U-SIT And Think News Letter - 75

Unified **S**tructured **I**nventive **T**hinking is a problem-solving methodology for creating unconventional perspectives of a problem, and discovering innovative solution concepts, when conventional methodology has waned. **H**euristic **I**nnovation is an extension of **USIT**.

Subject Keys

PD = Problem definition

H = **Heuristics**

T = **Theory**

M = Metaphors

A = Analysis

BH = Brain hemispheres

EX = **Examples**

Dear Readers:

. Nice inquiries about my health and whereabouts have prompted this quick mini-lecture.

. Excuse for my absence? Too much travel (and more coming in the next weeks) plus time spent beginning work on an upcoming brief series on reinvention.

. People who have registered for these newsletters since the last one appeared may be wondering if they were too late. I hope not, and I hope this one will serve to fill the gap until the next one.

Mini USIT Lecture – 75

Conceptual Solutions

Conceptual solutions for real-world Problems

In a recent discussion with a college mathematics professor, who had inquired about USIT, I was asked to explain what is a conceptual solution to a real-world problem. I first explained how a real-world problem is reduced to a conceptual problem and gave an example. Then I explained that the goal of applying USIT tools is to find multiple solution concepts as quickly as possible. This led to describing an example problem. That discussion is the basis of this mini-lecture.

A real-world problem

A real-world problem statement is cast first into a single unwanted effect and then worded in terms of objects, attributes, and functions. This produces a well-defined problem *a la* USIT. Solution ideas often come to mind in this process – it's unavoidable for inquisitive problem solvers. However, the problem statement, at this stage, needs simplification and balance to engage effectively both brain hemispheres in the ensuing creative thinking process. This is achieved by reducing the problem statement to a conceptual problem.

It may appear that the next steps remove any engineering from a problem. In a sense they do; they put the problem into its pre-engineering phase – we can't engineer a solution until we have generated a concept for it. The first steps are designed to produce a minimal set of information with which to spark rapidly both intuitive and logical thinking – right-brain and left-brain traits.

A conceptual problem

A conceptual problem is produced from a well-defined real-world problem in several steps (in no particular order). New thought paths are created at each step of the way.

Conceptualizing a real-world problem involves applying the heuristic called

SIMPLIFICATION entailing …

- elimination of all metrics (numbers, dimensions, and other specifics); though needed for engineering, they are too limiting to innovative thinking,
- minimization of the number of objects (try two for starters),
- generification of object, attribute, and function names to spark new thought paths – ambiguity is key to sparking intuition,
- construction of a graphic description (a simple sketch) that makes evident points of contact between objects where functions can be imagined to exist, and
- description of functions as the interaction of two objects in contact that enables an attribute from each to interact, thus supporting a function.

Conceptual solutions resolve an unwanted effect in one of three ways …

- Utilization – finding ways to convert the unwanted effect into a useful function,
- Nullification – applying a new function that cancels the unwanted effect, and
- Elimination – breaking the supporting object-attribute structure so as to eliminate the unwanted effect.

The USIT process of finding conceptual solutions involves iteration of all the above (including rewording of the problem definition) in whatever sequence comes to mind.

High school students can be introduced to this process as a game using a set of rules for rapid innovation, with any number of players, from one to a team.

Rules for playing “U-SIT and Think”:

- only a single unwanted effect is allowed in the problem statement;
- no filtering (rejection) of any proffered concept is allowed.

A test case

The above description of a conceptual problem and conceptual solutions may sound rather simple, but it often surprises the uninitiated when first they try to apply their understanding of these ‘simple’ ideas. In the case of the conversation with the mathematician, he pressed me for an example to show how these ideas come into play. Specifically, he was most concerned with my definition of a conceptual solution and my defense of its relevance in the real world. Given that I was talking with a mathematician, not an engineer, and one with many early years of experience teaching high school mathematics, I described a geometry problem as (fortunately) my intuition quickly assembled it.

“How can you divide a round cake into three equal parts?”

Here is how (I like to think) the discussion went.

The round cake example

Ed: *“I’m sure you were already searching solutions as you heard me speaking the words of the problem statement. That’s how our technically trained, inquisitive, problem-solving minds work. We are quick to search intuitive solutions (a right-brain trait).”*

Mathematician: *“Yes, I was.”*

E: “*Go right ahead, and while you’re thinking about it I’ll describe what I think a typical student might be thinking on hearing the problem. In this case, I’ll assume that this ‘typical’ student is a bit advanced and has had a class in geometry and beginning calculus.”*

M: “*OK. Actually, now days, many high schools offer geometry and calculus in an integrated fashion.”*

E: “*I chose trisecting a round cake as a real-world problem in contrast with an ideal mathematical problem. We were taught in high school, while we were learning how to prove theorems using a compass and a straight edge, that you can’t trisect an angle using just these two tools. Knowing that could stymie some students at the start of the problem – hence the cake was introduced.*

The student has probably already recognized a circle as an angle subtending any integer multiple of 360^o.

Obviously, in the real world of cake cutting, mathematical precision of dividing an angle is not the goal. But the job must be done to the satisfaction of the recipients of the thirds of the cake. This contrast probably gave a moment’s pause to recognize that mathematical analysis is not real world, in an engineering sense, because of the contrast in reasonable precision.”

☼ M: *“Well, you didn’t mention any tool limitations, so I just inserted the knife at the approximate center of the cake and made three radial cuts from there – as best I could judge.”*

E: “*Excellent start! You have offered our first concept. At this point we don’t worry about its practicality or hidden problems it may create. Those issues are addressed at the end of the exercise. Now let’s go for more concepts. Since we’ve studied geometry and calculus let’s use these mental tools. Actually, my calling them to attention is unnecessary, with our backgrounds this type of thinking comes automatically.*

I have one caution to offer, however. In your explanation of your concept you introduced a new object, a knife. Adding unnecessary objects can have a negative subconscious effect in subsequent thinking. It may inadvertently limit one’s thought paths. Notice that the problem only said to divide the cake. Cutting it was not mentioned. Engineering the concept of dividing may involve cutting – and it may not! (There’s a thought path.)”

M: “*You mean, we’re going to trisect an angle?”*

E: “*No, that was your first concept. Now let’s look for others.*

As you are aware, no limitations were specified in the problem, such as tools and precision. This kind of problem, one having minimal information, is ripe for all kinds of innovative solution concepts – our thinking is not hindered with constraints. Hence, simplification, among other heuristics, is a ploy for engaging both intuition and logic (i.e., right-brain and left-brain thinking).”

M: “*What do you mean by heuristic?”*

E: “*As you’ve already guessed, it is any thinking tool you apply in problem solving.”*

M: “*Mathematicians may like this kind of problem but usually students complain because there is not enough information given.”*

E: “*I see that complaint as a basis for distinguishing crank-turning-type of problem solving from innovative-type of problem solving. In the latter, minimal information forces you to make rational assumptions and find where they lead you, which is creative thinking.”*

M: “*I’m not being critical. But I am waiting to see how this example turns out.”*

☼ E: “*Here’s a solution concept that comes to mind. Construct a chord that divides the area of the circle into a 1/3 section and a 2/3 section. We can use mathematics to find where it should lie. Then erect a perpendicular to the chord to bisect the 2/3’s section – all pleasingly mathematical. And notice that our first two concepts have mathematical origins but we did not actually apply any equations or numbers. These are conceptual solutions to a conceptual problem using conceptual mathematics. Engineering comes later.”*

☼ M: “*Okay. If you can do that, I can simply draw another chord of equal length parallel to the first. This must necessarily produce three equal parts.”*

E: “*Now we’re making progress.”*

☼ *Here’s another idea: Find two chords of equal length, joined at one end to from the letter ‘V’, and placed so as to produce three equal areas.”*

☼ M: “*How about this? Make two concentric circles forming two circular rings and a central circle, all of equal area.”*

☼ E: “*That makes me think of making two circles of equal area within the given one such that the remainder, the area exterior to the two circles, has the same area as one of the two circles.”*

☼ M: “*If you can do that, I can make any two shapes, not necessarily of the same kind, but of equal area, that leave a remainder of equal area!”*

E: “*Bingo! Your idea adds an infinite number of solution concepts and we haven’t searched all thought paths!”*

M: “*When we get to an infinite number of solutions, what’s the point of hunting more?”*

E: “*Our USIT goal is to find as many different solution concepts a possible. Because we have disallowed filtering we don’t know which, if any, of these ideas will pass whatever set of filters may be applied later. Furthermore, in the real world, management wants options.”*

M: “*So what solution paths have we not searched?”*

E: “*At this point we can readily recognize that from the beginning we made a very limiting assumption that seems now to have slowed our search of new concepts. We assumed that we could approximate the round cake as a two-dimensional circle. This was good as a first mathematical approximation to our real-world problem. But now we need to recognize the assumption and relax it’s constraint. So, how do we divide a round, three-dimensional cake into three equal parts?”*

☼ M: “*I like this turn in thinking. And an immediate solution comes to mind: have a three-layer cake which is already divided. We simply serve each recipient a single layer. But, wait a minute. That presents a problem of serving unequal amounts of icing. I see a possible squabble arising.”*

☼ E: "*Right! And wrong!*
Right – for dividing the cake by two equally spaced planes perpendicular to the symmetry axis of the cake as a solution concept.
Wrong – for introducing a squabble over icing. First, that violates the rule against filtering. Second, no icing was mentioned in the problem!"

M: "*Okay, but do I get partial credit?* ☺*"*

☼ E: *"Now your parallel planes intersecting the cake's symmetry axis leads to more thought paths. For one idea we can tilt the parallel planes relative to the cake's axis and space them to produce equal volume sections."*

M: "*This can go on for some time. I get the idea of solution concepts and I see the value of simplification and disallowing filtering. But when and how do we deal with filters?*

E: "*That's a good question. But I'd like to make a couple of observations about the value of conceptual problems before I answer that.*

I find conceptualization of real-world problems to be a powerful tool for encouraging new views of a problem, especially when you continuously iterate the process. For example, if we iterate again the problem definition of trisecting a cake we may discover more opportunities for new thought paths.

When this problem first came to my mind I thought of cake as an edible object. But cake is a generic word in that it has multiple applications. I also thought of it as a solid, at least a soft one. And I thought of round as describing a circle, but that too may be a restrictive assumption. It then occurred to me that cake would not necessarily have to be already cooked. We could refer to the set of ingredients ready to be cooked as a cake. All of these variations on the problem offer new thought paths.

One other note is that USIT encompasses a variety of other thinking tools which together bring many encounters with new ideas for real-world problem solving. Here's just one example. The heuristic of taking things to extremes can have you dividing the cake into molecules, for example, before trisecting it.

Now I'll get back to your question about filters.

Where filtering starts is where USIT ends and we make our transition back in to the real world, so to speak. Understand that USIT is a problem-solving methodology originally designed for use in engineering. Actually I introduced it first into the automotive industry while I was manager of the Physics Department in the Research Laboratory of Ford Motor Company. I won't go into the details of that history except to use its environment to make it easier to understand filters and why they must be set aside until this transition phase is reached.

We must eliminate filters as unnecessary interference with innovative thinking. They are red herrings that introduce other problems before we have solved the first one.

Concern that a new concept may introduce new problems is merely a filter. We have the tools for problem solving so we simply address the 'potential' problems using the same tools – but we do it in proper time, namely, later!

Industrial engineers sometimes refer to solving job-stopping problems, that arise suddenly without warning, as fire fighting. These are urgent situations requiring rapid analysis, multiple options (solution concepts), identification first of a temporary fix (that may be expensive), and then of a long-term fix. In *this real-world environment filters address many issues, such as timing, window of opportunity, resources, manufacturability, reliability, safety, environmental impact, and many more. Furthermore, filters can change such that what may have been acceptable in the past is not acceptable now. So, once solution concepts have been found, filtering becomes a real-world issue that can involve engineering, quality control, reliability, management, and other corporate groups. USIT was developed to address the problem of how to get fire-fighting teams into a rapid and flexible mode of effective, innovative problem solving."*

The discussion ended with an invitation to present this topic at the next local mathematics teachers conference.

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I wish you each a very happy ending of the year with pleasant expectations for the next.
Ed Sickafus

Other Interests

1. Have a look at the USIT textbook, "Unified Structured Inventive Thinking – How to Invent", details may be found at the Ntelleck website: www.u-sit.net
2. See also "Heuristic Innovation", and register for multiple resources.

Publications	Language	Translators	Available at …
1. Textbook: Unified Structured Inventive Thinking – How to Invent	English	Ed Sickafus (author)	www.u-sit.net
2. eBook: Unified Structured Inventive Thinking – an Overview	English	Ed Sickafus (author)	www.u-sit.net
	Japanese	Keishi Kawamo, Shigeomi Koshimizu and Toru Nakagawa	www.osaka-gu.ac.jp/php/nakagawa/TRIZ/
	Korean	Yong-Taek Park	www.ktriza.com/www/usit/register_form.htm
"Pensamiento Inventivo Estructurado Unificado – Una Apreciación Global"	Spanish	Juan Carlos Nishiyama y Carlos Eduardo Requena	www.u-sit.net
3. eBook "Heuristic Innovation – Engaging both brain hemispheres in rapidly solving technical problems for multiple solution concepts"	English	Ed Sickafus (author)	www.u-sit.net
4. U-SIT and Think Newsletter	English	Ed Sickafus (Editor)	www.u-sit.net
	Japanese	Toru Nakagawa and Hideaki Kosha	www.osaka-gu.ac.jp/php/nakagawa/TRIZ/
	Korean	Yong-Taek Park	www.ktriza.com.
Mini-lectures from NL_01 through NL_67	Spanish	Juan Carlos Nishiyama y Carlos Eduardo Requena	www.u-sit.net click on Registration

Please send your feedback and suggestions to Ntelleck@u-sit.net and visit www.u-sit.net

To be creative, U-SIT and think.