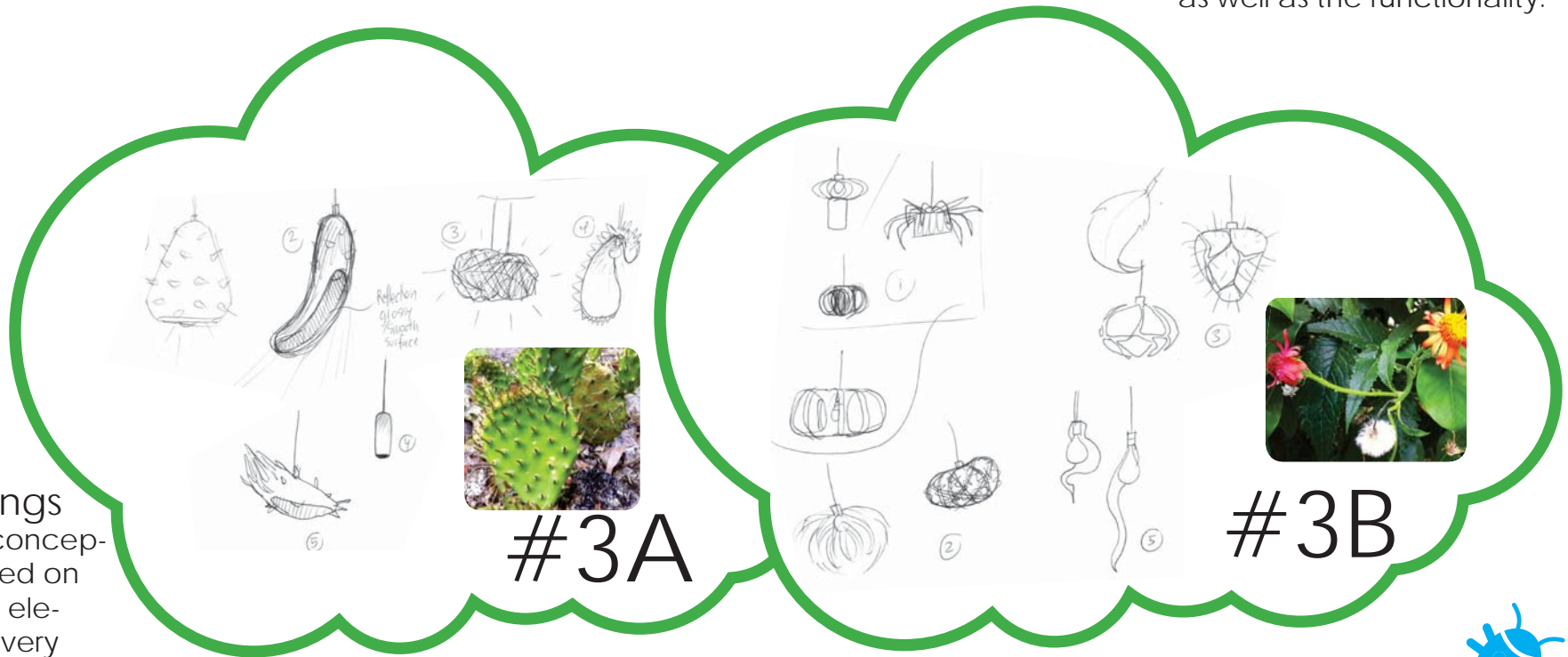


#2A

#2B

#2C

#2 Action reaction  
 The conceptual ideas adopts functional principals. The lack of focus on aesthetics parameters seems to make the designer directly transfer the look of the natural element, as well as the functionality.



#3A

#3B

#3 Split feelings  
 Even though the conceptual ideas are based on the same "natural element", they have very different looks.

#4 Impressions on the spot  
 When looking at the conceptual ideas  
 as a collective, it is easy to see the com-  
 mon but spacious inspirational source.



#4B



#5A

#5 Inspiration boards  
The conceptual ideas are restricted to one look but varies still in shape and expression within this frame.



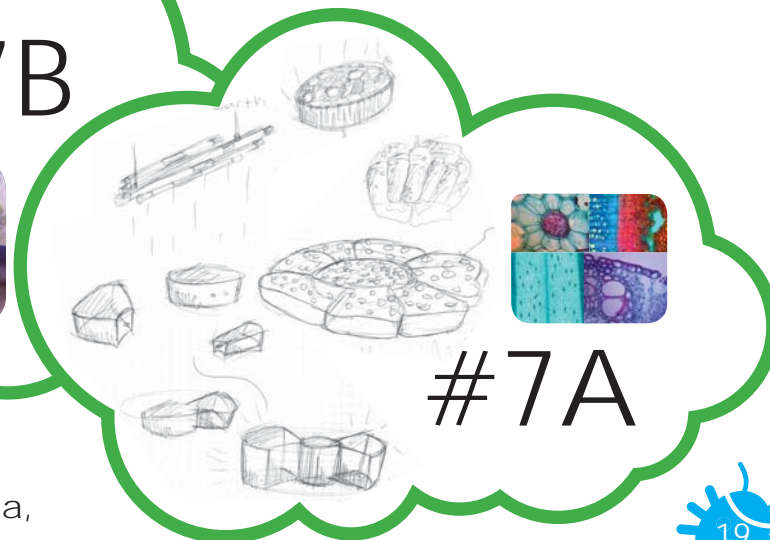
#6A

#6 Pattern of inspiration  
Loads of expressions with a high level on details.



#7B

#7 Inspiration wheel  
Free from interpretation after collecting data, which shows in these conceptual ideas.

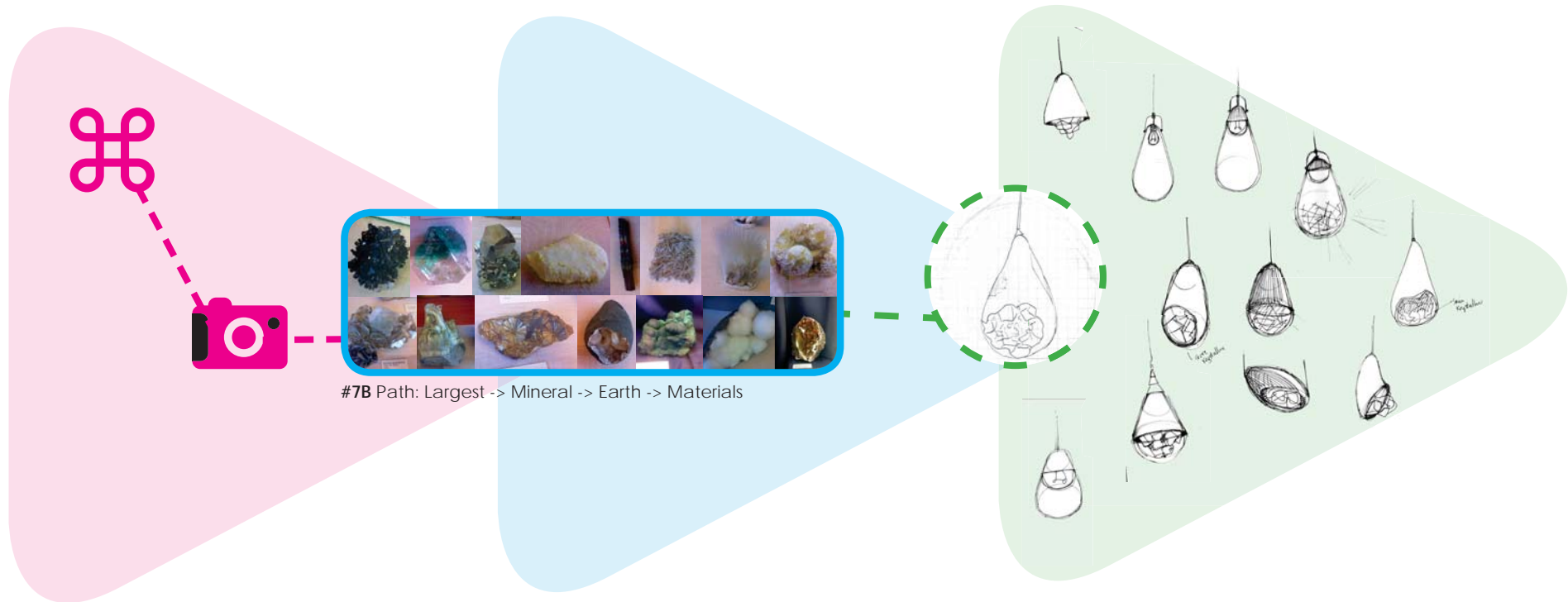


#7A

# Combining into concepts



# Epis

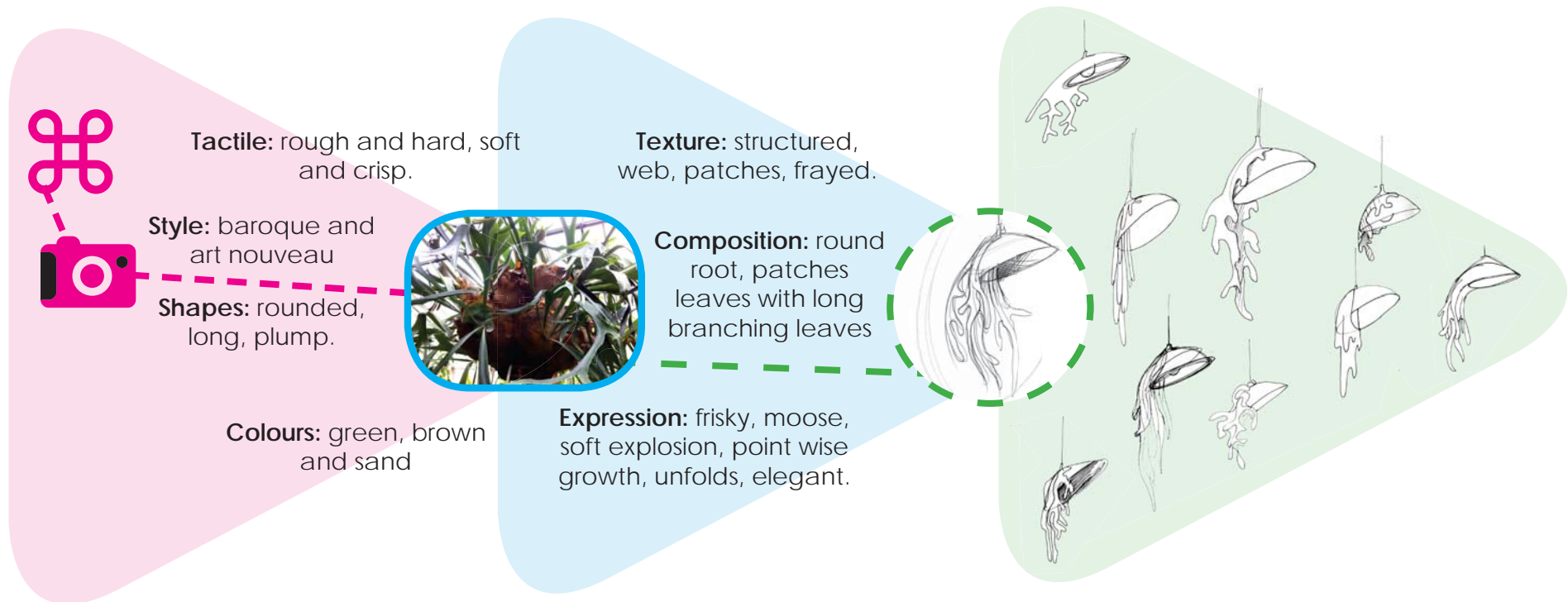


The Epis lamp is calm, expressive and modern.

The pendant is inspired by the Epistilbit mineral. The lamp looks almost similar to the actual mineral in regard to shape and colours. The materials are not the same. The pendant is made of a dark grey metallic outer shell and a crystal-like shaped transparent inner shell, made by plastic. The Epistilbit crystal can be found on the geological museum in CPH.



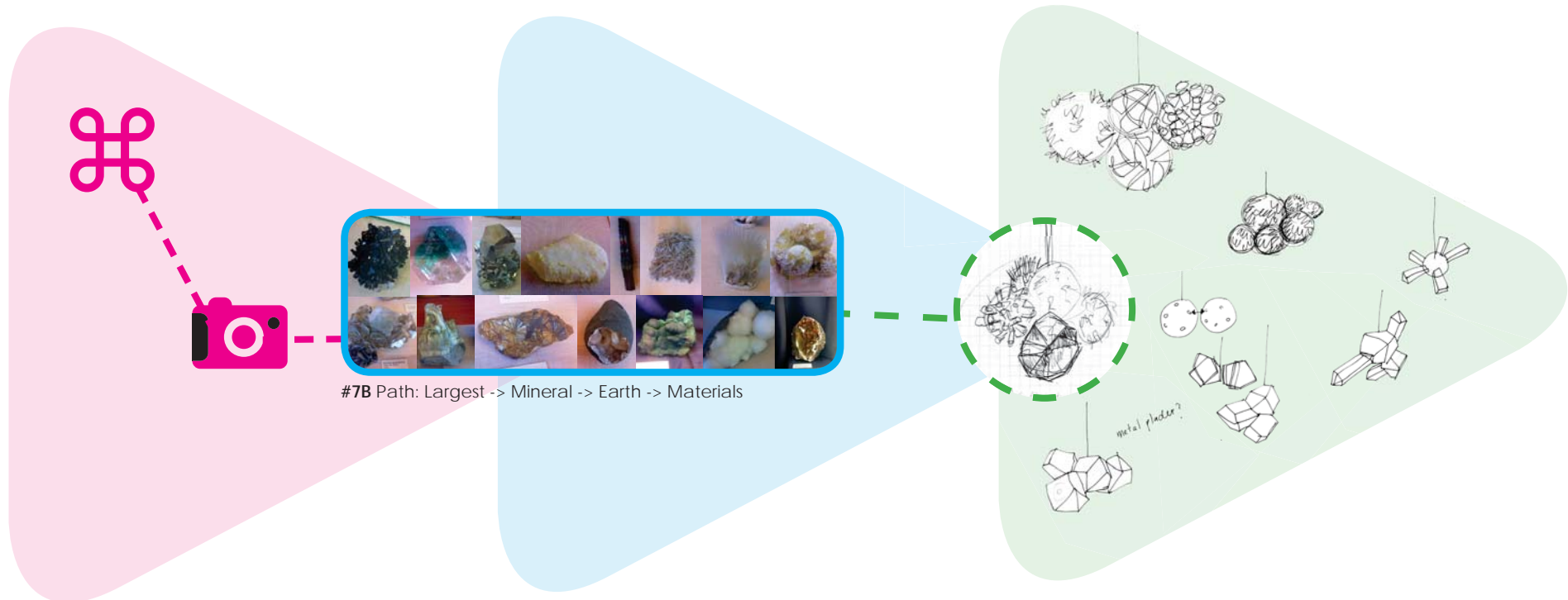
# Antler



The lamp is asymmetrical, cosy and crazy.

It is inspired by the antler fern. The shape on the leaves on pendant has a clear reference to the plant. The entire pendant is semi transparent. The lamp shade is made in thick hard plastic and the pedals in thin flexible plastic. The antler fern can be seen in the botanical garden in CPH.

# Crystallization



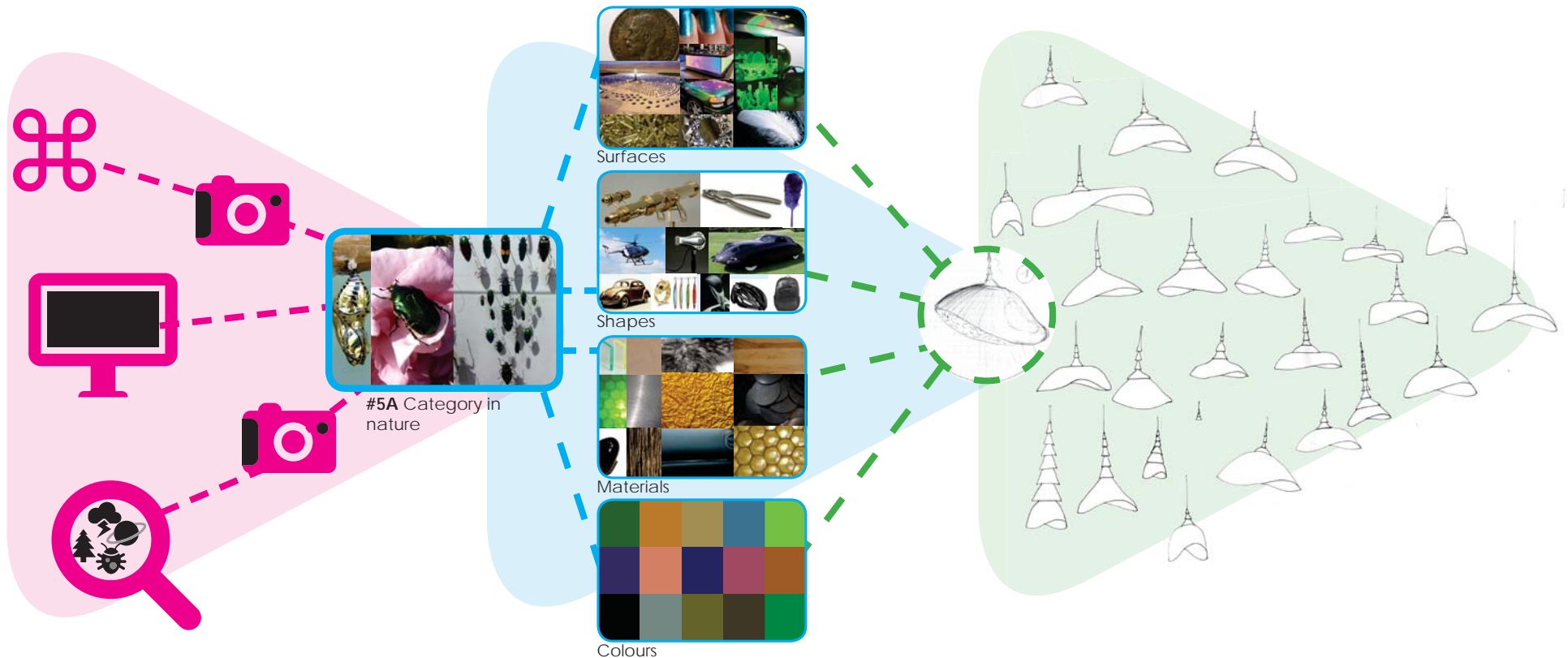
The lamp is eccentric, different and modern.

It is inspired by the crystallization of minerals. The modular lamp has the ability to grow as crystal balls are added.

The different balls, has different structures, materials and colours and is inspired by various types of crystals.

The various crystals can be seen in the geological museum in CPH.

# Cetonia



The Cetonia lamp is conservative, simple and modern.

It is inspired by beetles. The details on the pendant holder are inspired by the telescopic joints on the beetle legs.

The lamp shade is streamlined inspired by the beetle shield. The outer colour of the lamp shade is black while the inner colour shifts between dark blue and green. The pendant holder is made of shiny brass. The beetles that were used as an inspirational source, can be found in nature, the web and at the zoological museum in CPH



Chosen concept

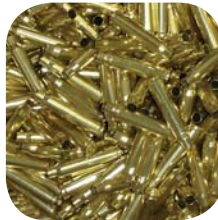
# Cetonia



Surfaces



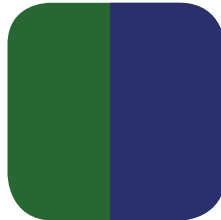
Shapes



Materials



Colours



Transforming inspiration into a detailed concept

**Cetonia** is elegant and silent at the first glance at its simple silhouette. The matt black lamp shade radiates a secret look, as a lonely beetle resting on a hidden leaf. When exploring the inside a new world reveals. The colours are mysterious and constantly shifting between dark blue and green, scattering a delightful glow. Like the reflection in the shield of a playful beetle when spreading out its glorious wings, seeking the grand northern light. The structured brass pendant holder stands in contrast to the streamlined lamp shade. It draws the mind to a beetle's leg, fragile but still so strong.



# Reflection and conclusion

## The development of the methods

Our goal was that the methods should be able to be performed without high drawing skills, why most of them are based on photography. The photo is not able to capture all details, why it has been important to apply feelings, expressions through words as a support to the essential on the photo. As earlier mentioned the methods have each their inspirational source, but they have undergone changes in the development process in an iterative process by testing and discussing pros and cons.

**#1 Nature as a product** has not been changed, as it worked well during testing. It was found that the method beneficially could be supported with a pre-made list of vocabulary Inspiration to describe aesthetics - sensory and perception - stylistic[11]

**#2 Action Reaction** had originally a lot of facets; a sequence, pre, during, after, change of seasons etc. The final solution ended up with two photos documenting the reaction; before and after, as it was this methods which captured the most of the actions. One can take photos in nature, where a disadvantage is that it can be hard to capture the moment of the reaction. It is also possible to find pictures on the internet, a quick and easy accessible source. One way to capture the moment in nature is to draw the action/reaction, which will appeal to one user segment.

**#3 Split feelings** started out as just consisting of pictures with one connected word to each. This was changed to pic-

tures having two opposite connected words, which creates a tension and triggers the creativity in a higher degree. Here it was found that the method again beneficially could be supported with a pre-made list of vocabulary Inspiration, but this time in order to describe perception - symbolic [11].

**#4 Impressions on the spot** was as a starting point meant to encourage the user to go out and take photos of impressions on a restricted spot in nature and afterwards describe these at home. This method was changed so the impressions are listed simultaneously with taking photos of these. This change eases the process in remembering why a certain impression was captured and capsule the impression in the moment instead of an interpretation of the expressions in the picture is needed afterwards. The method was originally thought as a sequence model, later it became a variety of a brainstorm, as it seemed more naturally standing in the field. It also seemed more naturally that the different elements were possible to connect to each other in a crisscross pattern.

**#5 Inspiration board** originally stated out as an inspirational source, which should be distributed to four boards with different categories. Generally speaking the use of this board was tested either where one could get an overall inspiration from all the boards at the same time or by partial features on the different boards.

**#6 Pattern of inspiration** worked immediately. It was tested with different categories, the more categories or too close related categories the more complex and visually obscure became the concepts. Four categories seemed suitable.

The category: structure could be omitted and the concepts would still have the most important dimensions/attributes.

**#7 Wheel of nature** has not been changed. The 1. level can cause confusion, as there are too many scales to relate to. A future generation could potentially just work with three scales: micro, macro and full scale. The wheel contains categories which do not match, as space + animal, but these can be remedied by spinning the wheel once again.

**Sum up**

By evaluating and discussing the methods independently it became clear that it was relatively easy to transfer/rewrite the original starting points. By testing the methods we found that a lot of them needed to be modified further. The areas we worked with included: Ease of documentation, the simplicity and quality of the method, ease of generating exiting and a high quantity of concepts and the intuitiveness of using the method.

## Overall evaluation of the process and methods

The methods have been evaluated on the following factors: The innovation height, aesthetic qualities, quantity/quality, ease of use and the place on scale of biomimetics. The innovation height can be perceived on two levels, on a personal level or in relation to existing ideas. It describes whether the methods forces the designer to think out of his own frame of references or if the methods deliver "new to the world" concepts. The place on scale of biomimetics is based on Volstad's and Boks's figure 5[8]:

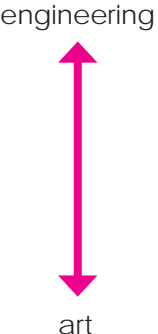
Materials material science	Approach 1	
Mechanics/Dynamics general engineering locomotion	Approach 2	
Structure structural engineering, architecture	Approach 2	
Form architecture and art	Approach 3	

Figure 5: Applications in relation to design aspect categories[8]

### #1 Nature as a product

The innovation height of the concepts depends on the individual designers frame of references. The concepts have a high focus on aesthetic details and the overall style. The method may be beneficial to use when making product series. There was a tendency to create loads of conceptual

ideas per analysed natural element. This may be because of the analytical aspect of the method, which allows the designer to explore various aspects of the natural element. For designers with knowledge of how to analyse products the method may be easy to use, for others it may be difficult. It demands both knowledge of historical styles and abstract thinking. This method lies in the industrial design area, approximately in the middle of the technical and arty area of the biomimetic.



### #2 Action reaction

The conceptual ideas became different and somewhat innovative in relation to ones from other methods, since they contained dynamics. The aesthetic qualities easily diverged in favour of functional principals. There was a tendency to create one detailed conceptual idea per function. This may be because of the methods functional constrains. The method is easy to use. The rules are simple and give the designer a degree of freedom, in regard to the symbolic and visual aspects of the conceptual ideas.

This method lies in the industrial design area, but triggers a higher focus on functionality than art in the area of biomimetics.



### #3 Split feelings

The innovation height of the conceptual ideas depends on the individual designers frame of references. The aesthetic output is variable, in regard to the style. The method is able to create a diversity of conceptual ideas, even though they are inspired by the same natural element. There was a ten-

dency to create loads of conceptual ideas per analysed natural element.

The method is quite challenging and requires a huge deal of creative and abstract thinking, both when discovering the feelings in nature and even more when transferring these into a product. This method lies in the industrial design area, but leans towards a more arty area of biomimetic.



### #4 Impressions on the spot

The innovation height of the conceptual ideas depends on the individual designers frame of references. The conceptual ideas have a common focus on the overall style, but still contain a great aesthetic diversity. This makes sense since they are inspired by various natural elements that added up gives one overall style. There was a tendency to create loads of conceptual ideas. Since the conceptual ideas have such different styles, the natural flow when drawing one style is at risk and the quality of the conceptual ideas can be affected. The method is relatively easy to use and requires a huge deal of creative thinking, but at the same time it has a large degree of creative freedom in regard to the written word/associations. This method lies in the industrial design area, but leans towards a more arty area of biomimetic.



### #5 Inspiration boards

The innovation height of the conceptual ideas depends on the individual designers frame of references. The method secures a focus on the aesthetic qualities. While some of the aesthetic details are the same there is no apparent

overall style. This method makes you focus on the materials, used. By combining the different details on the boards there are many different possibilities of conceptual ideas. For designers with knowledge of design boards the method is quite easy to use, for others it may be a bit challenging, to transfer the attributes from nature to boards, and boards to product. This method lies in the industrial design area, approximately in the middle of the technical and arty area of the biomimetic.



### #6 Pattern of inspiration

Forces you out of your habits, and creates compositions that normally would have been considered odd or strange. It forces you to make conceptual ideas with focus on the shape, structure, colour and surface. Delivering conceptual ideas that focuses on these aesthetic areas. The quantity of the conceptual ideas can be enormous; it is possible to combine the different pictures in almost endless ways. Some may hold more quality than others. This method lies in the industrial design area, but leans towards a more arty area of biomimetic.



### #7 Inspiration wheel

The inspiration wheel forces you out of your habits, and may inspire you to create conceptual ideas you would not create without this method. It forces you to make conceptual ideas with focus on e.g. the gender, texture and colour. Ensuring conceptual ideas that focuses on these aesthetic qualities.

The amount of conceptual ideas varies depended on the

source of inspiration. But the inspiration is endless, if further conceptual ideas are needed just spin the wheel. The wheel can be difficult to understand but when you have, it is easy and fast to use. This method lies in the industrial design area, but leans towards a more arty area of biomimetic.



### Overall reflection of methods

The innovation height and aesthetic qualities is often, but not always, conflicting in the methods and it is obvious that all methods are revolving industrial design but they either tends to deliver concepts with a high focus on functionality or with a focus on aesthetics qualities such as shape or textures. Some of the methods have a high focus on quantity and others quality. Therefore in a future generation the methods should be shaped in that matter that they embraces and take care of balancing between innovation height and aesthetics qualities.



## Conclusion

As mentioned earlier; the existing methods are either focusing on the functional aspects of biomimetics or they are too comprehensive or expensive for a small studio or a student. It is proposed that biomimetic design holds unlimited potential for technological innovation and thereby lead to the identification of processes and mechanisms in nature. This booklet proposes that it is possible to draw inspiration from nature's aesthetic attributes and that this can be done methodically. Currently there is a lack of methodically tools within this field. The booklet has presented 7 new methods, where the benefits and use of these have been demonstrated through the lamp case. The methods seems to they have different qualities in relation to innovation height, aesthetics, quality/quantity, ease of use and is placed differently on the place on scale of biomimetics. This means that they can be used individually or compliment each other in the design process beneficially.

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