Proceedings of IDETC/CIE 2007
ASME 2007 International Design Engineering Technical Conferences &
Computers and Information in Engineering Conference
September 4-7, 2007, Las Vegas, Nevada, USA

DETC2007-35776

INCLUDING FUNCTIONAL MODELS OF BIOLOGICAL PHENOMENA AS DESIGN STIMULI

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ABSTRACT

This work explores the representation of biological phenomena as stimuli to designers for biomimetic design. We describe a study where participants were asked to solve a micro-assembly problem given a set of biological representations of leaf abscission for inspiration. The visual aids presented to the designers are investigated, and the use of functional models of biological phenomena in particular is critiqued. The designs resulting from the study are classified and theories drawn as to possible influences of the biological representations. Observations, retrospective conversations with participants, and analogical reasoning classifications are used to determine positive qualities as well as areas for improvement in representation of the biological domain. Findings suggest that designers need an explicit list of all possible inherent biological strategies, previously extracted using function structures with objective graph grammar rules. Challenges specific to this type of study are discussed, and possible improvement of representative aids are outlined.

INTRODUCTION

Motivation

Design is a cognitive task, susceptible to the stimuli and other information presented to the designer. Biomimetic design – where biological phenomena are used as stimuli or sources of analogy – has been shown to enhance the problem-solving process [Vakili and Shu 2001; Shu et al. 2006]. An important fact is that the manner of presentation of images and text describing biological phenomena affect the designer's understanding of the phenomena, and therefore his or her problem-solving success.

A standard, comprehensive, clear and learnable schema of model representation is needed so engineers can extract biological strategies. The use of functional models is seen as an appropriate approach to articulate biological strategies to designers. A related topic is the growing research in capturing empirically derived design knowledge from consumer products, and cataloging these in a Design Repository [Kurtoglu et. al. 2005]. This work asserts "[knowledge] representation is crucial because it establishes the limits of the search space and the scope of design complexity." The Functional Basis of Stone and Wood [2000] is the model schema for the function structure diagram used in this study.

The use of formal function structures is likely transferable to the organization and presentation of complex biological models, a step toward standardization and ease of compilation [Sridharan and Campbell 2004]. This has motivated the exploration of functional modeling of biological phenomena in a similar way to the modeling of consumer products. It is hoped that functional modeling will lead to more powerful techniques for designers to extract strategies from biological phenomena.

Objectives

This study explores the features of biological representations that help or deter engineers in biomimetic concept generation. In particular, it explores the use of a function structure based on standard schema and language basis as a functional model for a biological phenomenon. The insights taken from this small-scale, experimental study will guide future research in the area of biological representation and how it is used by designers.