Chapter 13
Engineering Inspiration:
Enhancing Scientific Creativity through Image Flows

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ABSTRACT

This chapter proposes a computerized tool to promote inspiration in a specific, but very important, kind of scientific creativity, for significant scientific breakthroughs are often enabled by conceptual revolutions. The creative process is often divided into four phases: preparation, incubation, inspiration, and verification/elaboration. The proposed tool enhances the incubation phase of scientific creativity, with the goal of inspiring fruitful reconceptualization of a problem. It accomplishes this by exposing the scientist-user to continuous sequences of images designed to engage innate, unconscious cognitive structures. The sequence is not fixed, but may vary either randomly or under user direction. When this image flow seems relevant to the problem, users can record their position in it and their own ideas with a variety of low-interference recording techniques. Several simple image flows are described, along with the computational engine for generating them.

BACKGROUND

Scientific Creativity

There is no need to rehearse the importance of science in our society, both for the technological developments it has enabled and for the profound revision of our worldview that it has entailed. Although much of this scientific progress has been incremental, at its heart are conceptual revolutions, including quantum mechanics, special and general relativity, the structure and function of DNA, and the neo-Darwinian synthesis. These are among the germ cells from which contemporary science has developed. Further, as Kuhn (1970) argued, new paradigms generate new research programs, asking questions that were not asked — or *could not* be asked — from prior perspectives. Therefore, conceptual revolutions in science reveal new worlds, previously unimagined, awaiting exploration. The goal of our research is to provide technological support for future conceptual revolutions (minor as well as major).

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It is widely recognized that it is important to distinguish degrees of creativity based on novelty and significance (Kozbelt, Beghetto & Runco, 2010; Ward & Kolomyts, 2010). For example, Gardner (1993) distinguished little-C creativity and big-C creativity. More recently, Kaufman and Beghetto (2009) have argued for a "four C model," but Gardner's classification is sufficient for this chapter. *Little-C creativity* is the sort of creativity that scientists, artists, engineers, designers, and most other productive people engage in on a regular basis: finding new, non-obvious solutions to relevant problems. Although little-C creativity is critical to the improvement of human well-being, it is not the primary concern of this chapter. Rather, the focus is on *big-C creativity*, the sorts of creative accomplishments that loom large in history books, and in particular the sorts of scientific accomplishments that effect conceptual revolutions (Sawyer, 2006, pp. 27–29). More modestly, the focus is on scientific creativity that results in a new, more fruitful way of understanding some class of phenomena. This chapter will argue that Big-C creativity requires a different sort of technological support than "ordinary" (little-C) creativity (see below, "Archetypal Processes").

Unfortunately, much of the research on creativity, especially research aimed at improving creativity, has focused on little-C creativity (Sawyer, 2006, pp. 66–67). Indeed, many of the problems used in these studies amount to puzzles in which objects in the environment must be used in innovative ways in order to solve some well-defined problem. Certainly, seeing things in new ways, and avoiding a kind of functional fixation, are important in big-C scientific creativity, but what the latter often requires is a new perspective on a scientific domain, rather than a clever redeployment of existing elements. The goal here is to use technology to encourage new conceptualizations and perspectives on scientific problems, and thereby to enable scientific breakthroughs.

Boden (1991) draws a useful distinction between P-creativity and H-creativity. *P-creativity* (*psychological creativity*) refers to the production of something that is new and interesting to the creator, although many other people may have already created the same thing. In contrast, *H-creativity* (*historical creativity*) is the production of something new and interesting that has never been produced before (at least in the creator's culture). For well-prepared scientists (see below), the two notions largely coincide, because these scientists will be aware of what has been accomplished in their field, and so if an idea is P-creative it is also likely to be H-creative. That, at least, is the goal, but it is not uncommon for a scientist to discover that a psychologically original idea has been anticipated by others, that is, that an apparently H-creative idea is only P-creative. The author's project focuses on ideas that are P-creative, but simultaneously, as a consequence of professional preparation, very probably H-creative.

Graham Wallas's (1926) description of four stages in the creative process is well known, but they had been enumerated already by Poincaré (1908/1952), and the first three were mentioned by Helmholtz (1896) (see also Whiting, 1958). They are

1. Preparation,
2. Incubation,
3. Inspiration (or illumination), and
4. Verification (or elaboration).

Regardless of the domain of creativity, *preparation* involves conscious work on the problem, *incubation* entails a suspension of this conscious activity, *inspiration* refers to the relatively effortless appearance of an attractive solution, which must be followed by (perhaps extensive) *verification* and/or *elaboration* of this inspired solution. Thus, according to Reichenbach (1938), the first three stages occur in the context