

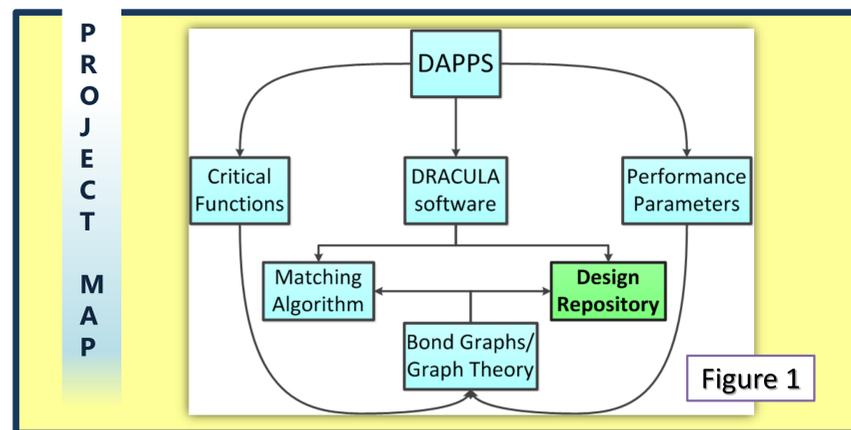
Collaborative Research: MAPS – MetaAnalogy via Performance Specification

Megan E Tomko, Georgia Institute of Technology
Peter Morgenthaler, Colorado School of Mines

DR. CAMERON J. TURNER, Colorado School of Mines, College of Engineering & Computational Sciences
DR. JULIE S. LINSEY, Georgia Institute of Technology, Woodruff School of Mechanical Engineering

Research Motivation

Design-by-analogy is a prominent approach being utilized in innovation efforts [1-3], including bioinspired design [4-6]. Design-by-analogy is the subject of ongoing efforts to develop methods and computational tools for retrieving examples from distant knowledge domains – a difficult task for designers. In efforts to create an analogy retrieval tool, it is necessary to evaluate how analogies are currently used by designers so as to understand how to implement analogies into an analogy retrieval tool known as Design-Analogy Performance Parameter System (DAPPS).



Design-by-Analogy

In order to generate new solutions to a design problem, design-by-analogy proposes withdrawing principles from existing examples and applying them in the context and domain of the design problem.

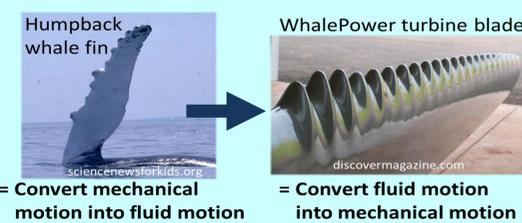


Figure 2: [10, 11]

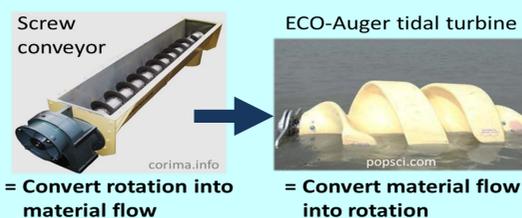


Figure 3: [12, 13]

Empirical Product Study

In order to evaluate how analogies are currently used by designers, we classified and analyzed a collection of 70 analogy-inspired products and the design processes that were involved when the product was created [7-9].



Results

- Designers often directly borrow critical functions from analog systems for their products.
- Designer invert critical functions, see Figure 3.
- Designers are typically inspired more by natural analogs than by man-made analogs.
- Academic design teams are more often identified as biologically cross disciplinary than commercial design teams.
- Biologically Cross Disciplinary teams tend to use more solution-driven approaches than problem-driven approaches.

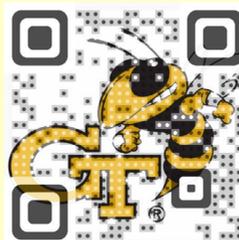
Contact Us

Megan Tomko | mtomko3@gatech.edu
Dr. Julie Linsey | julie.linsey@me.gatech.edu

NSF CMMI-1304383 & CMMI-1234859

QR Code

Check out a video on this research!



Classification

Context variables:

Describing the personnel and circumstances related to the design example

Variables:	Categories:	Used to describe:
1. Inventors' Occupation	Academic only, Non-academic only, Mixed	The professional backgrounds of the personnel involved
2. Biological Cross-Disciplinary (BCD)	BCD, Non-BCD	The diversity of the personnel involved
3. Driving Approach to Analogy Mapping	Solution-driven, Problem-driven	The design scenario surrounding the analogy-inspired example

Analogy variables:

Describing the analogical mapping(s) made in the design example

Variables:	Categories:	Used to describe:
4. Analogy Source Domain	Natural analogs, Man-made analogs	The source(s) of the inspiring analog
5. Analogy Multiplicity	Single, Compound	

Outcome variables:

Describing the outcomes achieved in the design example

Variables:	Categories:	Used to describe:
6. Additional Function	Additional function, No additional function	The benefits achieved by using the analogy-inspired concept
7. Improved Performance	Improved performance, No improved performance	

References

- [1] Casakin, H., and Goldschmidt, G., 1999, "Expertise and the use of visual analogy: implications for design education," *Design Studies*, 20(2), pp. 153-175.
- [2] Leclercq, P., and Heylighen, A., 2002, "5,8 Analogies Per Hour," *Artificial Intelligence in Design '02*, J. S. Gero, ed., Kluwer Norwell, MA, pp. 285-303
- [3] Christensen, B. T., and Schunn, C. D., 2007, "The Relationship of Analogical Distance to Analogical Function and Preinventive Structure: The Case of Engineering Design," *Memory & Cognition*, 35(1), pp. 29-38.
- [4] Vogel, S., 2000, *Cats' paws and catapults: Mechanical worlds of nature and people*, WW Norton & Company.
- [5] Benyus, J. M., 2009, *Biomimicry*, HarperCollins.
- [6] Shu, L. H., Ueda, K., Chiu, I., and Cheong, H., 2011, "Biologically inspired design," *CIRP Annals - Manufacturing Technology*, 60(2), pp. 673-693.
- [7] Ngo, P., Viswanathan, V., Turner, C. J., and Linsey, J., 2013, "Initial Steps Toward an Analogy Retrieval Tool based on Performance Specification," *Proceedings of the 2013 ASME IDETC-Computers in Engineering Conference*, Portland, OR, USA.
- [8] Ngo, P., 2014, "Surveying Trends in Analogy-Inspired Product Innovation," *Mechanical Engineering M.S. Thesis*, Georgia Institute of Technology, Atlanta, GA.
- [9] Ngo, P., Turner, C. J., & Linsey, J. S., 2014, "Identifying Trends in Analogy Usage for Innovation: A Cross-Sectional Product Study," *Journal of Mechanical Design*, 136(11), 111109.
- [10] Rossitier, W. *Student Science*, Web, 9 Nov. 2015.
- [11] Subirana, J., *DiscoverMagazine*. Web, 9 Nov. 2015.
- [12] "Tubular Screw Conveyor," *Corima*, Web, 9 Nov. 2015.
- [13] Carnett, J.B., "ECO-Auger," *Popular Science*, Web, 9 Nov. 2015.