New Ideas from Nature:

Using a Metaphorical Approach

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1. Abstract

Following Lakoff and Johnson, Metaphor is an unconscious tool to recognize and define every thing in our life. And creating new metaphors is a result of increased storage of perceptions or conceptualizing new things actions …etc. ourselves. These metaphors affect the way man looks at the surroundings and creates, modify new metaphors, to be more creative, capable of organizing and connecting the different elements to fit his needs. And here we can find the problem; That metaphor becomes a kind of barrier to develop new designs. Many designers keep using the information or knowledge we already know, although it has been used thousands of times, and the rate of developing this knowledge in design is much slower than the rate of using it, which prevents us from creating new metaphors, slowing down design development.

In this paper the investigator explores what is needed to know about how and from where the designer can get new ideas or concepts from Nature using a metaphorical approach.

Keywords: Creativity, Function, Nature, Metaphor

2. Introduction

Since human beings appeared on earth, man has tried hard to improve his life. He has used what already exists in his environment, made tools, and found new ways to satisfy his needs by observing the creatures around him, developing his own ways to manage & control his life. But this has not happened in just one day or even a year, it has happened through many years and ages of observing and studying consciously and unconsciously, all that his eyes can see, and his fingers can touch. Until he started to create images, understand his environment and what it means being a part of it. In this phase, he begins to create real products with recognizable aspects. Following Lakoff and Johnson this could be because by increasing the storage of perceptions they become understandable information. This leads him to develop new metaphors. In turn these metaphors affect the way he looks at the surroundings, to create and/or modify metaphors, and there is also a feedback in the other direction, where these existing metaphors encourage us to make new observations to think about it, and develop/create metaphors. But the direction of this process is mainly based on the experience we have, and the level at which we interact with the elements around us. It is an infinite process renewing it self and changing human life all the time - Figure 1.

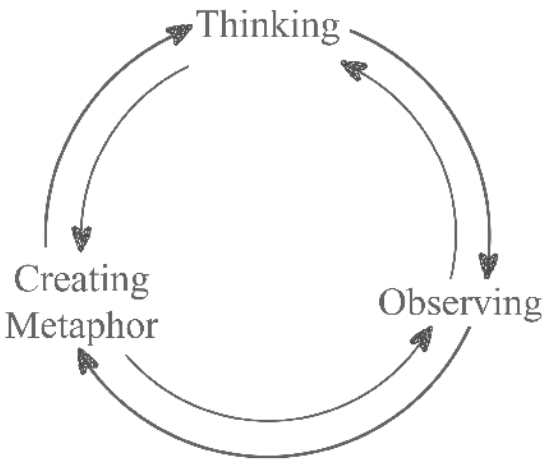

Figure 1. Metaphoric creation process

These new Nature based metaphors have given man the chance to be more creative in finding new solutions, capable of organizing and connecting the different elements to fit his needs in what we today call Design. But the information or knowledge we know has been used thousands of times, and the rate of developing this knowledge is much faster than the rate of using it, so in many cases we can see repeated designs. Previous design elements are reused in new orders, but still carry the same features representing the same metaphors. "*Where our cultures limits the creative process to a certain extent. Designing, strictly following conventions, as prescribed, for instance, during the time of the craftsman guilds, then becomes a*

kind of copying! But taking any conventions into consideration when designing, we are certainly not forced to copy precedents. It will though, lead to a certain prototypical form feature, resulting from the kind of function fulfilment and to certain behaviour-typical features following from a specific kind of product usage" (Muller, 2001).

Many designers aim to establish relations with specialized sciences to achieve a development in the results of their design process. And one of the recent sciences which deals with Nature as a source of design solutions is Bionic design or biomimicing. Unfortunately it has been used much more in engineering design than product design. This could be as a result of the presented technical information, where the engineer is prepared to understand and use such information more than the product designer, or because the product designer deals with form aspects more than technical solutions which represent the functions in many cases. Making organic design rather than bionic design[1], showing this shortage of appropriate sources presenting the suitable kind of information.

Shortage of information causes different types of design conflicts. Such as the conflict between the preformed function and the given form. And there are many examples showing this conflict for instance in figure 2. These designs has been made by students in Industrial design department (faculty of applied arts - Helwan Univercity - Egypt, in 1998). To the left, the Spotted Ray and the sweeping tool as an example for organic form in conflict with preformed function, where neithere form or shape of the fish give any specific feature for the function. Giving the product the formal characteristics of a creature does not mean that this design is bionic. Even when it seems that the mimicked creature performs a similar function.

On the other hand using a creature's shape to enhance the functional performance of a product, as is shown to the right in figure 2. The Spoonbill bird's peak and food picking tool is a simple example for bionic design. The peak's shape serves the function of the picking tool, with no necessity to use bird`s head form. A simple matter of form giving, will not make the design bionic. But using the form of a bird`s head may complete the image about the perfection of the performance in the consumer mind, or at least give a good impression.

Consumer's impression is a very important factor in design successes. It is a result of many variables like culture, education, gender …etc. All these variables are framing our metaphors controlling our feelings and impressions. Here we can see Another kind of conflict could happen with consumer's metaphors, and cause product failure. When the design represents some creature's features, it may relate to the performed function/s, but reflects bad experiences with this creature. For example (Juicy Salif) by Philippe Starck, 1990 - Figure 3. It is a revolutionary functional design. But there is no relation with the spider's shape it takes, which may be not intended. It reflects an embodiment of Consumer's fear of spiders and its behaviours.

Figure 2. (to the left)The Spotted Ray fish and the sweeping tool as an example for conflict between form and preformed function. (to the right) Spoonbill bird and food picking tool as an example for bionic design.

Figure 3. Juicy Salif by Philippe Starck - 1990

[1] Bionic design (also known as biomimetics, biomimicry, or bionical creativity engineering) is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology. www.wikipedia.org

I propose that designers should deal with aspects of form related to function in nature, and what is beyond them, what purposes these forms serve and what could be done to make these designs more optimal - in production, performance, etc.

So in this paper I will explore what we need to know about how the designer can get new ideas or concepts from nature to achieve real progress in his work. I will investigate my main hypothesis, that preparing the designers to be more conscious, and more able to understand the related information of design aspects in nature. Then exposing them to brand new nature based information, in a suitable way with all the related details could develop creativity, improving design results. Discussing the ways used to adopt the individual structures of the creatures, behaviors and skills to fit the environment. Which could provide a wide range of different solutions to solve design problems that mainly represented in the relation between form and function.

2. Nature and Design: refreshing the oldest relation

Nature provides many of the information sources, that could be used to explore new usable information into design. All of these sources may deal with the same information, but from different perspectives. It depends on the way we define the design problem, and what type of information we are looking for. At the same time, nature's information sources actually complete each other reacting together as a total, or in small groups to create enormous number of alternatives. This complexity needs a great ability of the designer to control this process very wisely.

Due to it's wealth of information, Nature represents an alternative tool for designers – a multidisciplinary source that researches the principles, properties and mechanisms of natural systems (structures, processes, functions, organizations and interrelations), with the aim of applying them in the development process of new products or solving technical problems that may arise during the project-phase. However, in order to achieve an efficient consolidation of Nature to the development of a product, it is necessary to guide and qualify the designer during the research process, providing optimization for further use of the information. This achievement needs an early starting point, in the beginning of the design education process. "*We can justify the designer's solution-focused strategies and appositional thinking styles as promoting a certain type of cognitive development in educational terms, the concrete/iconic modes that are often assumed to be the 'earlier' or 'minor' modes of cognition, and less important than the forma/symbolic modes"* (Cross, 2006). It will always be a matter of how a designer deals with design problem, or how he could recognize it. And based on the way selected to either look or think about the design problem to recognize and define, automatically one or some of the proper solution sources will show-up. This of course could be affected by what is the main interest of the designer, or according to which design school or methodology he/she works in. What is called design fixation, which is defined as a blind adherence to a set of ideas or concepts limiting the output of conceptual design. Design fixation is a measurable barrier in the conceptual design process (David G. Jansson and Steven M. Smith, 1991). The problem here is how to overcome the design fixation, where in the same category all products looks nearly similar to each other, carrying the same features of both form and function, except rare designs based on individual experiences/interests dealing with new information.

This design fixation caused by the habit of following the others, Learning from their previous achievements and building our new version of knowledge up-on it, by modifying, adding and removing. In addition, we have been raised in contact with these designs carving storage of metaphors. These metaphors represent a guide line, helping tool or even a kind of automatic reference for any problem we face. But it also limits our chances to be creative, that we keep thinking or acting through it. Or in another words we keep using this knowledge gained over our lifetime of observation, tracking and replicating the same concepts/principles across history, reflecting a massive lack in communication between design and different natural sciences. But this does not deny that we keep dealing with nature as a source of our ideas and even reactions indirectly; it takes the shape of a legacy across history. Man starts from a simple arrow head - Figure 4 - and will keep working with it for ever. This is caused by the unconscious nature of creative process, where mind deals with the information and connects it, finding what we can call not a new solution, but something results from abstracting or mimicking what is

actually there. And this process is more like a chain reaction. When starts, it keeps renewing itself by orienting the mind to search for new information, to be added to this huge storage, then reconnecting the elements in new ways creating new design based on this new information, which could be new elements itself.

So when we think that we are reviewing the previous design or theory, we are just reviewing the newest version of the oldest idea which came from Nature as a start point whether consciously or unconsciously.

"Typically, genes are thought of as replicators - An entity that passes on its structure largely intact in successive replications- *while organisms, and sometimes groups, are thought of as interactors* -An entity that interacts as a cohesive whole with its environments in such a way that this interaction causes replication to be differential-. *The search within the technological domain for analogues of genes and organic traits is an expression of the thought that distinct replicators and interactores should be found here also. The replicators/interactores distinction is of limited value, I shall argue, because, depending on changeable contextual variables, all of artifact/idea complexes, and so forth, can act as replicatiors"* (Lawson, 2006).

Figure 4. Collection of primitive and modern arrowheads

Here we must not forget to mention how knowledge transfers, "…which can be subdivided into (1) knowledge sharing, the process by which an entity's knowledge is captured; And (2) knowledge reuse, the process by which an entity is able to be locate and use shared knowledge" (Majchrzak, Cooper, Neece, 2004). "Knowledge reuses within organizations are typically performed for two distinct objectives: replication and innovation" (Majchrzak, Cooper, Neece, 2004). "Knowledge reuse for replication (KRR) focuses on knowledge acquisition through which best practices are transferred (replicated) in order to increase productivity. Knowledge reuse for innovation (KRI) focuses on knowledge integration through which other's knowledge is adapted (integrated) into one's existing knowledge stock in order to accomplish an innovation task". (Majchrzak, Cooper, Neece, 2004) [Lawson, 2006] -Innovation here represents the activity of interactors-. Also idea exchange may both facilitate and interfere with the generation of ideas as a result of idea exposure (Dugosh, 2000; Nijstad, 2003; Dugosh and Paulus 2005).

By reviewing the existing designs/ideas, we might find ourselves somewhere between a replicator at some times and an interactor at other times, and this usually leads us to (KRR). It depends on how professional we are, and how much experience we have already. But we are still more replicators than interactors, moving in this narrow circle away from the unlimited three-dimensional chaos of Mother Nature -Figure 5 -. According to Muller, this because all what we can create based on the previous idea will always keep somehow many of the spatial, semantic and behaviour-typical features. It is a kind of evolution or development for the existing designs/ideas to be adapted to the recent requirements and conditions which embody the environment. It is similar to creatures evolution, where many changes reshaped the structure and form of the creatures to be able to survive .

To become interactors and move out from the effect of replicatoral nature of artifact/idea, we need to explore and conceive new concepts/metaphors, to move out from this circle by dealing directly with the main sources which are in our case Mother Nature. Allowing ourselves to observe, think and create our own metaphors for functions indicating the main design problem. And function here is not that physical performance of an organ or trait only, it is a cause for a result. Where the cause could be a single action for a specific organ / trait, or a compination of reactions for individual system or more. And the result could be subjective or objective, it is more than what we think. It is a kind of matrix full with alternatives for these elements to compose any creature. So that all the creatures has the same kind and number of elements represented by one or more of alternatives (behaviours *(protective, follower,…)*, instincts *(fear, hunger,…)*, structures *(skeletons, ties,…)*, …etc.), Creating a state of balance and harmony between the

creature and the environmental context.

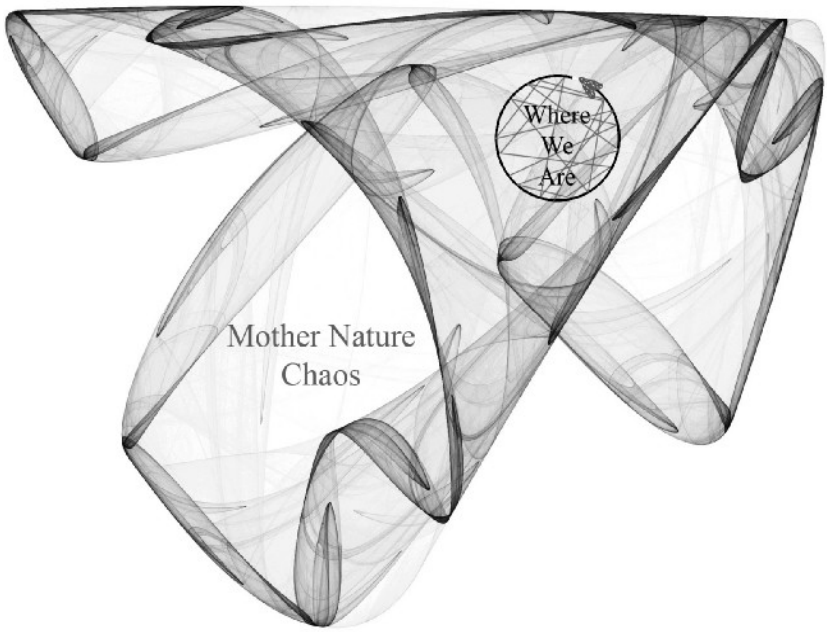

Figure 5. Where we are in Mother Nature's chaos

3.Looking for what we do not know

Searching in Nature is not an easy mission. Especially when the researcher is missing the appropriate experience. The enormous varity of creatures and the solutions which could be discovered, make it more difficult than a crazy maze.

"It seems that nature has taken pleasure in varying the same mechanism in an infinity of different ways. . . . She abandons one class of production only after having multiplied the individuals of it in all possible forms." (Denis Diderot, 1753 - as cited in Endless Forms Most Beautiful, Sean B. Carroll, 2005)

Avoiding this unclear starting point, it is very important to define the design problem when planning of the search, pointing to the required or expected functions with all the related aspects and circumstances which may affect the performance of these functions. Such a procedure has been studied before as a primary stage in the design procces. But dealing with function requires a lot of thinking to recognize and define. Especially when we focus our efforts at figuring out how a new design presents an effective solution to a defined function. So, in many cases the designers work reduces the number of functions and the related aspects he has to deal with. But this holds back progress forwards finding a new design. It will just provide a slight development in the product, keeping all the original features. In some cases it could lead to design failure. The product will not perform its function/s.

Every slight change in any of the design elements leads to sequenced changes in the rest of the elements. This is all too clear in Nature. *Warren* has described the changes in creatures structure and it`s effect on the preformed function, comparing these changes in design. He has given many examples of slight changes in structure in the same species of creatures, and how this affects the preformed function. But this is still a kind of mimicking of a certain kind of information, without controlling the entire design process.

The fundamental nature of design transcends the state of the art. Thus it follows that historical case studies that illuminate those aspects of conceptualizaion, judgment, and error that are timeless constants of design process can be as important and valuable for understanding technology and its objects (petroski, 1994). These case studies represented here by Nature`s creatures as they are now and their evoultion. And once again, we need to study this not as biologists looking for details to reveal, but as designers who understand the methods and the philosophy beyond the ways these changes refit the creature to the environment, enhancing it and keeping it alive. For example: the different kinds of ants and their changes in the main shared structure (figure. 6). These changes fit every ant kind of the environment with all the related conditions like weather, predators and type of availble food. Applying this analysis to the various types

of creatures, we find that there is a kind of main module for every element in universe, and every creature is composed of a number of behavioural and structural alternatives from these module. Each of nature elements symbolize the function as instincts, behaviours, needs, sensory and physical capabilities, including the environment as a container module. And nearly all the creatures sharing the same elements metaphorically, but the differences among the creatures start as a result from just a small change in one of the elements to adapt the creature to the change in living requirements. It starts a kind of adaptational reaction, trying to return to a state of balance, where all the elements can perform the given function without conflicts.

It is a kind of chaos matrix - figure 7 -, where every element has been represented by a gigantic number of alternatives. Connecting these different alternatives to the different elements produce a new species, class, or kind of creature.

But what appears to an outsider as complete chaos is clearly not chaotic to the designers and biologists involved. It is similar somehow to what happens in design, but the problem, I argue, is the shortage of the elements in the design matrix, and it`s representative alternatives. The shortage caused by misunderstanding the relation among these elements, and/or the absence of some of these elements.

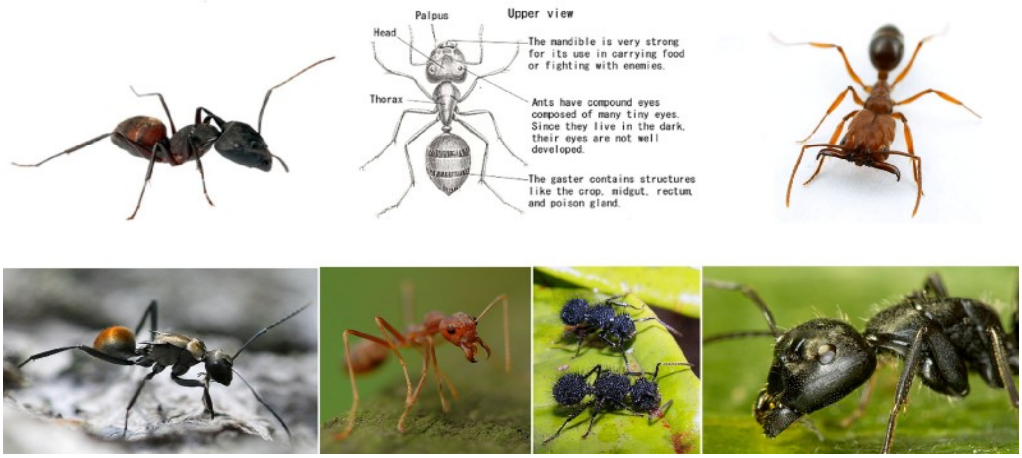

Figure 6. Different kinds of Ants and the changes in their main shared structure.

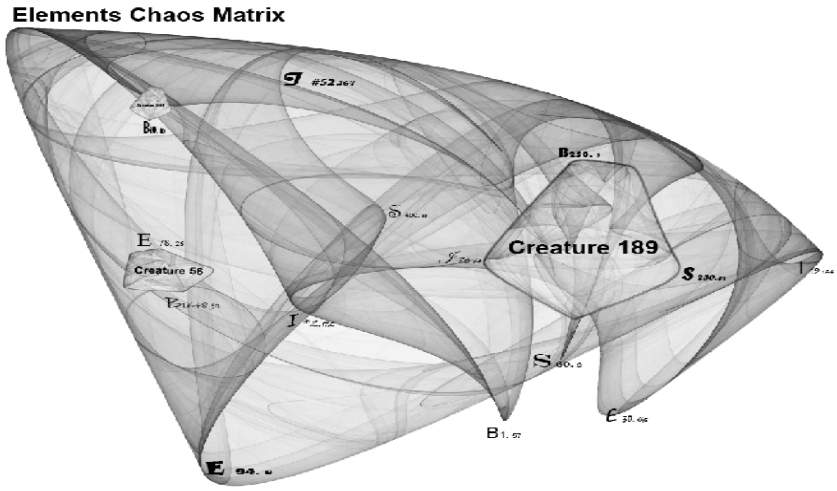

Figure 7. The Chaos Matrix of elements where - I instinct, B behaviour, S structure - with different shapes represent different types and modifications

As mentioned before, there are many sources (sciences) coming out of Nature, so how do we know that the selected source is the most proper one to find the best solution for the defined problem?. The answer will not be that easy. There is no most proper source to deal with, from the point of view of information related to a certain creature/s. But it will be just a matter

of which source might help us to conceive concepts as abstract idea, a mental symbol, or maybe metaphors that compare seemingly unrelated subjects. This means that all the sources which deal with the same information will just give a new dimension to the information, and drive the search for another source where the required aspect may be found. And this means that it will form a wider vision for the information with more relations and/or aspects, that may ecourage the designer to think about things he did not before, and of course will increase the chance to make a better solution or design.

In addition to the complexity of understanding Nature based information and use it to get new ideas, particularly when you are looking for it with details by your own. Where every thing is foggy, and a lot of relations and interactions among the creature/organ you are dealing with and so many of other organs/traits or even creatures. That we as product designers are not familiar with these biological aspects of function. For these reasons until recently, many designers who work with nature, work out of personal interest, with a suitable background in some cases. This skilled work depends on the designer's particular knowledge and experience. Schutz explains that operation of a stock of knowledge is not a systematically held 'database' that is processed cognitively when applied in practice, but is made up of 'typifications', understandings of aspects of our lifeworld, that are rather organised according to criteria of relevancy. Typifications are always related to problems and to actions in the lifeworld and in this sense designers are proceeding with a stock of knowledge that is 'embodied'. But unfortunately in most cases they are doing those designs as a kind of instant reflection of what they knew or saw, and this usually leads to short lived unrecognizable designs.

Although nowadays there are better relations between designers and biologists, more sources of information about nature, which could help the designers to deal with it and to be more creative. It is still a matter of personal interest and skills to search, observe, conceive and create metaphors for the various types of design problems and their solutions. The reasons that prevent better interaction between nature and designers are many, such as:

- Missing the proper searching tool/method for the biological information.
- The enormous number of creatures, related information and details.
- Misunderstanding/ignoring unconsciously the meaning / philosophy behind the performed function, because of the reason above.
- Limits of time.

These reasons could be solved by working on finding or suggesting proper tools for providing the required information, saving time, effort and at the same time dealing with a maximum number of creatures and details. I am designing and proposing such a tool , an on-line database called BOND (Bank Of Natural Design) - figure 8 -, where the designer can find all the related available information to the function he deals with, saving time and effort. At the same time freeing himself from the box of his previous knowledge, surfing within nature until he finds what he did not know before, striking his mind and imagination with new concived ideas.

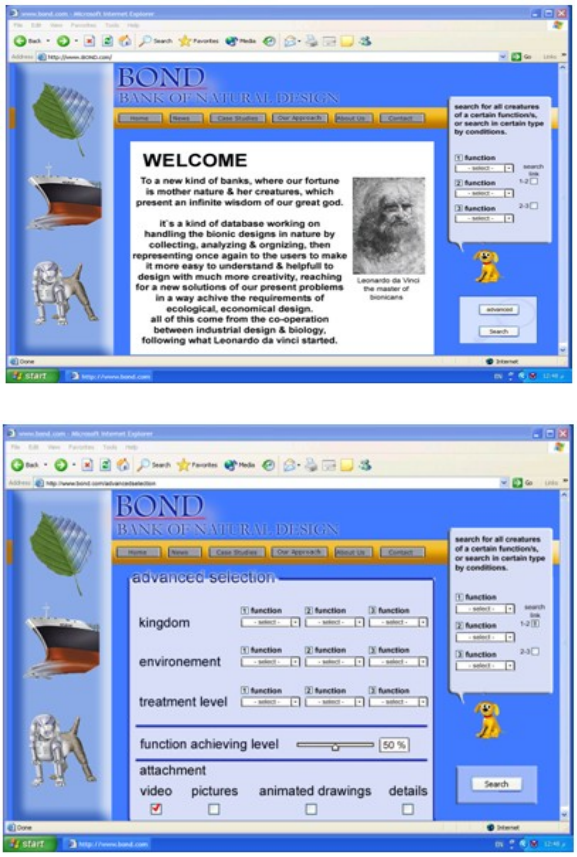

Figure 8. The welcome page of BOND (left), and the advanced search page (right)

In figure 9. some of the results stimulating the use of BOND to design a can-opener, representing different levels of mimicking (totlal mimicry - partial mimicry - abstraction - inspiration), with the development process in getting these solutions.

There is also a necessity for lot of work on the

basics of design education to prepare the student designers to deal with and understand Nature based information, which is more philosophical than biological. Of course the designer may rely in the beginning upon some theoretical knowledge that enables the sizing of the structural member in the solution. This might be the way muscles act, the effect of ties or the knowledge that initially informed this may well have been collected and documented a considerable time ago and the theory formulated and expressed in many books.

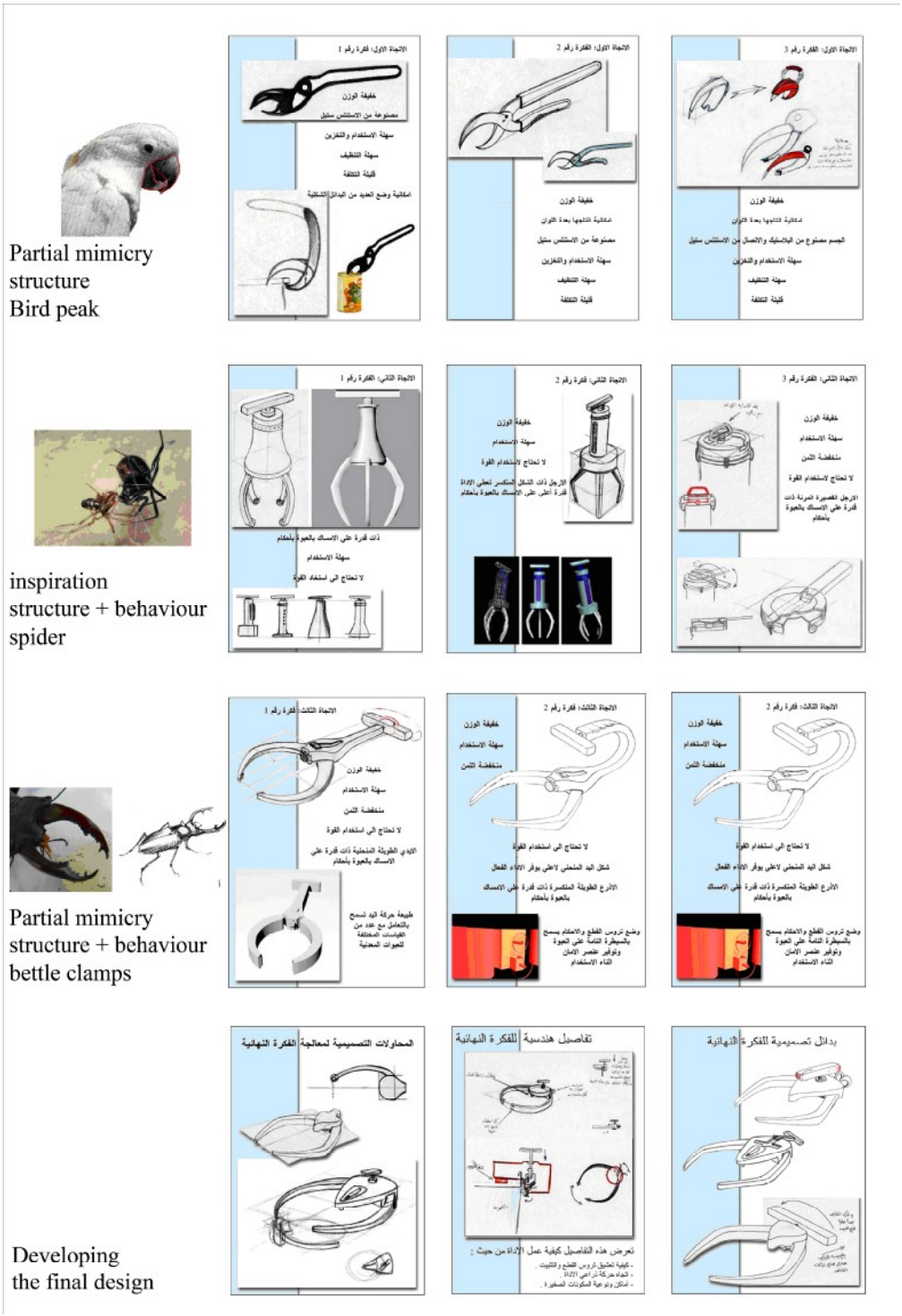

Figure 9. Some of the results stimulating the use of BOND to design a can-opener.

"Unfortunately the designer was not provided with a context in which access to other sources of knowledge was either available or thought necessary. This is one of the serious failings of the laboratory gathered design protocol upon which a great deal of our understanding is

based." [Lawson, 2004]. Fixing this failure will not lead to certain results in design, but may start to modify the way designers think, because of the hidden nature of the design process. Basing design on field studies will affect some knowledge elements which represent information to be emerged and embodied into a primary form of paradigms/metaphors according to the type of information, lead by thinking in turn to look for more supportive information improve this paradigms/ metaphors to be used in solving design problems.

And we must not forget to mention the role of sketching in this stage, the oldest way used by man to understand his surroundings. Where drawing different types of sketches describing what designer saw and knew is a very helpful tool to understand and clarify more relations among the collected information, which could be hidden or not clear enough. In the same time these sketches ensure that designer recognized as much of the given information as he can.

Returning to the previous idea where a module for every function in Nature is flexible, to be modified according to several factors, and every creature is a result of combination of number of alternatives for the functional modules (Behaviour, Structure): This combination which looks chaotic, needs more studies to de-code these Natural modules of creatures behaviour and structure to be adopted to the surrounding environment. Working on this claim, more empirical studies and experiments are needed to elaborate and understand the differences and the roles of effecting factors. What causes the differences in performance for the same kind of creatures fitting these differences in inhabited environment.

4. Conclusion

Following Nature as an unlimited source of knowledge, and working to understand it better, using all what we can, to explore details and their relations which look chaotic among the composing elements, will lead to improving the design process and results. This is not a new way to work but actually it is the oldest way to get ideas and designs. All that has changed is that the designer replaced with dealing directly with Nature as main source, following and reusing previous design knowledge. Mentioning that this knowledge represents the perspective of previous designers, maybe with some development in some cases, but he stills limiting himself to a narrow space by his devoted commitment to the old metaphor of the designed product. So all that he needs is to start looking for new knowledge directly from the main source with more consciousness of the variables, and to adopt methods used into Nature to fit the creature's structure and behaviour to the surrounding environment.

The designer needs a kind of tool helping him to do this exploration, and BOND could be such a solution to open this huge source to be used a better way.

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