Revisited and Remixed: Creative Variations and Twisting Knobs

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"The secret to creativity is knowing how to hide your sources."
– Albert Einstein

"Originality is nothing but judicious imitation." *– Voltaire*

"Fill the tanks, fill the tanks, fill the tanks. Constantly watch things, and things you don't normally watch. Step outside your viewing zone, your reading zone. It's all fodder, but if you only take from one thing then it'll show."
– Joss Whedon

Introduction

Creative people, be they artists or authors, scientists or musicians, are often asked where their ideas come from. Stephen King, in his book "On Writing" replied that his ideas came from "a small bloodthirsty elf who lives in a hole under my desk". His son, Joe Hill, an accomplished author in his own right, offers a similar tongue-in-cheek response suggesting that his ideas come from "Schenectady," specifically from a Mom and Pop store on Route 147! As an aside – more of these stories of inspiration are found at: http://wheredoyougetyourideas.wordpress.com/

In our previous November 2013 article in this series on creativity and 21st century learning, we argued that creativity is not a "magical" process, rather it emerges from combining pre-existing ideas and concepts in unique and novel ways (Henriksen, Mishra, & The Deep-Play Research Group, 2013). Creativity builds on that which already exists, i.e. every creative idea is, in some way, derivative of what has come before. Creativity has a "combinatorial" nature (Ferguson, 2011; Popova, 2012) emerging from permutations, combinations and alterations to existing ideas or artifacts.

This view of creativity as emerging from existing work faces an important challenge. If creativity is simply variations on a theme – then how do we explain the striking originality of a Bach Sonata, or Einstein's theory of relativity, or a Picasso's painting? Were these individuals merely "appropriating" ideas and themes from others? How do we explain creative work that seems uniquely novel, in which we cannot see any traces of the influence it was derived from?

It is one thing to discuss these ideas and another to ground them in actual cases of creative practice. This article is a continuation and extension of the core principle of "variations on a theme", described in our previous article (Henriksen, Mishra, & the Deep-Play Research Group, 2013). Here, we ground it in specific examples taken from the world of puzzle and game design.

Double Maze

Let us begin by describing a computer puzzle-game called Double Maze. Double Maze was designed by Scott Kim, a noted graphic artist, author, dancer, puzzle and game designer. Imagine a simple maze game, in which you must navigate a ball (or any other object) through a maze keeping it away from some pitfalls, such as holes, to a pre-determined location

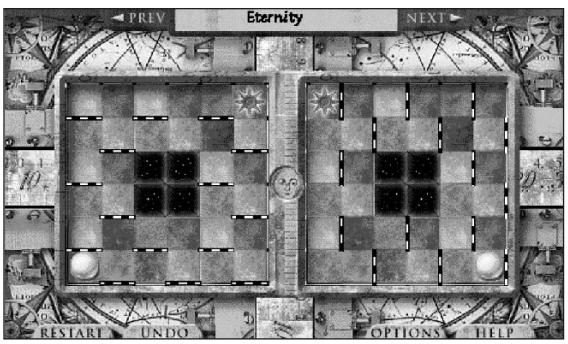

Figure 1. The Double Maze puzzle game designed by Scott Kim

(Figure 1). Now imagine two different mazes that work in tandem with each other. A move in one maze is paralleled by a move on the other. So if you shift the ball left in one maze it shifts to the left in the other maze as well. The goal now is to get both the balls to the final pre-determined spot, simultaneously. In the version shown below, you have to maneuver two pieces (the balls at the corners to the "star" at the opposite end of the board. You have to do this without falling into the holes (the four squares at the center) or without falling off the board. You can take advantage of the strategically placed walls (indicated by the striped lines) to change the relative location of the balls from each other.

Double Maze can be fiendishly difficult to navigate – as you have to control not just one object, but two (and the relative positions of both), in order to get them both onto the "star" at the same time! As puzzles go, this is a new style of puzzle and we would rank it high along the three dimensions of creativity, as being *novel, effective and whole* (Mishra, Henriksen, & the Deep-Play Research Group, 2013). The question for us is how did someone like Scott Kim come up with a game as original, unique and creative as this one? We'll return to this question, as we consider the idea of creativity as "variations on a theme", with other examples of creativity in puzzles and games.

Variance in Variations

The "variations on a theme" concept compares the creative process to "twisting knobs" – where "knobs" are the variables on an object or idea which can be altered, and the creative person must be able to spot these knobs and see which ones to twist and how – to generate variations that are creative (or again, *novel, effective* and *whole*).

Consider for instance, the Rubik's Cube. Now imagine you are tasked with creating other puzzles based on the Rubik's Cube. What are some "knobs" that you can tweak to generate variations of the Cube? One set of obvious variations is changing the colors and shapes of the stickers on the sides of the Rubik's Cube. Figure 2 gives some examples of variations of this nature—changing the shape of the stickers, using it as a key-chain, making them embossed or with jewels so that they can be solved by visually impaired individuals, or the funniest of all, a Rubik's Cube where all the sides are of the same color!

Figure 2. Somewhat superficial variations of the Rubik's Cube.

Alternatively one can look at the Rubik's Cube and wonder why the cube has to be a 3 by 3 by 3 cube? Changing this variable leads to another set of variations. For instance Figure 3 shows a 2 by 2 by 2, a 4 by 4 by 4, and a 5 by 5 by 5, variant of the original Rubik's Cube.

Figure 3. 2 by 2 by 2; 4 by 4 by 4; and 5 by 5 by 5 variations of the Rubik's Cube.

Another set of variations can emerge if the designer looks at the Rubik's Cube and wonders whether it must be seen as n by n by n slices (3 by 3 by 3 in the original, and other variations as shown in Figure 3) or whether each of these slices needs to be of the same size. This leads to another set of variations as shown in Figure 4 — where the Rubik's Cube is re-envisioned with dimensions of 2 by 2 by 3; or 3 by 2 by 3, but with different sizes; or 3 by 3 by 5; or 3 by 3 by 5 again with different sizes!

Another set of variations can emerge if we notice that a cube is an example of a Platonic solid. What is sacrosanct about the Rubik's Cube being a cube? Could it be a tetrahedron? An icosahedron, or a dodecahedron? Figure 5 shows variations of the Rubik's Cube based on other platonic solids.

Finally, one can wonder why the Rubik's Cube even needs to be constrained to the 3-dimensional world we live in. So Figure 6 presents the 4th Dimensional HyperCube puzzle. This puzzle of course cannot exist in the real world – so it exists in the form of a software program that you can manipulate on your computer! You can see a working version at http://superliminal.com/cube/cube.htm

We must add that these are just few of the many variations of the Rubik's Cube that have been developed by puzzle designers. An exhaustive list can be found at the website http://www.twistypuzzles.com (from which we have taken many of these examples).

So what do these examples demonstrate? First, that one can generate an immense range of variations of the Rubik's Cube by changing one variable at a time. However, these variations exist in a continuum from the obvious (changing the shape of the sticker), to the less-obvious or deep variations (puzzles that are based on seeing the Cube as being a Platonic solid, or a 3 dimensional object, and so on). But in each case there is nothing magical happening. Even the most "distant" variations are based on (a) identifying one aspect of the original design; and (b) varying it to create new designs.

Second, the kinds of variations generated depend greatly on identifying the right variable to tweak. The "deeper" the variable selected, the more novel the emergent designs are. Being able to identify "deep" variables clearly appears to be a function of knowledge of the field. Only someone with deep mathematical knowledge would know that a Rubik's Cube is an example of a Platonic Solid, or that it is possible to think of it in 4 dimensions!

Is this real creativity?

Now we come to the heart of the question of creativity. An obvious challenge to the argument we have developed so far is that none of these variations of the Rubik's Cube demonstrate *real* creativity. Real creativity,

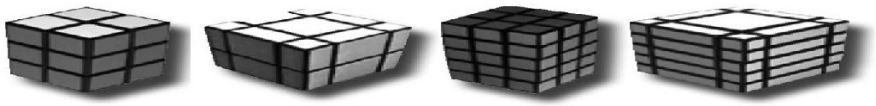

Figure 4:. Variations of the Rubik's Cube that slice the cube in different ways than the normal n by n by n!

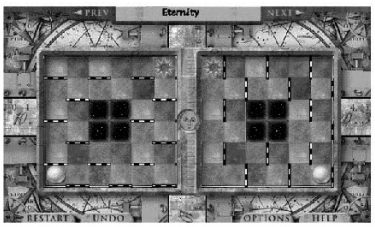

Figure 7: The Rubik's Cube served as an inspiration to Scott Kim in designing the Double Maze puzzle

the critic could argue, belongs to Erno Rubik who came up with the Rubik's Cube in the first place. Surely, his original puzzle, so original in appearance, structure, approach and method of play, was the true example of creative inspiration – everyone else was just twisting or copying his idea. All the examples we have shown here are variations that depend completely on the first original work/insight that Rubik had. *That* was real creativity (or so the critic would say), the rest are just piggybacking on his idea.

To address this criticism let us go back to the game we had described earlier in the article – Scott Kim's Double Maze. When you read the description of Double Maze did it occur to you that this was a variation of Rubik's cube? We would guess that it did not. On the face of it, the Rubik's Cube and Double Maze are very different. What is interesting though is that Scott Kim speaks to how Double Maze was actually inspired by the Rubik's Cube, most specifically by the idea (variable) of "simultaneity." Simultaneity in the case of the Rubik's Cube is the fact that any move in the puzzle creates a simultaneous shift in the problem space – as you twist a section of the cube, there's a resultant shift in the position of other faces of the cube. This is what makes the Rubik's Cube so difficult to solve—every move you make simultaneously changes the orientation and location of other parts of the puzzle.

It was this variable of simultaneity that Scott Kim focused on in constructing Double Maze (see Figure 7). In both cases, we have combination puzzles where the problem solver must manage several aspects of the problem space simultaneously.

Thus it was identifying and twisting a "deep", or less obvious, variable that led to the design of a unique and creative puzzle. Yet the "creative" design is ultimately based on a variation on a common theme (combinations

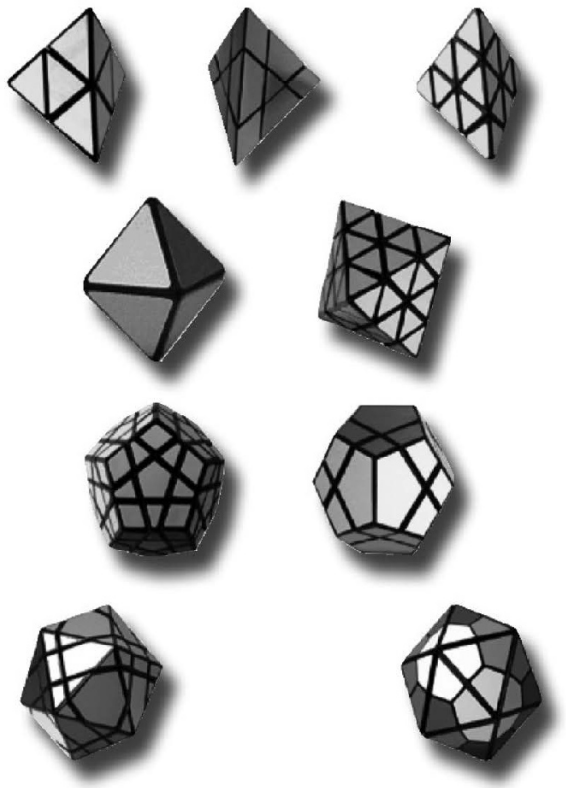

Figure 5. Variations of the Rubik's Cube based on other Platonic Solids

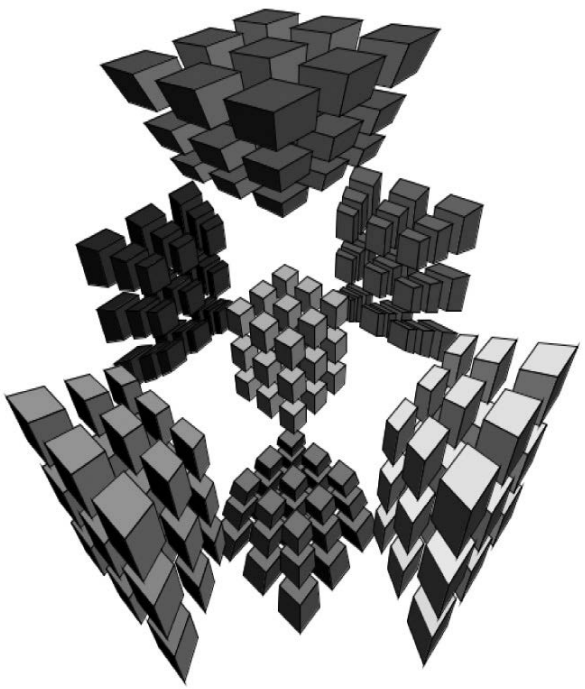

Figure 6. A four dimensional Rubik's HyperCube puzzle (3 by 3 by 3 by 3) that exists only in software work. The image above is the solved version of the Rubik's Cube.

and/or simultaneity). The other variations on the cube that we initially described (variations in dimensionality, materials, colors, etc.) are still creative, but they seem perhaps a bit less novel and original, mainly because they twist the more obvious and visible/surface themes. Many designers can spot the "knobs" of dimensionality in a Rubik's cube, but it is the deeply knowledgeable creator that takes inspiration from the deeper notion of simultaneity and plays with ideas of space.

Scott Kim derived a variation that appears totally novel, because he focused in on a more complex variable. In order to see these less obvious variables, and create highly novel variations, a person must have a wide variety of experiences and knowledge (background knowledge of the subject, and also diversity of knowledge in general). This allows them to spot the unusual knobs and twist them in novel, effective, and whole ways. The kinds of background knowledge people have may lead them to see deep patterns as opposed to superficial ones – to perceive the less obvious themes as opposed to more noticeable ones.

Visualizing the Possibilities, what matters

Designers create new games or puzzles based on how they think, what they know, and most importantly *what possibilities they see* – and from here, their individual knowledge creativity can produce a wide spectrum of products. This wide spectrum may range from a rather commonplace piece of work that resembles what already exists, to something that feels fresh, unique, beautiful or cool yet still has clear roots in a pre-existing thing, to something that feels so wildly different and original that it is hard to spot where it takes inspiration from – it feels like "its own thing".

There is often a range of creative work shown in any medium – a spectrum of creative production (Csikszentmihalyi, 1996; Gardner, 1999). This range extends from very simple variations on a theme (in which a creator simply tweaks some obvious variables of an existing artifact or idea), to dramatic new combinations or twisting of unseen variables (in which a creator produces something that feels very original) (Hofstader, 1985).

So, what accounts for this variability of creativity, or the range of differences in how creative individuals see knobs and "twist" them accordingly? Why do some people see more able to see such possibilities and thus are more creative?

Creative work involves being able to look at what already exists, and see the range of possible variations, and how they might be altered to create something new. Along these lines, we have suggested in prior writings (Mishra, Henriksen, & the Deep-Play Research Group, 2012; Mishra et al., 2013) that having a wide variety of background knowledge and varied experiences is central to the ability to come up with creative possibilities. The most creative work seems to arise not from merely tweaking the obvious variables, but from working with variables many people cannot obviously see. Spotting more complex and less-obvious variables (and also seeing how they can be reconfigured) is more amenable to people with a wider diversity of experiences and depth of knowledge across different disciplines. This supplies a person with a richer repository of inspiration, and the potential to see more prospects than people with narrower foundations (Henriksen, Mishra, & The Deep-Play Research Group, 2013).

A broad base of knowledge for seeing connections across disciplinary boundaries is a foundation of transdisciplinary thinking (Root-Bernstein, 1999; Freedman, 2003; Mishra, Koehler, & Henriksen, 2011). And beyond this, it requires the ability to work across these disciplinary boundaries, to see connections and ways of thinking that cut across them. This primes the mind for seeing novel connections, spotting unique knobs, and twisting or transforming them creatively (Popova, 2012). It might all be summed up with the simple phrase, "the more you know, the more you see."

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