Art/Science: Problem-Solving Model as a Unifying Principle of Creativity in Art and Science

Slobodan Dan Paich
Artship Foundation, San Francisco, USA

Abstract
Possible procedural similarities between abstract problems mathematically expressed, engineering problems mechanically resolved, collective tensions and yearning expressed as significant poetic, acoustic or visual manifestations in art will be explored through a series of open questions and reflections. We begin with a short analysis and comparison of the methodologies of Nicola Tesla and Leonardo da Vinci, and explore issues raised by examples of imagination in scientific discovery, such as the German chemist Friedrich August Kekulé resolving the riddle of the benzene ring in 1865. The exploration will include reflection on issues of:

1. Mastery and skill sets
2. Preparing the field and gathering elements for research
3. Cognitive modeling in Art and Science
4. Unexpected connections/discovery
5. Motivation to complete

Before ending with an open-ended summary, we will include the segment of questions and answers from an ongoing dialogue between the author of this paper and Dr. Paul Pangaro, Board Member of Artship Foundation, Cybernetics practitioner, theorist and the proponent of Conversation Theory.

[**Keywords**: art, Science, problem, creativity, solution, model]

Problem-solving models and the scope of the paper

There are many theories and cognitive models of creativity in the literature of psychology, neuroscience, and brain-mapping research. They are outside the expertise and the explorations of this paper.

It may be useful to ask certain questions just outside the scope of our deliberations as threshold ideas: Is creativity an outcome of the same cognitive processes as intelligence? Is creativity judged as creativity only in terms of its consequences? Where is the physical location of creativity in the regions of the brain? What is relationship of intelligence to creativity?

In this paper we shall focus on the nexus of ideas and outcomes put under an umbrella of creativity as byproduct of problem solving. This view of creativity comes from the perspective of doing and making practice such as prototype making, art practice, traditional craft, and mathematical paradigm model-making. We are less preoccupied with defining what creativity is than exploring the potential similarities and differences in the creative processes of art and science.

Rupkatha Journal on Interdisciplinary Studies in Humanities (ISSN 0975-2935), Vol 3, No 3, 2011
Edited by Tirtha Prasad Mukhopadhyay
URL of the Issue: http://rupkatha.com/v3n1.php
URL of the article: http://rupkatha.com/V3/n1/01Principle-of-Creativity-in-Art-and-Science.pdf

Problem-solving models of Nicola Tesla and Leonardo da Vinci

We begin by reflecting upon the complexity of the field where creativity is sparked by problem solving happens, via a short analysis and comparison of the methodologies of Nicola Tesla and Leonardo da Vinci will open this paper.

The field's significant questions are about the continuum from defining a problem, to triggering a response: from an initial idea in the internal world of the problem-solver to its externalization. Once discovery happens, how, is it captured, modeled, and externalized as a written down, calculated, drawn, or prototyped solution?

The envisioning and modeling explorations of Nicola Tesla and Leonardo da Vinci outwardly look very different. It was with great detail that Leonardo drew his inventions and expressed his ideas. Leonardo's drawing mastery and his notebooks were his lab and his first tries. The unified field between his internal imaginings and his sketchbook were a kind of matrix, a womb for his emerging ideas. On some pages we can almost follow his thoughts through the versions he refined in the drawings. For Tesla, the intense imaginings in his mind were his matrix; there, from an initial notion, he worked out the specific details and even tested them. His collaborators recorded that once Tesla tested an electro-motor that required eight hours of continuous running entirely in his mind. To save time, he ran the experiment at precisely double the speed, accelerating his imagined model and concentrating for four hours. Only when he was convinced about the validity of his imagined models—existing only in his mind—would he externalize and try those ideas with actual prototype materials. Making blueprints and drawings would slow him down and clog the flow of imagining and making. After testing his notions in his mind and confirming them with a working prototype, he probably delegated the technical drawing for patent and production to assistants. Like the pen and paper of Leonardo's notebooks, the tangible materials, coils, and wires in the initial prototype concluded his experiments.

The apparent "miraculousness" of both Leonardo's drawing ability and Tesla's precise imaginings are due in part to their developed mastery, which was, for Leonardo, the art of drawing, and for Tesla, directed visualization. Both men started to develop their skills as children, so that by the time they were teenagers, they were equipped to externalize ideas.

What made them persevere? What was the motivation, the charge, that kept them going?

Mastery and skill sets

The issue of mastery is a pivotal one in understanding the continuum of process from problem-solving impetus to a realized project. The author of this paper has engaged in a number projects over the last thirty years where creativity and problem-solving addressed some urban and societal problems. Over and over again, mastery came up as one of the key issues in forwarding or finding solutions from within communities.

There are never shortages of ideas, associations, and useful memories, but there is always a shortage of mastery. The three quotes below address issues of mastery. Two are from real-world projects carried out in Oakland, California from 1992 to 2004, and the third is from a book about brain science and mastery. They are all examples for possible discussion beyond this paper:

> Crisis of perseverance, as articulated by Slobodan Dan Paich and Artship initiative members, was a response to a local need addressing a contemporary problem, particularly among youth, of having no role models or witnessing a success through perseverance. Artists of all types are the embodiment of achievable mastery and the tangible experience of completion, hence the name "Artship," an exciting, ever changing campus surrounding hardcore training programs. (Fulton, 2002)
>
> When Hallie Williams—a founding member of Artship, its long time chair, and a juvenile probation officer in Oakland—and Slobodan Dan Paich worked at Juvenile Hall, it became clear that Slobodan's relative mastery of drawing and other arts helped the youth realize their ideas. The presence of a trained artist was essential. What we also discovered over and over again while we had the ship, was that bringing people to the ship itself accelerated the motivation in acquisition of skills and mastery better than when we went to their familiar environments. It seemed that the stationary ship—too old for transcontinental voyages and therefore stationary—brought people directly to their imaginative self. They were on, to use Stanislavki's term, an as if poetic journey. The connection to imagination seemed to feed their perseverance and attention. (Giunta, 2004)

Levitin, D. J. (2006) writes of mastery in his book, *This Is Your Brain On Music*, in the chapter titled, "What Makes a Musician"?:

> …Ten thousand hours of practice is required to achieve the level of mastery associated with being a word-class expert—in anything. In study after study, of composers, basketball players, fiction writers, ice skaters, concert pianists, chess players, master criminals, and what have you, this number comes up again and again. Ten thousand hours is roughly equivalent to three hours a day, or twenty hours a week, of practice over ten years. Of course, this doesn't address why some people don't seem to get anywhere when they practice, and why some people get more out of their practice sessions than others. But no one has yet found a case in which true world-class expertise was accomplished in less time. It seems that it takes the brain this long to assimilate all that it needs to know to achieve true mastery.

Levitin opens to us an appreciation and understanding of the expertise accomplished musicians or other artists have, and why a good one is rare and in demand. The same notion of mastery applies to scientists and inventors.

It also seems, in the case of artists and inventors, that two skills run parallel: one evident, and the other less so. The first is dexterity: the ability to manifest things and transform raw materials. The second is the associated level of containing an experience, sustaining interest through discomfort or boredom. As one ballet master explained to the author of this paper, "The pain caused by point shoes is transformed by good dancers into useful, masterful, will—through perseverance."

Aliveness of ideas, imagination, and arousal

The exploration of creativity from the problem-solving point of view is helped by the reality of the preconditions: a real-world issue and need, and, in the end, a measurable outcome. These concrete preconditions, if over-insisted upon, can obscure the elusive dimensions of an intense and internal series of events. After preparation and research comes a moment for a key idea to appear. Once the idea has risen out of the outer and inner unknown, it needs a form of life-force to propel it and sustain it. The idea's survival and generative life span depends on many factors. One element in the complexity of the creative process is the vital energy for the aliveness of the idea.

What is it that keeps an idea alive?

In the biology of procreation, arousal plays a crucial part. Something internal has to happen before the labor of union takes place. In the psychology of arousal, imagination plays a great and important part. Almost no culture, in the process of courtship, does not ad, subtract, change, or partly cover the body to enhance provocation, which aids the selection of partners for the successful continuation of the tribe. It may be of interest to speculate, without going into reductionist theories, that there could possibly be a correlation between engendering a progeny and giving birth to ideas.

The procreative or creative impulse triggered by the imagination and the outer stimulus is a source of vitality: aliveness. In order for the response to a problem—awakened as an idea—to survive and remain in the researcher's intellectual-emotional field, it needs some kind of neuro-procreative energy. This energy might link unknown parts of brain and cognition with other biological and environmental realities of the researcher.

As for the researcher who lives with ideas full of vitality, it takes a particular mastery of incubating to live with that intensity. That is why often, people engaged in bringing forth significant cultural contributions have idiosyncratic characteristics. Some are visible and manifest, whereas in others these characteristics are subtle. In case of Leonardo da Vinci and Nicola Tesla we can observe that both men had no families, but only collaborating assistants. The majority of their procreative fecundity manifested in work, sublimated into giving birth to ideas. The germ was the idea; the womb, the matrix, was the trained mind, the lab, the sketchbooks, the notebooks. This is not a requirement, it is an example.

Bach, a widower, was married twice, had five children, and lived in the cramped quarters of the kapellmeister, but at his instrument, he exhibited similar characteristics of mastery and vitality—his relationship to ideas was full of life-force. Not unlike Tesla testing his ideas internally, Bach most probably could play his fugues in his mind (as well as on the instrument) forward and backward, which made room for his welltempered inventions.

Preparing the field and gathering elements for research

As we follow some of the aspects of problem-solving as triggers of creativity, naturally, the significant part of the process is preparing the field and gathering elements for research. In this seemingly obvious accumulating data phase, laden with facts and findings, exists the paradox of an inadvertent creation of an empty space—a field for significant connections to happen. Calling it an empty space may not be accurate, as it is an internal activity of the brain. Perhaps it is only momentarily empty.

Maybe it is more a phenomenon of subjective timing than of an introspective space. Researchers have found that when people are losing memory, such as in cases of Alzheimer's, imagination comes in and the blanks are filled. This of course is devastating to the friends and family, as some unexpected and seemingly irrational connections are made. Every night, dreams offer these unexpected experiences to everyone. The moment we relax our rational guard or thinking habits, a compensatory flood of involuntary imagining comes in and fills our internal space. A natural process of all living beings, the imagination offers an experiential field with an infinite number of connections. In the case of problem solvers, this natural process is very helpful.

The German chemist, Kekulé, wrote about his discovery of the idea of the benzene ring:

> But it did not go well [the writing of his chemical text-book]; my spirit was occupied with other things. I turned the chair to the fireplace and sank into half-sleep. The atoms flitted before my eyes. Long rows variously, closely unite; all in movement; wriggling and turning like snakes. And see, what was that? One of the snakes seized its own tail and the image whirled scornfully before my eyes. As though from a flash of lightning I awoke. I occupied the rest of the night in working out the consequences of the hypothesis…Let us learn to dream, gentlemen. (Beveridge, 1950)

Cognitive modeling in art and science

Artists' maquettes, sketches, and tryouts have gained respectability as complete works since the establishment of the large scale museums, particularly in the nineteenth century. Paradoxically, the process of problem-solving has became almost invisible—because sketches have become viewed as finished products and not as developmental documents.

An example of modeling inspired both conceptually and physically was the process of the Spanish architect Antonio Gaudi. He would dip strings and weights into plaster and hang them between poles, creating natural curves pulled by gravity. Once the plaster set, he would invert them, against gravity, creating matrixes for his structures of never before seen beauty and freshness.

The late Renaissance astronomer Johannes Kepler relied on symbolic models prior to discovering his three Laws of Planetary Motion, which proved the centrality of the sun, and explained the elliptical motions of the planets. He steeped himself in Hermetic and neo-Platonic models of the universe and created fascinating original constructs and reinterpretations partly based on observations of planets and other astronomical phenomena.

Kepler also engaged in neo-Pythagorean experiments that compared musical harmonics to ratios of planetary orbits and the sun. These musical ratios helped him test his actual and conceptual models against observed phenomena. His discovery of the Laws of Planetary Motion completely contradicted his earlier Neo-Platonic hypothesis.

The veracity and the factual strength of this discovery gave him courage to calculate proofs and abandon the initial models, paving the way for modern science.

Kepler, in his Harmonicis Mundi, Book V, writes:

> It is now eighteen months since I got the first glimpse of light, three months since the dawn, very few days since the unveiled sun – most marvelous to gaze on – burst upon me…If you forgive me, I rejoice: If you are angry I can bear it. The die is cast, the book is written. It may well wait a century for a reader, as God has waited six thousand years for an observer.

Unexpected connections/discovery

In the complexities of the inner and outer world, the unexpected plays an important role. Often whole societies are structured to protect groups of people from the unexpected. But not all new things are threatening; the discovery of the wheel did not threaten the societies which found it—it improved them.

The French mathematician, Henri Poincaré, wrote on the solution of the problem of Fuchsian functions:

> Just as this time, I left Caen, where I was living, to go on a geologic course under the auspices of the School of Mines. The incidents of the travel made me forget my mathematical work. Having reached Coutances, we entered an omnibus to go to some place or other. At the moment when I put my foot on the step, the idea came to me without anything in my former thoughts seeming to have paved the way for it, that the transformations I had used were identical with those of non-Euclidean geometry. I did not verify this idea; I should not have had time, as, upon taking my seat in the omnibus, I went on with a conversation already commenced—but I felt a perfect certainty. On my return to Caen, for conscience's sake, I verified the result at my leisure. (Poincaré, 1913)

For an individual, the surprise of discovery always carries the quality of epiphany; it is a numinous experience. It can be potent enough to make Archimedes run naked in the streets of Syracuse, shouting "Eureka!" This quality of epiphany and the motivation to complete may have a direct relationship.

Motivation to complete

The field of psychology of motivation is vast and contradictory. Here, we only have room to invoke some contemporary research and thinking to pointing out the important trait of bringing forth results in the problem-solving process.

In his paper "The Emotions as a Culture-Common Framework of Motivational Experiences and Communicative Cues", Carroll E. Izard writes about motivation:

> The fundamental emotions are innate, universal phenomena…It has been proposed that the subjective culture is determined by innate and socio-cultural factors and by unique person-environment interactions. Since the emotions are considered to be man's principal motivation system and to be motivating, cue-producing experiences, they are viewed as the most fundamental and culture-common aspects of subjective culture and phenomenal field. (Izard, 1968)

The motivation to move from conception needs the life force to continue and complete. The desire to complete might have a direct relationship to a personal, deeply felt arousal by ideas. In this process, such arousal triggers problem-solving and a sense of meaning to inventors, researchers, or artists.

Artists and inventors have a particular relationship, skill set, and mastery for finalizing an idea to the point that it can be reproduced or appreciated by others—and these traits are particularly needed if their inventions or works are to bring new insights that do not yet have a container in the surrounding culture. Something has to sustain them in the loneliness of creating the new. Often, that which sustains them is the idea itself.

Perseverance patterns and their motivational charge also have an effect on the biological level. They exert some level of primal need and have relationship to the impulse for survival in the corpuscular, cellular, and liquid functions of the body—retaining equilibrium against environmental threats and changes—and also in the nervous system's ever-changing climate of moods. In this climate of the internal self, the psychological space of the problem solver is attuned to absorb the outer need for a solution into an incubating nexus of analysis, synthesis, arousal, and feelings. Perhaps the motivation to complete, this perseverance ability, is a possible key factor in the generation of ideas. There may be something of vitality, of procreative energy, which sustains artists, scientists, and inventors towards completion.

Max Planck, on the discovery of laws, writes:

> "Again and again the imaginary plan on which one attempts to build up order breaks down and then we must try another. Imaginative vision and faith in ultimate success are indispensable. The pure rationalist has no place here." (Beveridge, 1950)

Albert Einstein wrote on the discovery of laws:

> "There is no logical way to the discovery of these elemental laws. There is only the way of intuition, which is helped by a feeling for the order lying behind appearance." (Beveridge, 1950)

Cybernetics and Imagination

In this section, we include a segment of questions and answers from an ongoing dialogue between the author and Artship Foundation Board Member Dr. Paul Pangaro, Cybernetics practitioner, theorist, and proponent of Conversation Theory.

Q: From the point of view of Cybernetics, would you evaluate differently the processes and complexities in nature versus human-made, technological systems?

A: No. In cybernetics, all systems are seen in terms of information flows where sensing (feedback) and actions form a circular structure engaged in the environment, as the system strives to achieve its goals. However, cybernetics would also hold that "complexity" is a property of the observer, not the system under scrutiny. This is because the language used to describe an experience creates the degree of complexity (or order). (von Foerster, 1981)

Q: Can cybernetics explain, model 'imagination'?

A: Imagination is a special case of thinking and hence is subject to all the usual constraints: The nervous system is a “structured-determined system”, which means that all prior occurrences lead to the present structural state of the system, and hence to imagination. (Maturana, 1980)

Thinking is what observers call the natural action of the nervous system in creating order in its perceptions for the sake of survival. Language is part of the order-creating process. Imagination is that part of thinking that conjures what might be, rather than what has been (memory).

Q: What is the nature of 'involuntary imagining'?

A: From the perspective of an outsider, involuntary imagining is subject to randomness or happenstance, usually conceived as unpredictable neuronal behaviors, leading to images or concepts and potentially leading to new ideas; hence, a source of insight.

Q: And from the perspective internal to the nervous system?

A: As above, all that occurs can occur because of prior conditions that lead to the present structural state of the system.

Q: How would that relate to positions asserting a pre-existent pattern, like in Plato’s system of Archetypes?

A: If Plato meant “pre-existing in the evolution of the species”, I believe the positions would be consistent. This eliminates any invocation of the absolute or ideal, as well as soul, divinity, intuition, or action-at-a-distance, when explaining how new ideas arise. Perhaps when I close my eyes before sleep, I interpret the noise patterns in retina and brain as clouds and faces; perhaps when I dream, I imagine fantastical circumstances and actions that are new and impossible, but in all cases, they arise as a consequence of where I have arrived as a result of my living in the world up to this point.

As Heinz von Foerster pointed out, the nervous system can be structure-determined but still unpredictable. The complexity of the system is so great that no computer—even were it the size of the universe—could predict what anyone will think next.

Q: Do you have an example of this?

A: Consider our surprise in a wonderful conversation: 'Who could have predicted that fabulous idea would come out?' The answer is, no one. This applies to conversations across individual people, as well as internal conversations where we let our individual imagination 'take flight' and, involuntarily, we conceive new ideas. Involuntary imagining, yes, but sourced from my own imagination.

Q: In your opinion, what is imagination?

A: Just as we 'converse with ourselves' in an internal dialog, we can create an experience 'in our minds' that is not 'happening right now'. This can be remembering something in our past, or the conjuring of a future moment that is possible, or even the inventing of a creature that has never existed (dragons). In this last case, we are combining parts of what we already have available, into new combinations. Sometimes these combinations are novel and ‘interesting’.

Q: Where does creativity fit in?

A: We use the term 'creative' because something unexpected has come from nothing—well, not quite nothing, but, from what has come before, something novel and surprising arises. All ideas come from prior ideas, in some fashion. (If these were not the case, there might have been a Egyptian Dante, or a Sumarian Shakespeare; but we immediately sense how impossible that is.)

Q: How are some individuals 'more creative' than others?

A: As Linus Pauling said, 'It's important to have lots of ideas, and to keep the good ones.' As Gordon Pask has modeled in his 'conversation theory' conversations create points-of-view that are, structurally speaking, organizations whose success or failure is determined by their 'fitness to survive' in a milieu in which disturbances comprise competing viewpoints that may obliterate others, or cause their mutation. The individuals who, for whatever reason, are skilled at creating valuable ideas—ideas that are persistent and generative of new ideas—we call 'creative'. (Pask, 1976)

In Closing

From the careful positioning of many ancient buildings in the land, we can discern that ancient people made acute and inspired observations of the world. A Stone Age tally stick, a wolf's thigh bone incised with intentional increments, or prehistoric stones inscribed with the phases of the moon are all evidence of systematic observation. The earliest remnants of pottery or fragments of petrified baskets show a profound involvement with pattern and decoration.

Across history and cultures we can enjoy the diversity of the natural process of giving birth to ideas. The intention of this paper is to celebrate and open possible discussions about the individuality and universality of creativity in art and science, and to tentatively sketch out a chain reaction, a process: from a problem to a response—an initial idea in the internal world of the problem-solver, and its externalization as discovery or expression. In doing so, we hoped not only to reflect upon creativity but also to celebrate, paying homage to that indomitable human characteristic of imagining, and to represent imagination in art or science as a sentient, numinous flair of humanness.

Bibliography

Beveridge, William, I. B. *The Art of Scientific Investigation*. New York: Norton & Company, 1950. pp. 55, 56, 66.

von Foerster, Heinz. "Disorder/Order, Discovery or Invention". *Disorder and Order, Proceedings of the Stanford International Symposium. Ed.* Paisley Livingston. Saratoga: Anma, 1984.

Fulton, Orion. Baili, R. *Master Plan, Oak to Ninth Avenue Waterfront Development*, Oakland: Port of Oakland, 2002, p. 55.

Giunta, Frank. *Case Statement and Archives*; Oakland: Artship Foundation, 2004, p. 3.

Izard, Carroll. E. *The Emotions as a Culture-Common Framework of Motivational Experiences and Communicative Cues*. Nashville: Vanderbilt University Press, 1968.

Kepler, Johannes. *Harmonicis Mundi.* Prague: Book V, 1609.

Levitin, Daniel, J. *This Is Your Brain On Music.* New York: Plume 2006, p. 197.

Maturana, Humberto. and Varela, Francisco. *Autopoiesis and Cognition*. Boston: Boston Studies in the Philosophy of Science. Vol. 42,1980.

Pask, Gordon, A. *Conversation Theory: Applications in Education and Epistemology*. Amsterdam: Elsevier Publishing Co, 1976

Poincaré, Henri, J. *The Foundations of Science*, trans. G. B.Halsted. London: Science Press 1913, p. 36.

Slobodan Dan Paich is Director and Principal Researcher, Artship Foundation, San Francisco, USA.
