

DETC2001/DTM-21715

TOWARDS BIOMIMETIC CONCEPT GENERATION

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ABSTRACT

This paper describes efforts towards generalizing biomimetic concept generation in engineering design. Biomimetic design fully or partially imitates or evokes some biological phenomenon. Nature has often inspired solutions to engineering problems. While biological phenomena hold a vast amount of ideas, a method for finding and using these ideas would make biomimetic innovation faster, easier and more accessible. The paper begins with a brief review of related research, recognition of engineering ideas in biological phenomena and advantages of the natural brand. Next presented are strategies for finding potential analogies in biological phenomena, including searching functionally across multiple levels of organization, from the molecule to the biosphere. Initial efforts at finding appropriate analogies are documented using an example in design for remanufacture.

Keywords: biomimicry, analogy, function, remanufacture

NOMENCLATURE

- Biomimetic design: Design that, fully or partially, imitates or evokes some biological phenomenon.
- Biological phenomenon: Any natural phenomenon pertaining to the biological sciences – the term “biological phenomena” includes all levels of organization pertaining to the biological sciences (see Table 1).

INTRODUCTION

Nature has often inspired solutions to engineering problems. For example, the Wright brothers devised their breakthrough flight control system after studying the flight movements of vultures. Biomimetic design has spawned innovation in design as well as pointed to ways of improving existing designs. Biological phenomena hold a vast amount of

ideas. A method for finding and using these ideas would make biomimetic innovation faster, easier and more accessible.

The main components of the paper include:

- A brief review of related research.
- Recognition of engineering ideas in biological phenomena and advantages of the natural brand.
- Strategies for biomimetic concept generation.
- Documentation of initial efforts towards generalizing biomimetic concept generation using an example in design for remanufacture.

RELATED WORK

Offner (1995) offers excellent case studies of biomimetic design and discusses the biomechanics of systems found in a number of animals, some plants, and the cell. He outlines a course designed for engineering students and dedicates a chapter to a discussion of techniques for the development of creativity.

New modes of propulsion based on animal locomotion have been explored for robotic locomotion. For example, MIT's RoboTuna is an underwater autonomous vehicle that uses oscillating-foil propulsion based on that of the blue fin tuna (Machine Design 1995). The ornithopter is a flapping-wing aircraft, imitating bird or bat flight. The University of Toronto's Institute for Aerospace Studies made its first successful remote-piloted ornithopter flight in 1991.

Sfakiotakis *et al.* (1999) presented an overview of fish swimming mechanisms. With recent developments in oscillating-foil, underwater locomotion, the authors aimed to introduce engineers to the existing literature on fish swimming. This type of research provides a useful reference for engineers who are using a specific biological model.

Vincent (1992, 1994) raised awareness of biomimetic design in the area of materials engineering. Materials engineers have been studying biological tissues and creating new