Using Pragmatic Imagination to Create Solutions to Complex Problems

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Introduction

> "To imagine something is to think of it as possibly being so[1:184] This terse formulation sums up a considerable range of attempts to grasp the complex nature of imagination. It captures both the sense in which we can conceive of the world as other than it is…..and also the sense in which the historian or physicist or any of us strives to conceive of the world exactly as it is……..Both senses of this capacity to think of something as possibly being so, point to the imagination as the source of novelty, originality, and generativity."[2:17]

PRAGMATIC IMAGINATION
'a productive [and purposeful] entanglement of imagination, reasoning and action'[3]

In this article I want to explore how the concept of pragmatic imagination developed by Ann Pendleton-Julian and John Seely Brown[3] and how the idea might help us understand how imagination works in the context of inventing our own (novel) solutions to complex problems. It's my belief that the way these authors represent imagination and its role in thinking and acting will help higher education teachers appreciate more clearly the way imagination features in critical thinking and in practice and it might help them to create educational designs that are more likely to cultivate imagination and enable learners to use their own imaginations.

Using imagination to create unique solutions for complex problems

A study in the 1980's at the Microelectronics and Computer Technology Corporation (MCC) looked into how people solve problems[4]. The study focused on design, but the results apply to virtually any other kind of problem solving or decision-making activity.

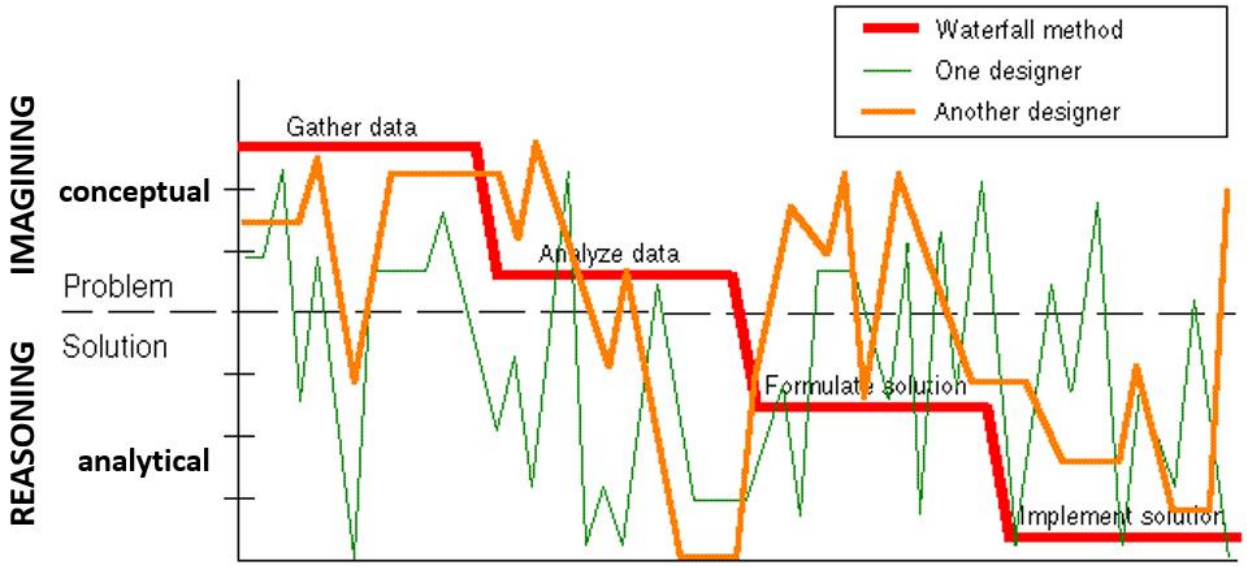
Geoff Conklin[5] describes how a group of designers participated in an experiment in which the goal was to design an elevator control system for an office building. All of the participants in the study were experienced and expert integrated- circuit designers, but they had never worked on elevator systems before. Indeed, their only experience with elevator systems came from riding in elevators. Each participant was asked to think out loud while they worked on the problem. The sessions were videotaped and analyzed in great detail.

The analysis showed, not surprisingly, that these designers worked simultaneously *on understanding the problem* and *formulating a solution*. They exhibited two ways of trying to understand the problem:
• efforts to understand the requirements for the system (from a one page problem statement they were given at the beginning of the session); and
• mental simulations (e.g. "Let's see, I'm on the second floor and the elevator is on the third floor and I push the 'Up' button. That's going to create this situation....").

On the solution side, their activities were classified into high, medium, and low levels of design, with high-level design being general ideas, and low being details at the implementation level. These levels are analogous to an architect's sketch, working drawings, and a detailed blueprint and materials list for a house.

Traditional thinking, cognitive studies, and the pre- vailing design methods all predicted that the best way to work on a problem like this was to follow an orderly and linear 'top down' process, working from the problem to the solution. This logic is familiar to all of us. You begin by understanding the problem. This often includes gathering and analyzing 'requirements' from customers or users. Once you have the problem specified and the requirements analyzed, you are ready to formulate a solution, and eventually to implement that solution. This is illustrated by the 'waterfall' line Figure 1.

Figure 1 The pattern of thinking in seeking solutions to the problem



This is the pattern of thinking that everyone attempts to follow when they are faced with a complex problem, and it is widely understood that the more complex the problem, the more important it is to follow this orderly flow. However, the subjects in the elevator experiment did not follow a waterfall. They would start by trying to understand the problem, but they would immediately jump into formulating potential solutions. Then they would jump back up to refining their understanding of the problem. Rather than being orderly and linear, the line plotting the course of their thinking looks more like a seismograph for a major earthquake, as illustrated in Figure 2. We will refer to this jagged-line pattern as opportunity-driven, because in each moment the designers are seeking the best opportunity for progress toward a solution.

These designers are not being irrational. They are not poorly trained or inexperienced. Their thought process was something like: "Let's see, idle elevators should return to the first floor, but then, you only need one elevator on the first floor, so the others could move to an even distribution among the floors. But the elevators need to be vacuumed regularly. I suppose we could add a switch that brought idle elevators down to the first floor. But then what happens in an emergency?" In other words, what is driving the flow of thought is some marvelous internal drive to make the most headway possible, regard- less of where the headway happens, by making opportunity-driven leaps in the focus of attention. It is precisely because these expert designers are being creative and because they are learning rapidly that the trace of their thinking pattern is full of unpredictable leaps.

In particular, the experiment showed that, faced with a novel and complex problem, human beings do not simply start by gathering and analyzing data about the problem. Cognition does not naturally form a pure and abstract understanding of 'the problem.' The subjects in the elevator experiment jumped immediately into thinking about what kind of processors to use in the elevator controller, and how to connect them, and how to deal with unexpected situations, such as if one processor failed. These are detailed solution elements.

These experienced designers illustrated that problem understanding can only come from creating possible solutions and considering how they might work. Indeed, the problem often can best be described in terms of solution elements. A requirement in the problem statement calling for 'high reliability' was quickly translated into the idea of using a network of distributed processors – a high-level solution that drove the rest of the design process.
Figure 1 illustrates another striking observation: problem understanding continues to evolve until the very end of the experiment. Even late in the experiments the designer subjects returned to problem understanding, the upper part of the graph. Our experience in observing individuals and groups working on design and planning problems is that, indeed, their understanding of the problem continues to evolve -- forever! Even well into the implementation of the design or plan, the understanding of the problem, the 'real issue,' is changing and growing.

The natural pattern of problem solving behavior may appear chaotic on the surface, but it is the chaos of an earthquake or the breaking of an ocean wave – it reflects a deeper order in the cognitive process. The non-linear pattern of activity that expert designers go through gives us fresh insight into what is happening when we are working on a complex and novel problem. It reveals that the feeling that we are 'wandering all over' is not a mark of stupidity or lack of training. This non-linear process is not a defect, but rather the mark of an intelligent and creative learning process.

In fact, this non-linear pattern does not come as a surprise to most people. Anyone who has ever worked on a complex project has the intuition that this jagged line process is what is really going on. But the experiment is significant because it gives us a real picture of the process that people follow when they really think about novel problems, and it is not the orderly and linear process we have been taught is proper!

The jagged pattern of opportunity-driven problem solving illuminates how imagination, perception and reasoning are used and integrated in the service of inventing solutions for a complex problem. It reveals the way creativity works in a domain specific context. The more novel the problem, the more the problem solving process involves learning about the problem domain. In this sense the waterfall is a picture of already knowing – you already know about the problem and its domain, you know about the right process and tools to solve it, and you know what a solution will look like. As much as we might wish it were otherwise, most projects in the knowledge economy operate much more in the realm of learning than already knowing. You still have experts, but it's no longer possible for them to guide the project down the linear waterfall process. In the current business environment, problem solving and learning are tightly intertwined, and the flow of this learning process is opportunity-driven.

Pragmatic imagination – imagination put to purpose

The story just retold illustrates how people use their imaginations in the context of a specific purpose, by combining and integrating their perceptions, reasoning, imagination to tackle a domain specific problem, to generate and evaluate possible actions, pursue the course of action and then reflect on analyse and draw out deeper understandings from the results of action. Imagination, is not just a capacity to imagine new possibilities but a capacity to imagine in ways that improve our ability to perceive, reason and make sense of situations and circumstances.

The story of the engineers designing a lift system reveals how, when we explore and inquire in order to try to solve a problem we use both our imagination and our critical ways of thinking in a complex synergistic interplay: what Pendleton-Jullian and Brown call *pragmatic imagination* (summarized in the adjacent box), 'a productive [and purposeful] entanglement of imagination, reasoning and action'[3]

THE PRAGMATIC IMAGINATION

THE IMAGINATION PUT TO PURPOSE

The Pragmatic Imagination is a concept that sees the imagination as a spectrum of coherent synthetic image making that runs from dealing with the known to projecting the novel, and from prosaic sense-making to poïetic sense-breaking. It values the entire spectrum but suggests that the last portion of the spectrum, the domain of the poïetic imagination, is necessary in a world that is rapidly changing and radically contingent. And finally, it proposes catalyzing, scaffolding and instrumentalizing the entire spectrum for pragmatic purposiveness.

"Imagination is not uniquely about producing novelty that fuels creativity, nor is it simplistically the undisciplined counter-faculty to reasoning, but an entire spectrum of activity associated with diverse cognitive processes from perception, through reasoning to novelty.

We suggest that it is a spectrum as a continuum, as opposed to three cognitive-imaginative steps, because within 'reasoning', we can further distinguish different processes which the imagination serves differently: **deductive reasoning** in which a conclusion follows directly from the premises presented: **inductive reasoning** in which the conclusion, while supported by the premises does not directly follow them – there are missing pieces; and **abductive reasoning** that is often understood as a 'best guess' hypothetical reasoning – a form of logical inference in which an observation leads to a hypothesis which might explain the observation. The hypothesis can be tested. In abduction one is seeking the simplest and most likely explanation without enough facts for a foothold on certainty. "

From deduction to abduction, each of these forms of reasoning relies on increasingly less facts, and increasingly more speculation, which in turn draws on the imagination." [3:24-5]

Pendleton-Jullian and Brown represent thinking as a continuum including perception, reasoning and imagination (Figure 2) with imagination having the potential to be connected to both perception and reasoning.

"In our framework for the pragmatic imagination, the role of the imagination has expanded from a simple imagination versus reason dichotomy to an entire spectrum of activity from perception, through reasoning, speculation, experimentation to the free play imagination we associate with artistic creativity, fantasy, radical scientific discoveries, and invention and novelty of all sorts. We can easily understand how perception and reasoning, and even speculation, have pragmatic purpose and therefore the imagination associated with these would be, by nature, a pragmatic use of imagination"[3:73]

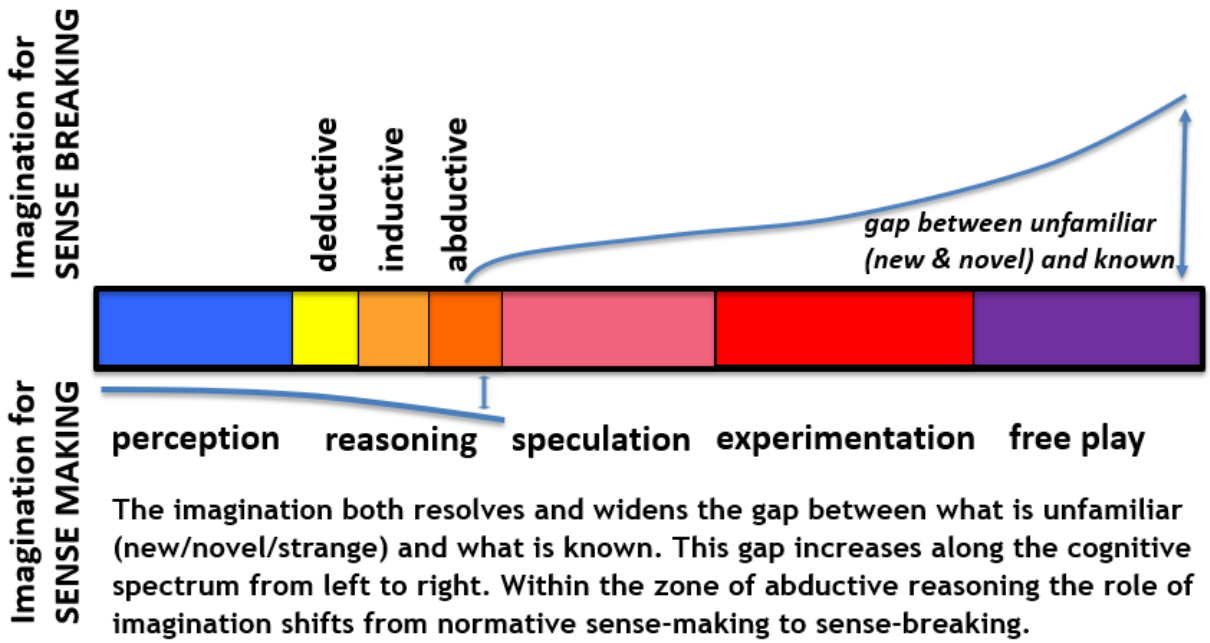
In visualizing the idea of pragmatic imagination, Pendleton-Jullian and Brown (ibid) draw on Pelaprat and Cole's theory of imagination "a process that resolves gaps generated by the constraint of past experience, cultural history, and phyologeny on the

imagination is constitutive of human thought, and should neither be understood as a specialized mental faculty nor as the creation of unreal fantasies. The contents of the imagination, though taken from the world, are not entirely "of" the world. Similarly, the contents of the imagination, though resolved within the individual, are not entirely "of" the individual. Normal mental processes are irreducible to either culture, biology, or individual experience. There are fundamental "gaps" that must be resolved for individuals to think or act in relation to the world. Resolving these gaps through image making constitutes the self and the world in the same process. It is inherent to the structure of human cognition and action[6]

individual so that he or she may produce an image of the world into which they can act and think in the present" [3:62 citing 6]

The imagination both resolves and widens the gap between what is unfamiliar (new/novel/strange) and what is known. This gap increases along the cognitive spectrum from left to right in Figure 2. Within the zone of abductive reasoning, there is a shift in the role of imagination from normative sense-making to sense-breaking, where we widen the gap and then resolve it using imagination.[3]

Figure 2 Pragmatic Imagination. Ann Pendleton-Jullian and John Seely Brown's representation of the cognitive spectrum and the role played by imagination in the continnum[3:53]



In another article[7] I try to show how pragmatic imagination is a core feature of an ecology of practice. Using a geologist making a geological map, I show how his imagination is entangled in a productive and synergistic manner to perception and reasoning as he engages in his domain-specific practical and intellectual task. As he carefully gathers information about the rocks he is studying and identifies them he immediately draws upon his knowledge of how these rocks have formed and begins to create mental models of the environment in which they formed and through this mental imagery he will start to form a hypothesis which he can then test.

In this way he begins to engage in opportunity-driven patterns of learning and problem solving. This is the way creativity emerges from our ecologies of practice when tackling novel and challenging problems in a particular context. The elements of a geologist's cognition and bodily actions work together in a merry dance through field, laboratory and office (writing, processing and cartography) environments. The knowledge and understanding that is developed is codified and explicated in the domain specific artefacts he makes – his geological map and reports.

The general conclusion that might be drawn from this narrative is that imagination is cultivated as individuals develop themselves through the cognitive and practical apprenticeships[8,9] they are serving when they pursue an undergraduate or postgraduate degree and engage in the signature learning experiences of the domain which prepares learners for practice in the field.

Sources

1 White, A.R. (1990) The Language of Imagination, Oxford, Blackwell.
2 Egan, K. (not known) A very short history of imagination. Imaginative Education http://ierg.ca/wp-content/uploads/2014/04/History-of-Imagination.pdf
3 Pendleton Julian, A. and Brown, J. S.(2016) Pragmatic Imagination available at: http://www.pragmaticimagination.com/
4 Rittel, H. & Webber, M. (1973) Dilemmas in a General Theory of Planning, *Policy Sciences* 4, Elsevier Scientific Publishing, Amsterdam, pp. 155 159.
5 Conklin, J. (2005) Wicked Problems and Social Complexity Chapter 1 of *Dialogue Mapping: Building Shared Understanding of Wicked Problems*, by Jeff Conklin, Ph.D., Wiley, October 2005. Available at http://cognexus.org/wpf/wickedproblems.pdf
6 Pelaprat, E and Cole, M (2011) Minding the Gap": Imagination, Creativity and Human Cognition. Integrative Psychological and Behavioral Science, 45, 397–418. Available at: http://lchc.ucsd.edu/mca/Mail/xmcamail.2014-12.dir/pdftKnEBmlThb.pdf
7 Jackson, N.J. (2017) Making a Geological Map through an Ecology of Practice Creative Academic Magazine CAM#9 December 2017 http://www.creativeacademic.uk/magazine.html
8 Collins, A., Brown, J. S., and Newman, S. E. (1989) Cognitive apprenticeship: teaching the craft of reading, writing, and mathematics, in L. B. Resnick (Ed) *Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser*, 453–494. Hillsdale, NJ: Lawrence Erlbaum Associates
9 Shulman, L. (2005) Signature pedagogies in the professions, *Daedalus*, 134, 52-59.

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