CHAPTER 2
INSECTS AS BIO-INSPIRATION

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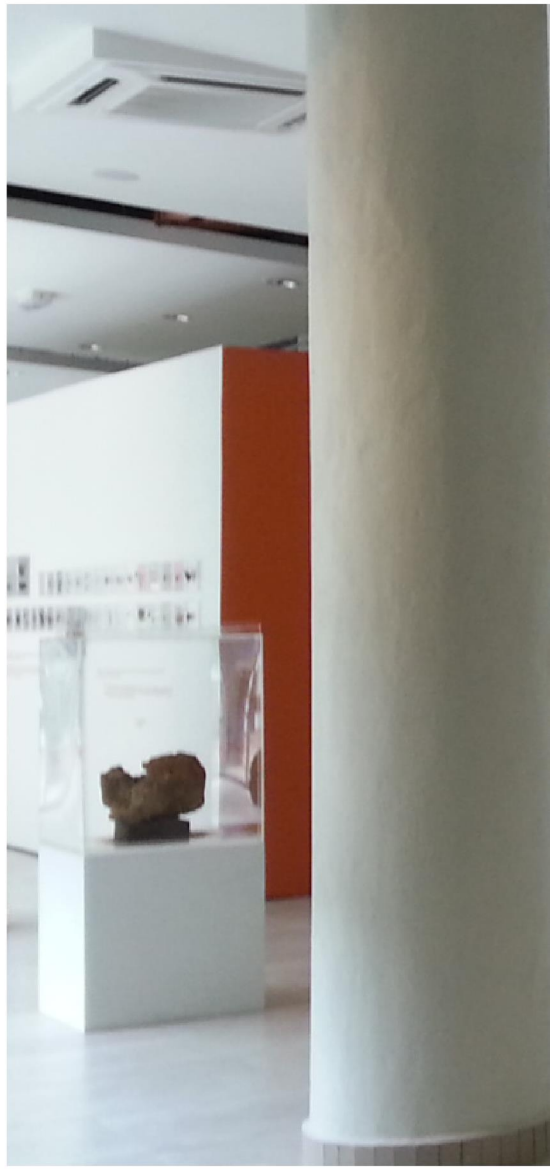

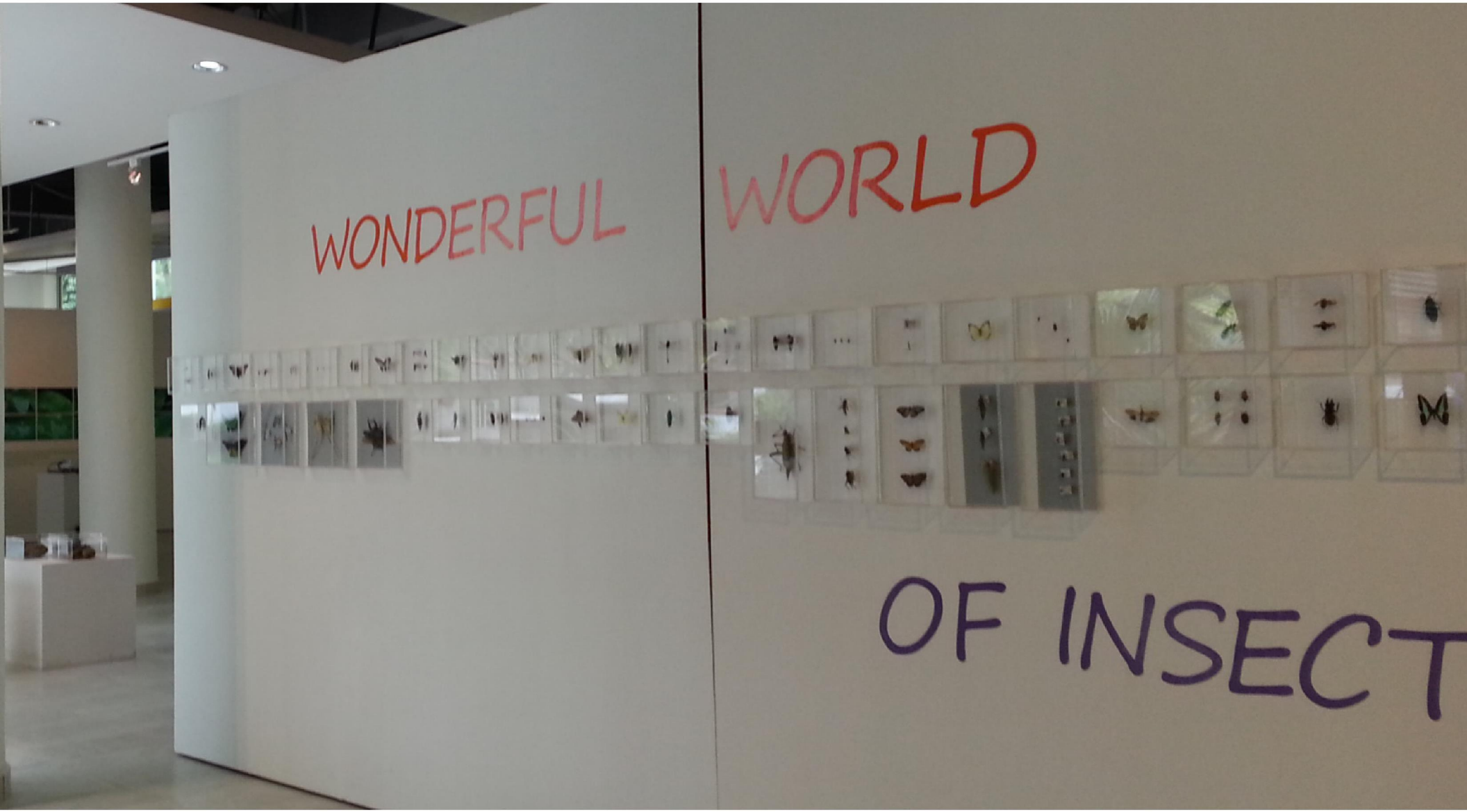

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a) Future Past

From the dawn of time, mankind has always looked upon his surroundings and observed other beings like the fauna and flora going about their lives. This in turn, piques our curiosity to understand the mechanisms and procesess entailed in fashioning a product. Often times, these creatures are more in tune with nature and thus able to build or make things that they need in harmony with their habitats. To date only 1 out of 10 insect species have been identified. This means for the million insect species out there, 900,000 remains unknown. The sheer magnitude of discoveries and potential bioinspirations yet to be explored is mind-boggling.

Thus, mankind is forever inspired by nature and insect is one of the major inspiration for architects, engineers, artists, chefs, designers, medical practitioners, and scientists. Existence of a journal called Bioinspiration and Biomimetics with an impact factor 2.412 goes to show the huge contribution of this discipline.

Researchers from Monash University, Australia led by Dr. Khan, use bio-inspired computing by studying the brain of the fruit flies and bees, to create a wireless sensor network (WSN). WSN are important for monitoring patient health, tracking air pollution and detecting forest fires early. The Aborigines of Australia had been eating green ants which have a citrusy flavour. Chef Redzepi, a world renowned chef called insects the food of the future and is encouraging the adoption of green ants to be served in restaurants.

Christopher Marley a designer who although initially was averse to insects during shootings as a model, but is now championing the elegance of the insect's elaborate design in his artwork called PHEROMONE. He showcases the butterflies, beetles, dragonflies etc. onto a clean canvas and frames them so that they are removed from the psychological fear of a swarm of insects.

Curative insects are prevalent in rainforest tribes, as treatment for pains, asthma and many other ailments. Dunn reported in a place called Chhattisgarh, India, over 500 species of insects, mites and spiders are used as medicine. The Oriental pharmacopeias include hundreds of species of insects, from house flies to rare ants, and their use is widespread and common. In South Korea, all medical clinics offered centipedes, silk moth larvae, and cicada nymphs as treatment. Of course this is culturally acceptable to these places. Nonetheless, if more scientific investigation can be pursued, the active ingredients can either be presented in a more palatable form or a synthetic version made.

Scientists at CSIRO have fabricated a near-perfect rubber with a 98 percent level of resiliency. They did this by

studying resilin, a protein that makes up the joints of many insects, including fleas (Harman, 2013). Resilin which acts like a spring allows fleas to store enough kinetic energy to leap 100 times their body length in a single bound.

b) Design Paradigm and Change

Designers normally used lots of samples and references from nature as their knowledge sources in order to develop their conceptual design process. Normally, designers develop the scientific biological knowledge and understanding regarding systems of nature classified by so called 'visual' and 'conceptual' process regarding nature and environment. The process of observation and the adaptation (or mimicry) from nature would advertise a pattern or codes of nature and relates to the behavior of the human being. This can be seen through many sorts of products where the processes of design development are presented. For example, in fashion, textile and fabric design, most of the design production is based from the biological natural body and structured formation of the skeleton, such as plants, flowers and insects. The whole process was created from a transformation where it could generate new challenges and demands for novel design concepts and transform into innovative creation. Even the process of transformation makes a great contribution to human where it can challenge the way humans react and change their habits, especially from conventional framework into innovative mechanical design systems. In particular, where designers explore different methods in relating to a new way of presenting and from what they had observed.

Therefore, the biological inspiration may be considered potentially as source of design knowledge in creating new and unknown concepts as what we call as 'innovation', 'invention' or 'discovery' in relating to the whole process of design and supported from other domains of knowledge. These inspirations provide high level abstract knowledge for designers seeking inspiration from outside their own domains to demonstrate potentially expanded design space, including nano-, micro-, and macro levels. The nano level deals with individual atoms in the systems being designed to focus on structural and functional design, the micro level deals with the individual system's component and the macro level deals with an entire design system. The process is driven by paradigm changes leading to novel design concepts. These changes can be understood as objective patterns of evolution, especially when seen from patented joints in steel structures of architecture or the formation of visual responses particularly in the form of living organisms.

With the system of living organisms, designers bring the formation of nature as bio-visual inspiration - an evolutionary strategy that mimicry from plant and animal, particularly insects which features an incredible patterns and attitudes that can be developed as similar-looking engineering systems or components in design process. It stimulates and utilizes the creative power of the human mind and enhances the spirit of relation between man and nature as a singular component in generating the living cycle which can support and benefit human life. This in turn can lead to interdisciplinary research, and addresses new challenges and issues of concept in 'bio-visual inspirational' design as paradigm of change and innovation.

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c) Back to Nature

Nature are the wonders of the environment and the physical world. The place where humans, plants, animals and other features of the world interact and live in general. They exist, change and evolve to their own ecosystems. At the same time nature offers humans and designers an abundance of solutions and ideas. For years scientists, designers and others have been coming up with ideas, design concept and resolution inspired by nature. Hence bio inspiration are ideas that are being inspired from the biological organisms and its natural system that surround us. Through a constructed process by an interdisciplinary team and expertise, potential new qualities and strategies inspired by the nature could be developed and realised. As suggested by Kuhn (1996) the designer as inspired by nature, states what are the issues to be resolved, what are the obstacles in addressing them, then defines as concepts and evaluates if this is realisable.

At the same time Santulli and Langella (2010) suggested some related examples of the form of Bioinspiration. It could be divided into several level of analogies which include the architectural, biochemical, morpho structural and others as presented in the table.

Level of analogy	Meaning of the analogy	Typical biological contexts
Architectural	Mimicking the organisation of structures built by living creatures e.g. in buildings or in systems	Termite nests, beehives
Morpho-structural	Mimicking biological microstructures to obtain specific properties	Cells, bones, shells
Biochemical	Observation of biochemical mechanisms e.g. photosynthesis, bioluminescence	Plants, fireflies, fishes
Functional	Understanding and repeating the logic of specific features aimed to some function	Super hydrophobic surfaces (Shark skin, lotus)
Behavioural	Transfer of some behavioural modes e.g. Protection, reaction to environment	Exoskeleton, armour-like skin
Organisational	Transfer of organisation strategies e.g redundancy, self-adaptation, autonomy, self organisation	Sensory and neural systems

At the same time according to Lui and Jiang (2011) there are some special biological solutions that provide inspiration to the scientists and engineers. This inspiration from nature help them to design multifunctional artificial materials with multi scale structure. Some of the examples of biological materials with function integration related to insect as suggested by Lui and Jiang (2011) are as follows:

Biological materials	Functions
Butterfly wing	Super hydrophobicity, directional adhesion structural colour, self-cleaning, chemical sensing capability, fluorescence emission functions
Cicada wing	Anti-reflection, super hydrophobicity
Mosquito compound eye	Super hydrophobicity, anti-reflection, anti-fogging
Water strider leg	Durable and robust super hydrophobicity

Therefore, nature has long been our school to learn, appreciate and inspire from them. Hence nature has always act as a source of bioinspiration for human beings to understand and recognise the nature and instigate its surrounding environment. These are but a few examples of how insects serve to inspire mankind in our quest to solve problems of living in a sustainable and peaceful world.

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