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Abstraction – the Essence of Innovation

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Abstract

Innovative thinking techniques, i.e., heuristics applied during problem solving, stir both subconscious thinking engines into action; our left- and right-brain hemispheres. However, these two engines use different protocols in viewing and analyzing the same problem simultaneously. One parses a problem logically, consciously rationalizing each step while expressing its progress in language – a more tedious process than that of its compliment. The other, which favors images to language, visualizes a problem situation holistically and proffers instantaneously intuitive solution concepts to the conscious. Both dredge the depths of memory searching meaningful, but different, associations with our past experience. One engine uses the preferred thinking of technologists. The other engine uses that of verbal and graphic artisans. Yet, both types of thinking are creative and problem solving.

This paper focuses on problem-solving heuristics commonly used by technologists and describes how these heuristics can be made to spark intuitive solution concepts through effective use of abstraction.

Keywords: heuristics, heuristic innovation, innovation, left-brain logic, problem solving, right-brain intuition, structured problem solving, unified structured inventive thinking.

1. Introduction

All problem-solving methodologies for invention or innovative thinking boil down to the essence of mentally-verbalized heuristics. The full power of these heuristics is hidden in abstraction. At issue in this paper is not the learning of new heuristics but the understanding of how heuristics work. Such understanding can help us to select the most useful heuristics to memorize. It can help also in creating new heuristics by understanding their essential properties. Most importantly, it can make us more efficient users of heuristics for innovative problem solving.

Heuristics are the thinking tools, learned and created, that can generate a new and pregnant view of a problem. Examples include "do it in reverse", "draw a simple diagram", "reduce a problem to one unwanted effect", "make one object do two functions", "draw a function diagram", "examine points of contact", and "separate conflicting functions in space and/or time". There are enumerable such heuristics. We learn them in school and on the job, and we create them from personal experience. But, what makes them work in an innovative-thinking way?

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When applying them, we verbalize heuristics consciously – a language effort that is the purview of one's left brain, which is dominated by trained logical reasoning. The following is an exercise in introspection. Please pay careful attention to your own thinking process. The issue is not whether you could have gotten the same ideas by a different route, but rather, are differences in logic and intuition evident in your problem solving efforts?

Underlying the essence of heuristics for problem solving are the tricks they play on our two brains.[1] By training, technologists are predominately left-brain thinkers who demand logical reasoning and loathe anything less. We are so captivated with our skills of rational reasoning that, unknowingly, we often disregard potentially creative insights passing through our minds. They may be easier to discredit, for lack of immediately evident rational, than to engage in serious effort to follow. This is evidence of conflicting thoughts from our two thinking engines using different protocols.

A dominant left brain, commanding the power of language, is able to preempt seemingly poetic interjections to problem solving that lack concrete rational. By understanding the preemptive vetting by the left brain, of right-brain's more metaphoric suggestions, we may discover surprising and fruitful insights to problems. But how can that happen? Shouldn't logic prevail? Yes, but new insight comes first followed later by constructive interpretations, then idea elaboration, testing of ideas, and finally culling of the less effective solutions. The process will be seen as a transition from the concreteness to abstraction and back to the concreteness. Key to innovative problem solving (i.e., invention) is creating new thought paths to follow for unusual insights.

The wealth of complimentary problem-solving resources offered by our two brains is illustrated in Figure 1. Left-brain verbalization operates consciously while right-brain intuition develops images subconsciously.

[1] For simplicity herein, our two brain hemispheres are referred to as left-brain and right-brain. Left-brain implies the center of language and logic while the right-brain refers to the center of metaphoric abstraction and holistic view (seeing the whole problem situation; i.e., without attention to detail – a left-brain function). In some individuals these functions are reversed between the two half brains.

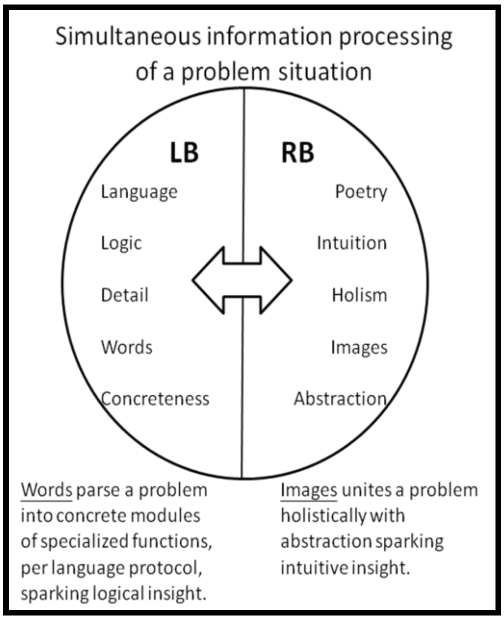

Figure 1. Complimentary problem-solving resources in our two brain hemispheres – left brain, LB, and right brain, RB (Edwards (1999), Levy-Agresti and Sperry (1968), and Sperry, et al. (1973))

Three aspects of heuristics are discussed: their make-up, application, and creation.

2. Targeted audience

The audience targeted for this paper consists of all types of technologists – those highly trained, accomplished problem solvers produced by modern education. Their skills enable thorough analysis of a problem situation. Such analysis sparks rational solution concepts with quick evaluation, and on-the-fly culling of thought paths deemed wasteful of resources. All of which is left-brain thinking. Obscured by this broad-stroke evaluation of technologists is the spottiness of their creativity and innovation as measured by awards, patents, professional envy, and often a sparsity of solution concepts offered in team-solving situations.

My first encounter with this shortcoming of innovative problem solving came in a large industrial company. A small group of engineers, who had conducted a survey of the success of corporate engineers in being awarded patents, discovered an unexpectedly small population of inventors. They approached me to sponsor a monthly luncheon to which young engineers would be invited to meet and discuss personal experiences with the hope of inspiring innovative thinking. This experiment led to development of a corporate, in-house program for teaching structured, inventive thinking. (Sickafus, 1997 and 1998)

3. Make-up of heuristics

Heuristics do not solve problems. Instead they aid the problem solver in creating thought paths that encounter new view points of a problem. Where do these insights lie?

It is taken axiomatically that technologists have adequate heuristics for left-brain thinking. Furthermore, they apply them with such fervor that they tend to squelch efforts of the right brain to solve the same problem. Hence, a potential source of new insight lies in our subconscious communication between the left and right brains. Both brains see the same problem at the same time, pose subconscious solution concepts, and share the information through the corpus callosum – the bundle of nerves joining the left and right brain hemispheres (see Figure 1).

Consider this example of a common heuristic. *"Do it in reverse."* We have said this to ourselves many times on a variety of problem-solving occasions. Of course, before we attempt to apply such a heuristic we will have carefully *constructed a well-defined problem*, which itself, is a heuristic for innovative thinking.

The first characteristic of "do it in reverse" is its simplicity, and the second is its lack of specifics. It is a very abstract statement. This gives a heuristic appeal for memorization and breadth in application. More importantly, it does not constrain the right brain with explicit problem detail. But what does it mean? A specific way of stating this heuristic is "*start with the answer and work back to the problem*".

The process of parsing this statement sets our minds onto new thought paths.

"Do" => (implies) take or modify an action.

"it" => an object or attribute in the problem or in our analysis of the problem.

"in reverse" => a counter intuitive directionality (including process and function).

As the parsing process unfolds, get-the-job-done-type rational thinkers may find themselves out smarted by the abstractionist-type thinkers. Consider these two plausible thinking processes in the following.

4. Application of heuristics

A common approach in structured problem solving is to describe a problem situation and then extract from that description a well defined problem. To this, heuristics are applied for analyzing the problem and then other heuristics for finding solution concepts. The process is then iterated as needed (Figure 2).

In a structured problem-solving process such as heuristic innovation (Sickafus (2006) much attention is given to how heuristics work and how to apply them for creating new thought paths to solution concepts. Emphasis is placed on throttling of left-brain dominance to allow right-brain ideas to be examined. A brief and simple example follows, which is scalable to all size problems of innovative thinking.

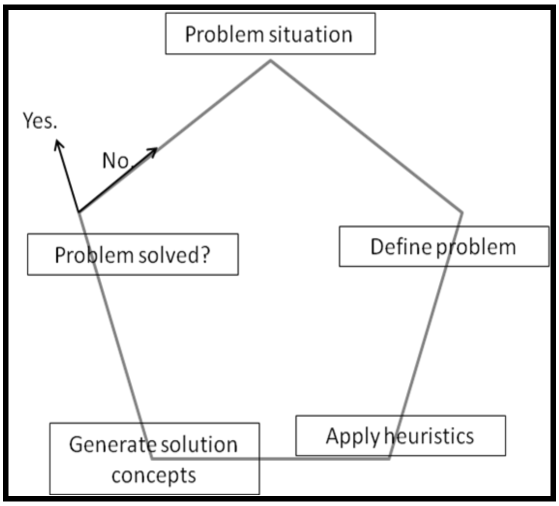

Figure 2. A typical structured problem-solving flow chart

Example of logical-to-intuitive thinking

As an example of emphasizing intuitive thinking at the expense of logic consider this useful classroom demonstration exercise. When told to invent something a class usually is unresponsive. No one knows where to start.

How to start (logic):

> "Pick an object, any object. However, for the limited time of this class, select an object that everyone present can reasonably be expected to understand its function and construction. Now invent a better one!"

Again, the class may be unresponsive. Selecting an object usually goes quickly enough, but 'inventing a better one' gives pause – where to start?

The real power in this exercise is daring one's self to instantly take on any object and subject it to innovative thinking. In order to turn it into a problem, make up a list of things it doesn't do.

An often selected object is a pencil or a pen. I'll select a generic pen for this demonstration. To gain the full value of this exercise thinking needs to be spontaneous, not practiced. I have seen many solutions to this problem from former class exercises. I'll attempt to set out on a fresh path.

"Everyone in this classroom is a technologist of some brand and certification. Hence, brainstorming this problem is a straightforward logical process that we are all familiar with. However, this exercise will attempt to invent a new pen using a mix of logic and intuition, with emphasis on the latter." (A period of brainstorming is now used to 'pick the low-hanging fruit'. Heuristic innovation follows.)

Our first step toward encouraging intuitive thinking is to generify the object. I'll call it a writing implement. 'Pen' and 'pencil' are already implanted in our subconscious. Now we have added 'writing implement'. To invent a better one we need to know what's 'wrong' with it. We can think of that question generically by wondering what does it not do? As will be seen, this question opens the door to innovation.

First establish what the implement does but in generic (or abstract) terms. For example, 'it physically couples a user to a surface on which marks are to be made'. That's its function. Attributes are needed to enable a function. (Sickafus, 1997)

What attributes are active in this situation? *Mass* and *shape* enable the user to grasp and move the implement. Its surface *texture* gives comfort. Its visible *rendering* gives esthetic pleasure in style. It has *capacity* to carry a supply of marking medium. It is pressure *sensitive* and dispenses marking medium on demand by modulating the rate of dispensing medium according to pressure applied.

All of the attributes identified offer logical thinking paths for discovering incremental improvements in a writing implement (resulting from specific focus on concrete attributes). To encourage innovative thinking consider the things a marking implement, that you are familiar with, does not do. No limits are placed on this phase and intuitive ideas yet to be rationalized are allowed. Surprising turns can be expected along any such thinking path.

A possible starting place is the '*point-of-contact* between the user and the implement' – to be thought of as two generic objects. What attributes of these objects might exist at this contact that are not now active? No odor is emitted that could activate one's sense of smell. No flavor is offered to activate a sense of taste. No sound is made to activate hearing. No vibration is made to activate tactile feedback. No light is emitted to activate retinal neurons. The first half of the last five sentences came to mind intuitively (instantly), the last half was motivated by a need of rational, requiring a moment of thought. One could continue this list but we need only to establish the fundamentals here.

An idea that comes to mind now is to look at these five attribute connections from user to implement in a metaphorical sense – moving from concreteness to abstraction. Metaphorically connecting an attribute to a particular human sense is a form of creating or passing information (in personal feedback or to other users of information). This is more of an intuitive jump, from the attributes of an implement, than a logical one if it occurs spontaneously.

Each new word introduced offers a thought path to innovation (Figure 3). Let's try it. (Probably you unconsciously have already investigated a few.) We now move from abstraction back to concreteness.

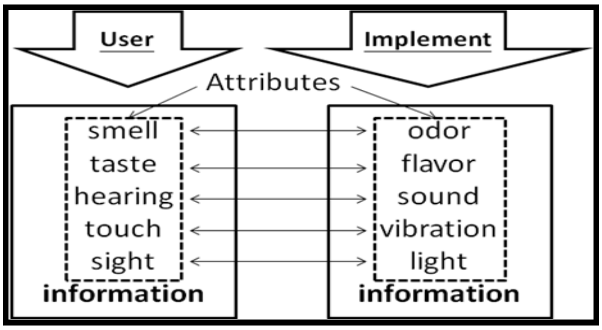

Figure 3. Coupling of two objects at their point of contact, user and implement, via attribute pairs to generate information

How can odor, coupled to smell, lead to innovative creation of information in a marking implement? This question immediately triggers logical brainstorming. These ideas came to mind:

(1) Distinguishing foods for appropriate price marking.
(2) Identifying freshness for dating life of food.
(3) Identifying flora for cataloging. (Notice how an initial idea leads to generic variations on the same theme.)

At this stage in innovative thinking no attempt is made to engineer or critique an idea. Such filtering comes after proof-of-concept engineering. This is the pre-engineering stage of thinking, even the earliest, least developed inkling of a solution-concept stage.

An implement that couples taste and danger warning.

(1) Taste sensors in an implement could identify degree of toxicity for labeling.

An implement that couples sound to hearing:

(1) An automotive instrument-panel button that identifies its function in voice when touched, thus not requiring the driver to take eyes off of the road.

An implement that couples touch and vibration:

(1) A proximity sensor in a walking cane could cause the cane to vibrate with intensity to indicate proximity, and modulation to indicate direction. This would eliminate the need to wave the cane about and thus enable more natural walking.

An implement that couples sight and light:

(1) A narrow beam shining across a page to guide and speed one's reading as the implement (and its beam) is moved along a page.

Generification and metaphorical thinking have different effects on people's brains. To generify leads me to group concepts by functional or technical hierarchy. Whereas using metaphor leads me to poetic type of abstraction. The former is left-brain thinking (logic) while the latter is right-brain thinking (intuition). Their effectual difference, in my thinking, is evidenced by instantaneous and subconscious reaction (intuition) versus deliberated and conscious reaction (logic). As trained technologists we do deliberation well, but we could benefit in search of new insights with some rapid, innovative, right-brain ideas.

5. Creation of heuristics

Heuristics that we create ourselves and test in our own professional environment are quickly adopted into our subconscious. They are reliable. We create these by introspection during and following problem-solving exercises. However, they can be made the more potent by designing them to throttle the left brain while freeing the right brain for recognition of its creativity.

The most important aspect of a heuristic that throttles one brain and frees the other is abstraction. Recall, "do it in reverse". Second in importance is awareness of left-brain's constant vetting of non-rational intuitive insights, and therefore practice is needed in freeing the resources of one's right brain.

6. Conclusion

The practice of structured problem-solving with application of heuristics can be made more broadly applicable and effective through abstraction that encourages use of right-brain resources. This does not replace conventional brainstorming. Rather, it is a potent alternative to turn to after the productivity of brainstorming has waned. Where conventional problem definitions are precise in their verbal and graphic descriptions – fodder of the logical left brain – innovative verbal and graphic descriptions are generic and abstract – fodder for right-brain intuition.

Obviously, both brain hemispheres work in our subsconscious, share information, and then raise ideas to our conscious level of thinking. We readily accept that heuristics applied logically create successful brainstorming with evident cause and effect connections. However, it is more difficult to give attention to instantaneous intuition that has no immediately obvious logical associations and no language with which to plead its case. The conscious practice of abstraction in structured problem-solving gives the left brain pause to withhold critique and evaluate new results.

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