

# INTEGRATING FUNCTION-BASED AND BIOMIMETIC DESIGN FOR AUTOMATIC CONCEPT GENERATION

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## ABSTRACT

This paper explores combining functional modeling and biomimetic design. Observed benefits of applying functional modeling to biomimetic design include a more complete, systematic modeling that reveals additional aspects of biological phenomena to be exploited. Incorporating biological phenomena into a function-based design repository requires that multiple facets of the potential solution be presented, including a natural-language description of the biological phenomenon, the strategy derived from the phenomenon, example implementation of the strategy in engineered solutions, and functional modeling of both biological and engineered systems.

This paper will illustrate the functional modeling of a single biological phenomenon at multiple levels of biological organization (organism/organ and cellular/molecular), the use of multiple biological analogies present in a single phenomenon in different engineering problems, and how the combination of functional modeling and biomimetic design leads to more complete exploitation of biological phenomena, as well as more complete representation of stimulus when including biological phenomena in a design repository.

*Keywords: biomimetic design, automated concept generation, function based design*

## 1 INTRODUCTION

The natural world provides numerous cases for analogy and inspiration in engineering design. From simple cases such as hook and latch attachments to articulated-wing flying vehicles, nature provides many sources for ideas. Though biological systems provide a wealth of elegant and ingenious approaches to problem solving, there are challenges that prevent designers from leveraging the full insight of the biological world. A fundamental problem is that the effort and time required to become a competent engineering designer creates significant obstacles to becoming sufficiently knowledgeable about biological systems to effectively execute biomimetic design.

In this paper, we describe a fundamental attempt to solve the knowledge requirement problem through the creation of a prototype biomimetic design repository. The design knowledge is stored based on the function the biological system solves as well as a natural-language description of the biological phenomena. We report the results of performing functional modeling of biomimetic design examples on the generation of additional concepts, compared with those generated using natural-language based biological stimuli alone. Key contributions include representing biological systems as solutions to desired functions, and increased discovery into the similarities and differences between biological and engineered systems.

## 2 BACKGROUND AND OBJECTIVES

### 2.1 Biomimetic design

The natural world contains some of the most elegant, innovative and robust solution principles and strategies. Biomimetic design aims to fully leverage the insight of the natural world into the engineered world by using analogies with biology to generate engineered solutions. Thus, at a more