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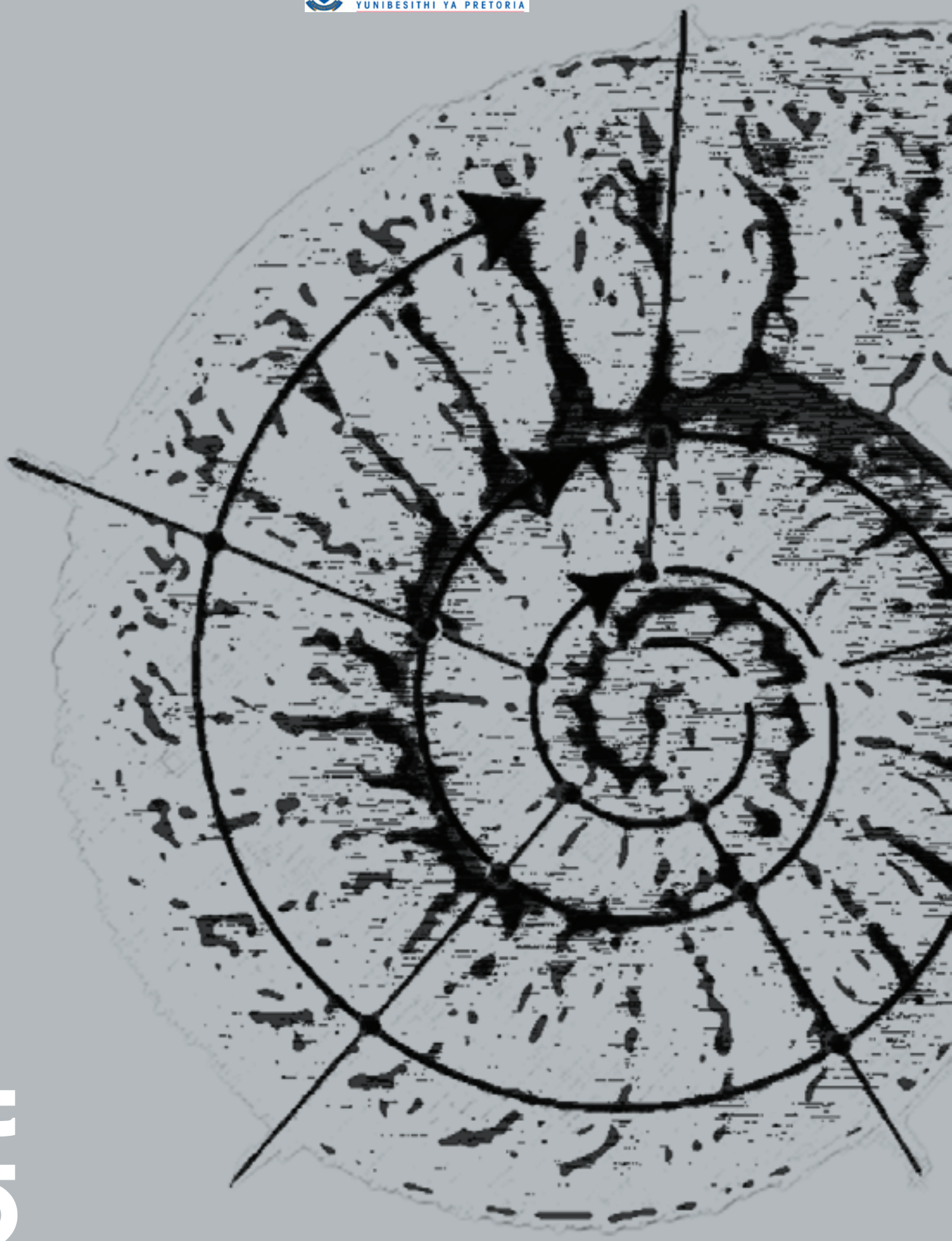

THEORY

03

CHAPTER 3 THEORY

"Human subtlety will never devise an invention more beautiful, more simple or more direct than does nature because in her inventions nothing is lacking, and nothing is superfluous. ."
- Leonardo Da Vinci

BACKGROUND

The use of principles found in nature in research and design is not a new concept,examples of biological role models can be found throughout history.

From the early investigations into the possibility of flight (see Figure 20) to invention of Velcro humans have used the characteristics of natural elements and systems to give them clues for designs.

In the twentieth century, architects and engineers repeatedly underlined the ties and relationships between architecture and nature by resuming ideas that had been known since antiquity.

Antonio Gaudi (1852-1926) developed a unique language of forms inspired by the laws of nature. Twenty years later Buckminster Fuller uses the principles found in nature to develop the intrinsic mathematics behind the geodesic dome.
(McLennan 2005, p.27)

Paulo Portogesi compiled a collection of analogies called "Nature and architecture" giving a vast list of examples of overlaps between architecture and nature dating back to classical Greece.

(Porthoghesi, P: Nature and Architecture, 2000, p.10)

"It is my feeling that living things and nonliving things are dichotomous….But I feel that if all living plants and creatures were to disappear, the sun would still shine and the rain still fall. We need Nature, But Nature does not need us."
Louis Kahn

Figure 19: The geodesic dome by Buckminster Fuller

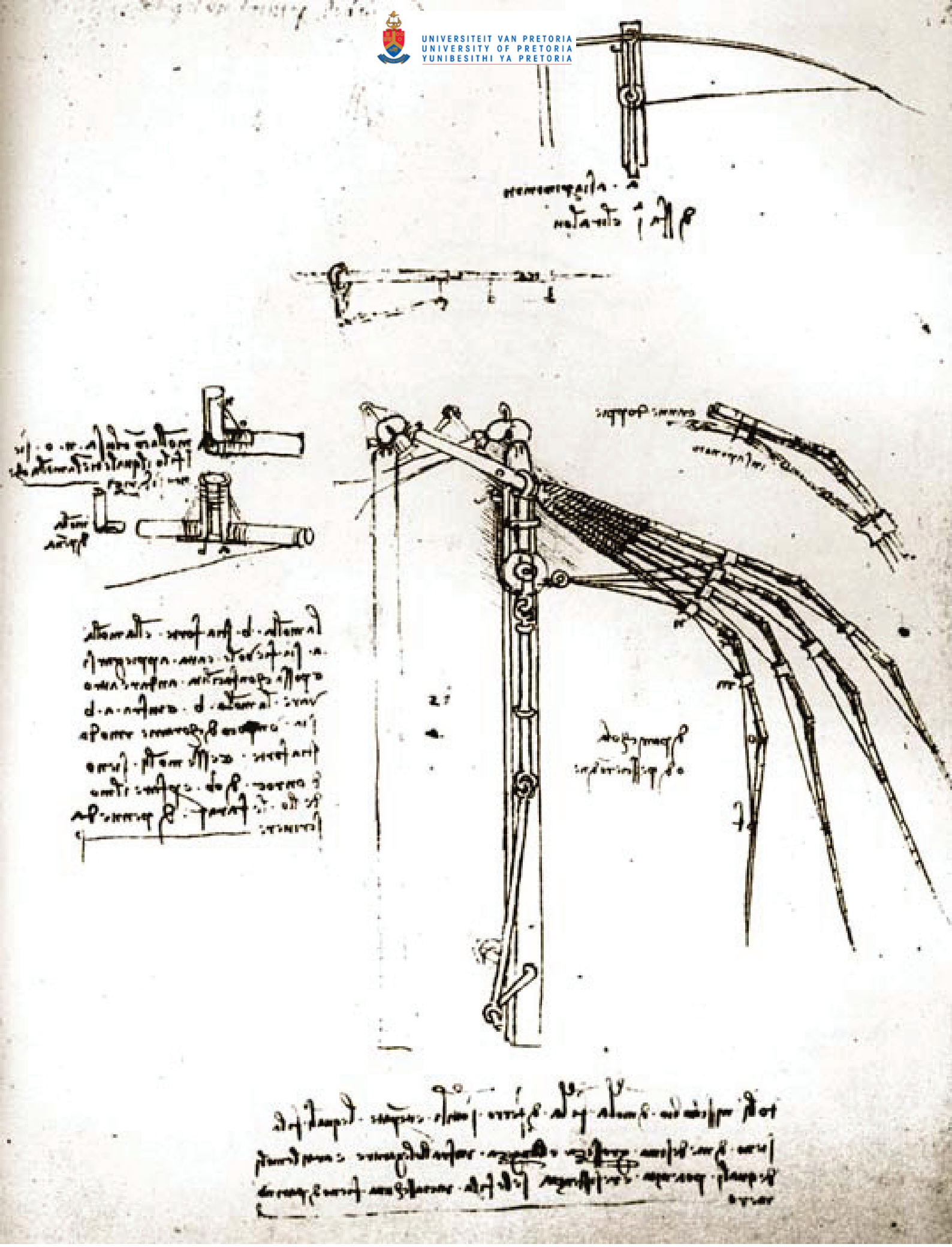

Figure 20: Studies in bird flight by Leonardo Da Vinci

CURRENT THEORY

SIMULTANEITY

Term refers to the idea that the irreconcilable can coexist in a abstract world of surreal reality as was depicted in the work of artist Salvador Dali.
The idea is that urban and natural can coexist within the city in a symbiotic relationship.
(YEANG, Ken, 2008)

BIOMIMICRY

[From the Greek bios, life, and mimesis, imitation]

Biomimicry or biomimetics is the examination of nature, its models, systems, processes, and elements to emulate or take inspiration from in order to solve human problems. (GRUBER, Petra, 2011)

NATURE AS MODEL

Biomimicry is a science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems, e.g. a solar cell inspired by a leaf.

NATURE AS MEASURE

Biomimicry uses an ecological standard to judge the "rightness" of our innovations. After 3.8 million years of evolution, nature has learned: what works. What is appropriate? What lasts?

NATURE AS MENTOR

Biomimicry is a new way of viewing and valuing nature. It introduces an era based not on what we can extract from the natural world, but on what we can learn from it.

As a design tool, biomimicry offers the means to achieving resilience, adaptability, and a sustainable design product. (YEANG, Ken, 2008)

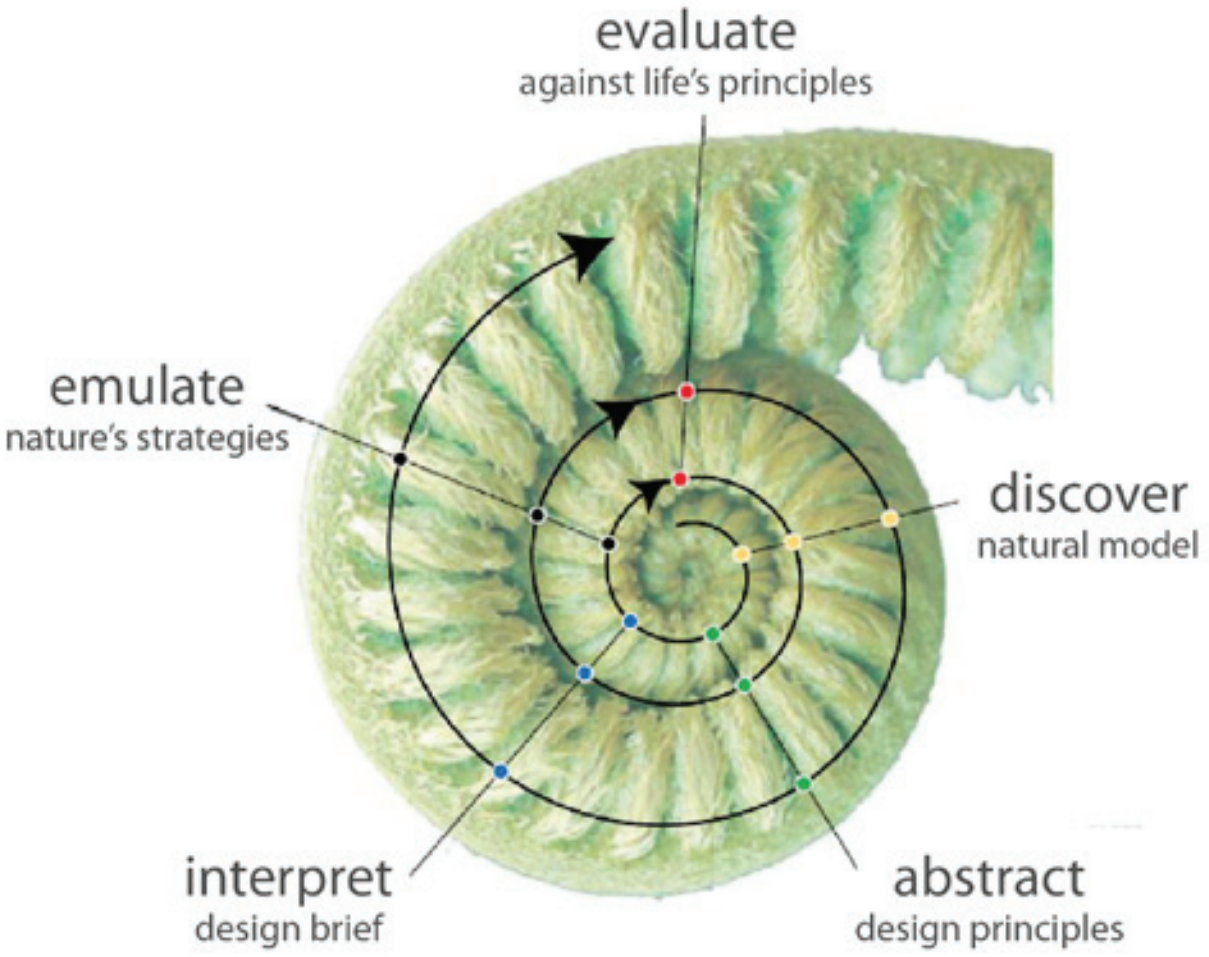

Figure 21: Biomimicry as a design tool

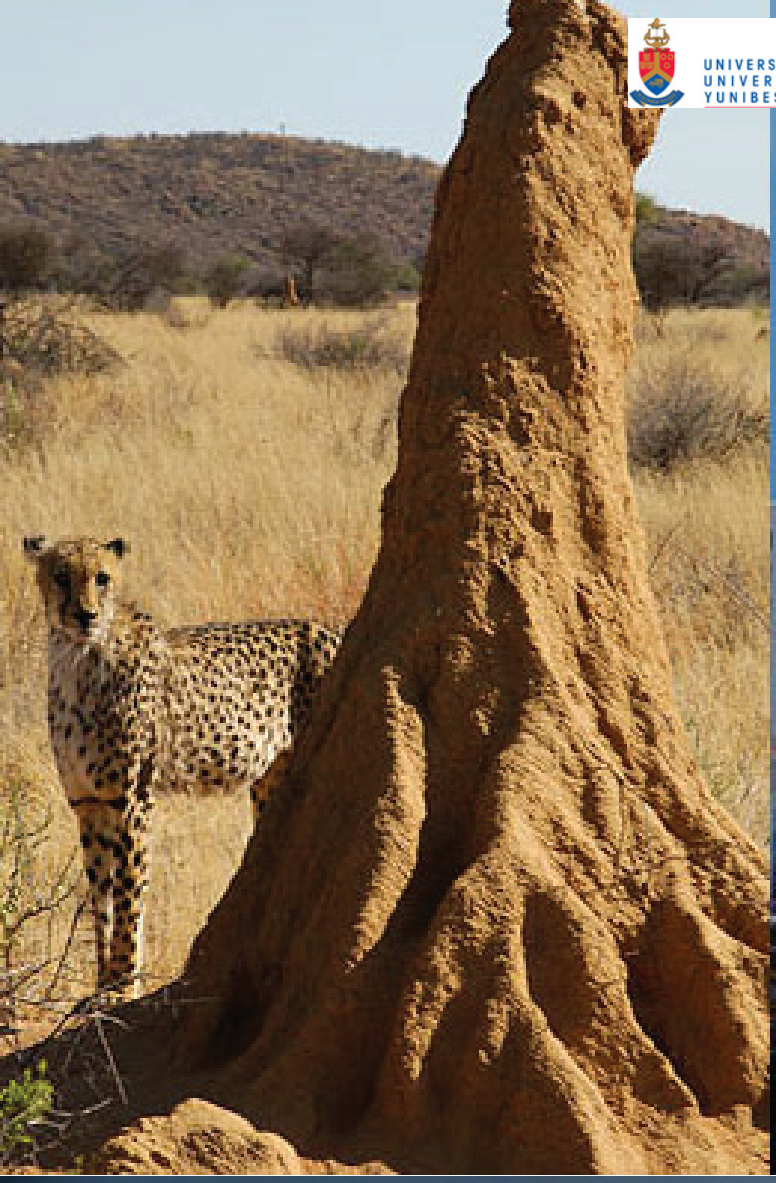

Figure 22: Examples of design inspired by nature

AUGMENTED SPACE AND LANDSCAPES

Architecture can be used as an interactive, dynamic communication device. This engages users and viewers through surveillance, cellspace technology and information display. Robert Venturi proposes that designers use electronic iconography to inform and enrich their design, thereby connecting with modern citizens through current paradigm and media. (Venturi, 1966)

Mark Smout explores this idea of augmentation of both architecture and landscape in his work and writing, showing how buildings can be augmented not only by the addition of modern day technologies but also by being responsive to it's natural environment. (SMOUT, Mark et al., 2007)

RESPONSIVE ARCHITECTURE

The natural environment is not a static system but is constantly subject to change brought on by it's biotic and abiotic components.

The response of a given material to changes in environmental conditions presents interesting opportunities for performance-oriented design. The research, conducted by Steffen Reichert of the Department for Form Generation and Materialisation at the Hochschule für Gestaltung (HfG) in Offenbach, Germany, explores the possibility of utilising the dimensional changes of wood induced by changes in relative humidity in the environment. The project was aimed at developing a surface structure that adapts the porosity of its skin, and related cross-ventilation, in response to relative humidity without the need for any mechanical control devices. Here the response is triggered by the changes in moisture content of the material and actuated through related shape changes in a material element, which affects the structure's degree of porosity.
(HENSEL, Michael and Menges, Achim, 2008)

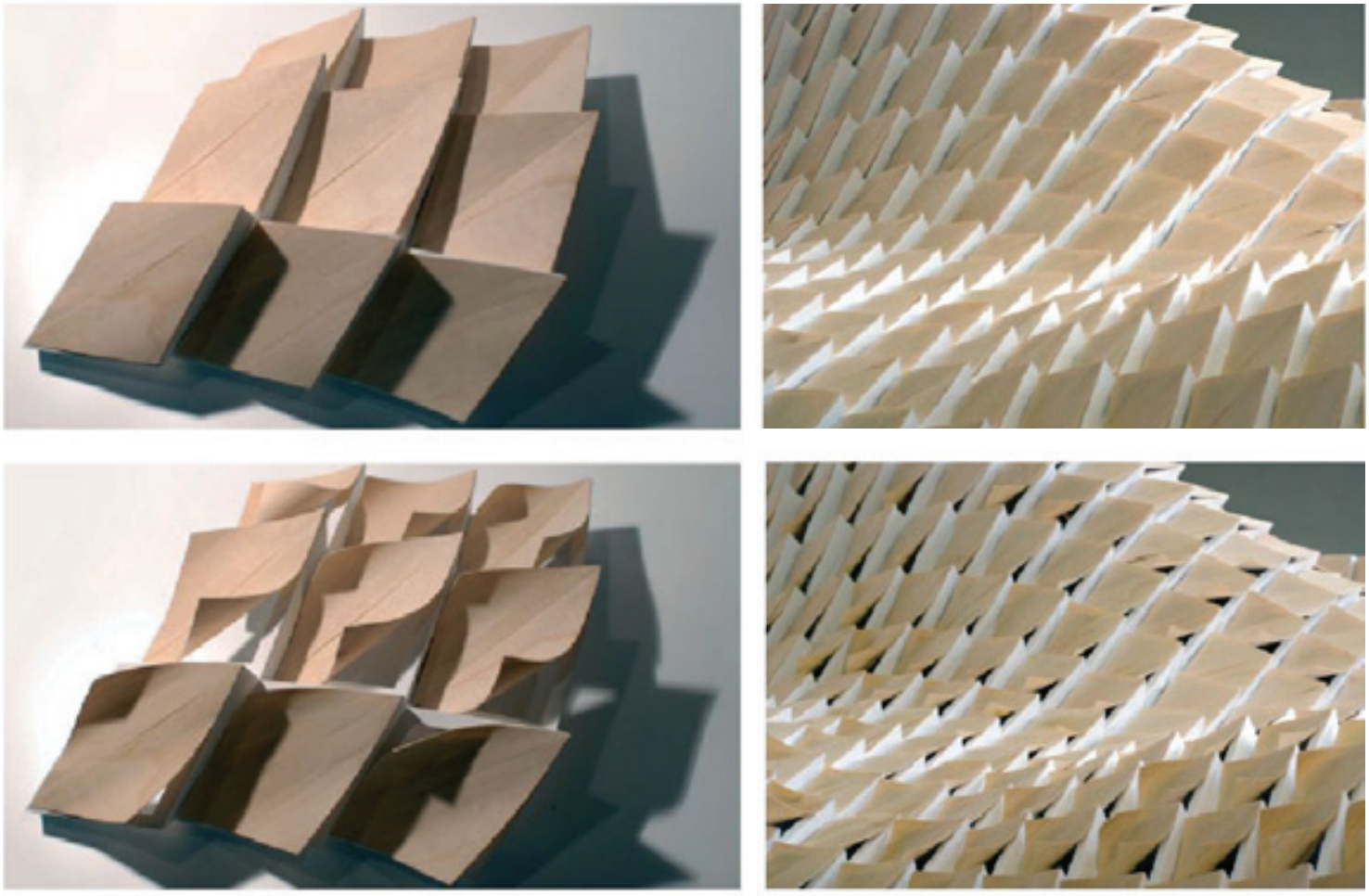

Figure 23: Responsive surface structures by Steffen Reichert

LANDSCAPE AS A METAPHOR

Jorgen Dehs describes the current acknowledgement of the word "landscape" as not simply a geographical term but as a metaphor:

"We have interest in landscape when we feel the need to stretch our eyes. Along with this common understanding - and probably because of it - the term landscape enjoys a comprehensive career as a metaphor... Every chaotic totality is assembled into unity as soon as it is labelled a landscape. The term "urban landscape" sheds a redeeming glow upon even the most dejected neighbourhood; "industrial landscape" transforms any romping ground for the ravages of industry into an object of aesthetic sensibility."

(Smout et al., 2007: 6)

THE ECONOMY OF CITIES

Jane Jacobs states in her book The Economy of Cities that cities are the primary drivers of economic development. Her main argument is that explosive economic growth derives from urban import replacement. Import replacement is when a city begins to locally produce goods which it formerly imported, e.g., Tokyo bicycle factories replacing Tokyo bicycle importers in the 1800s. Jacobs claims that import replacement builds up local infrastructure, skills, and production. Jacobs also claims that the increased produce is exported to other cities, giving those other cities a new opportunity to engage in import replacement, thus producing a positive cycle of growth.

In the second part of the book, Jacobs argues that cities preceded agriculture. She argues that in cities trade in wild animals and grains allowed for the initial division of labour necessary for the discovery of husbandry and agriculture; these discoveries then moved out of the city due to land competition.

GENERAL DESIGN STRATEGIES

ECO-DESIGN PRINCIPLES

Ken Yeang gives the following general premises and clear strategies for achieving sustainable, benign and seamless environmental integration:

- Interrogate Design Premise
- Determine level of environmental integration achievable in design
- Evaluate the ecological history of the site
- Design to integrate inorganic building mass with biomass.
- Design to Improve existing, and create new ecological linkages
- Design to reduce heat-island effect
- Design to reduce transport impact
- Design for improved and appropriate internal comfort levels. (Passive, Mixed-mode and Full- Mode)
- Design for optimal internal integration of biomass.
- Design for water conservation, recycling, harvesting
- Design for Food Production.
- Design for minimal waste during material life cycle.
- Design for Vertical integration.
- Design to reduce light and noise pollution.
- Design energy flow to reduce use of nonrenewable energy.
- Design to reduce pollution and waste.

(YEANG, Ken, 2008)