Using templates and mapping strategies to support analogical transfer in biomimetic design

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While biological phenomena can serve as meaningful analogies to inspire innovative design, previous studies found that designers often use descriptions of biological phenomena in non-analogous ways. Two experiments were conducted with novice designers to investigate how to decrease the non-analogous use of biological phenomena in concept generation. Properly applied, a causal relation template, developed based on Gentner's framework of analogical reasoning, decreased participants' non-analogous concepts. We identified two further interventions that reduce the tendency to develop non-analogous concepts: (1) one-to-one mapping instructions and (2) mapping the source analog to multiple problem-independent scenarios before concept generation. Understanding and reducing non-analogous application of biological phenomena may enable designers to more fully take advantage of biomimetic, or biologically inspired, design.

Keywords: biomimetic/biologically inspired design, conceptual design, design techniques, design method, design cognition

There is increasing consensus that analogies formed between concepts from two distant domains, such as biology and engineering, can stimulate creative ideas (Bonnardel, 2000; Jin & Benami, 2010; Lopez, Linsey, & Smith, 2011; Sartori, Pal, & Chakrabarti, 2010; Tseng, Moss, Cagan, & Kotovsky, 2008). Many studies assume that the use of distant-domain stimuli invokes analogical reasoning, which by Gentner's (1983) definition requires finding structural similarities between two concepts.[1] This however is not always the case, as a designer could develop an idea based on association from superficial characteristics of a distant-domain source.

Previous studies in biomimetic, or biologically inspired, design reported that novice designers frequently develop ideas based on non-analogous association with particular features of biological phenomena (Cheong & Shu, 2009; Helms, Vattam, & Goel, 2009; Mak & Shu, 2004, 2008). However, structural similarities of functions between biological phenomena and design problems

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