DESIGN CREATIVITY: REFINING THE MODEL

DAVID C BROWN & ELIJAH FORBES-SUMMERS
Computer Science Department, Worcester Polytechnic Institute, USA

1. Introduction

The work of Margaret Boden (1990; 1994) is familiar to everyone involved in the field of Computational Creativity. Her work, although at times philosophical, opened up new areas of research about creativity. However, some (Haase, 1995; Ram et al., 1995) have criticized the lack of detail in her models of creativity. Making a general model more detailed can remove some of the subjectivity; allow more options for a model to be tested; and, of interest to this workshop, move closer to models that concern designing.

More recently, Wiggins (2006) has continued to refine his formal framework around Boden's ideas about creativity as well as show that her model, even if lacking detail, was useful and revealing. Specifically he introduces a key distinction between $\mathfrak{R}$, a "rule set" that constrains the possible conceptual spaces, and $\mathfrak{I}$, a rule set that allows traversal of a space.

2. Proposal

There's a need to modify the model to explicitly include details that are absent or only implied in Wiggins' framework. The hope is that by making certain features explicit, about $\mathfrak{I}$ in particular, it will open up lines of reasoning about features common to all knowledge domains.

Wiggins' model is simple and very abstract, which is useful for the purpose of comparing and describing creative systems. However, by not elaborating on the structure of the conceptual space, or the rule-sets which operate on the space, certain processes which might be general to creative systems are hidden.

Using his framework Wiggins demonstrates the types of transformation that are part of what Boden calls Transformational Creativity, as well as discovering a new type of transformation that she did not recognize. However, Wiggins stops short of detailing methods for enacting these transformations.

In a way this makes sense as many methods for making these transformations (in real life) are techniques and heuristics belonging to a

specific domain. However, there are general purpose transformation heuristics: some even mentioned in Boden's writing (1994). These heuristics might be used to modify $\mathfrak{I}$ to $\mathfrak{I}'$ to produce a richer set of rules that select from or operate over the space.

One future challenge therefore is to relate them to designing. What kinds of transformations are appropriate for what kind of rules? Are some types of rules more important than others? Perhaps those should be transformed less often or less drastically.

However, to start with, considering the rules in $\mathfrak{I}$ as primitive ingredients of design activity moves the model closer to designing. The problem is at what level to pitch these descriptions. While most would agree that finding similar concepts, detecting differences, or making abstractions would be ingredients of creative designing (Brown, 2008) it is hard to know whether they are at the same level of abstraction. It is also difficult to draw a hard boundary between domain-independent and domain-dependent activity.

3. Implications

It's probably fair to say the current studies of computational design creativity are targeting rather large scale mechanisms, such as analogical reasoning. Even these are quite a distance from the very abstract model of Boden as refined by Wiggins, and also by Ritchie (2007).

As an example for discussion, consider analogical reasoning during designing (Goel, 1997).

At the highest level an analogical step takes a partial concept (target) and delivers a known concept (the source) that is related in some way, so that aspects of it can be transferred to help complete the target concept.

At a level below that, the actions involved are also traversing the conceptual space, but in ways that don't all produce a relevant design concept. While there are many theories of analogical reasoning, those steps are roughly a) finding suitable sources (reminding), b) matching source candidates to the target, and c) transferring aspects of the 'best' match to the target.

Consider the level below that, for step 'a' alone, "finding suitable sources". That might involve (a_1) abstraction of the target to existing or new concepts—a traversal of the conceptual space. These more general concepts might then be (a_2) used to find suitable sources, or abstractions of suitable sources, by using existing similarity or difference connections (links) or by searching—also a traversal of the conceptual space.

This sort of analysis of levels might also be done for evaluation steps ($\mathfrak{E}$ in Wiggins' model). As we understand it, Ritchie suggests that the decision about the creativity of a concept applies only to whole, "finished" concept

(e.g., a design). Wiggins, however, allows any concept, complete or partial, to be evaluated.

Consider the a_1 step above. As there are usually many ways to do abstraction, that activity needs to be monitored in order to try to ensure that it isn't getting too far from the purpose of the task. For example, one might abstract a needle to "sharp things" or to "sewing tools": quite distinctly different directions. Hence, the concepts generated by abstraction processes need to be evaluated. In fact, as Brown (2008) discusses, at all levels there are many design and design process choices that might lead to creative results, most of which might need evaluation.

We propose that the field needs to try to close the gap between abstract models and design-specific models in a deliberate way, both in a top-down and a bottom up manner. As suggested by the analogical reasoning example above, we envision layers of more specific models, with each one of a pair of adjacent models informing research about the other.

References

Boden, MA: 1990, *The Creative Mind: Myths and Mechanisms*, Routledge, New York.

Boden, MA: 1994, *Dimensions of Creativity*, MIT Press, Cambridge.

Brown, DC: 2008, Guiding Computational Design Creativity Research, *Proc. NSF Int. Workshop on Studying Design Creativity '08*, University of Provence, France. Available at <www.cs.wpi.edu/~dcb/Papers/sdc08-paper-Brown-25-Feb.pdf>

Goel, AK: 1997, Design, Analogy, and Creativity, *IEEE Expert*, 12(3), pp. 62-70.

Haase, KB: 1995, Too many ideas, just one word: a review of Margaret Boden's the Creative Mind: Myths and Mechanisms, *Artificial Intelligence Journal*, 79(1): 69-82.

Ram, A, Wills, L, Domeshek, E, Nersessian, N and Kolodner, J: 1995, Understanding the Creative Mind: a review of Margaret Boden's creative mind, *Artificial Intelligence Journal*, 79(1): 111-128.

Ritchie, G: 2007, Some empirical criteria for attributing creativity to a computer program, *Minds and Machines*, 17(1): 67-99.

Wiggins, GA: 2006, A preliminary framework for description, analysis and comparison of creative systems, *Journal of Knowledge Based Systems*, 19(7): 449-458.