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Using descriptions of biological phenomena for idea generation

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Abstract Biomimetic design uses biological phenomena to inspire solutions to engineering problems. While many examples of biomimetic design involved detailed understanding of a particular biological phenomenon, the level of understanding required for idea generation is unclear. This paper reports on a study of how descriptions of biological phenomena are used to develop concepts for a simple problem. This study is a continuation of past work on the use of biological analogies for concept generation. Since previous studies had revealed difficulties with fixation and mapping, participants in this study were provided with support for analogical mapping. While participants were observed to extract strategies consistent with the biological phenomena presented, they persisted in applying strategies to specific attributes of the example problem. Since concepts generated varied with attributes chosen, applying the strategy to each possible attribute of the example problem may result in a larger variety of solutions.

Keywords Biomimetic design · Bioanalogous design · Design-by-analogy · Idea generation · Analogical reasoning

1 Introduction

Biomimetic design draws from nature for design ideas. However, the use of natural phenomena as design inspiration has often been the result of chance encounters with interesting phenomena. The frequently cited example, Velcro was inspired when a Swiss scientist noticed cockleburs entangled in his dog's fur (Velcro 1955). More recent examples of biomimetic design involve applications of biological phenomena recognized to be of practical use to engineering problems (Clark et al. 2001; Dalsin et al. 2003; Iwase et al. 2004; Kikuchi et al. 2004). We believe that the use of biological analogies in design would increase if engineers were able to better determine which natural phenomena would be relevant, and how to apply these phenomena to their design problems.

1.1 Related concept generation techniques

To support engineers in biomimetic design, our previous work outlined a concept generation process that included the identification of relevant biological phenomena from biology texts (Vakili and Shu 2001; Hacco and Shu 2002). Our objective was to develop a formalized process that was comparable to other concept generation techniques, such as Synectics, or theory of inventive problem solving (TRIZ).

Synectics is a technique that guides creative thinking through four types of analogies: direct, personal, symbolic, and fantasy (Gordon 1961). Biological analogies are classified as direct analogies, and are considered by Gordon to be the most abundant source of direct analogy for creative concept generation. Although Synectics is a structured approach for creative thinking and recommends the use of biological analogies, it does not specify how relevant biological phenomena can be identified.

Theory of inventive problem solving presents inventive principles that resulted from studying over 1.5 million patents (Altshuller 1984). Recurring engineering conflicts

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