U-SIT And Think News Letter - 76

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** with continued simplification.

Subject Keys

PD = **Problem definition**
H = **Heuristics**
T = **Theory**
M = **Metaphors**
A = Analysis
BH = Brain hemispheres
EX = **Examples**

Dear Readers:

. This newsletter opens with remarks very apropos of the conversation with a mathematician in the last newsletter.

. A synopsis is given of a demonstration lecture on USIT presented to three groups of high school students at the monthly High School Science and Technology Program.

Mini USIT Lecture – 76

Conceptual Solutions Demonstration

Continuation of **Conceptual solutions for real-world Problems**

Response from Belgium

Michel Lecoq (Belgium) sent an interesting letter in response to the last newsletter's discussion with a mathematician concerning conceptual solutions for real-world problems. He very politely reminded me that there is an angle that can be trisected (2π)!

He wrote:

> It is always difficult to define the problem to be solved. Between the most generic – trisect an angle, -- and the most specific – divide a cake into 3 parts (having the same volume, weight, etc.) -- there is an infinity of problems
>
> A mathematician should have gone to a little less generic problem: for example, *'divide a circle in 3 parts having the same surface area'*.
>
> Once in front of a circle it is not difficult to find the center (intersection of the perpendiculars (orthogonal) in the middle of 2 chords [In French "mediatrice" for "perpendicular bisector"]). Having the center, we find the radius, which we put as a chord on the circumference and going from point to point we have divided the circle into exactly 6 parts. Noticing (for a mathematician) that 1/3 = 2/6 we can divide the circle into 3 equal-surface and equal-shape parts. By (unconsciously) having given the constraint "equal shape", the solution has been facilitated.

> When solving technical problems, I always give a lot of time to evaluate "what to solve". Sometimes, the problem is simplified to ease the solution, but sometimes you have to add some constrains to simplify. On the other end a very specific problem is *'divide a cake into 3 parts having the same ingredients'*. Some species (some birds) would even eat the cake and vomit it in equal parts for their "children"

A USIT demonstration for high school students

At a recent High School Science and Technology Program held at the Ford Research and Innovation Center I had the privilege of giving a 32 minute lecture on Creative Problem Solving. What -- you may wonder – can be accomplished in 32 minutes? My goal was to present a brief introduction to USIT, give a partially complete example, and then launch a class participation exercise in invention. Twenty-two minutes were allotted for the lecture and 10 for class participation. A url to access the PowerPoint presentation is attached (its free).

First, a word about how the HSSTP program works. Students from Detroit high schools who are interested in or taking science classes are invited to a Saturday morning program once per month during the school season. Each program lasts 2 ½ hours and includes three or more types of events: these include, at least, a lecture, a hands-on exercise, and a laboratory demonstration (with breaks for refreshments, of course). It's sort of a three-ring circus with three events going on in parallel and repeated three times in a morning's session. As you can guess, the student's level of understanding, their breadth and depth of interest, and the uniformity of their skills in the fundamentals of science are quite varied.

With these boundary conditions, preparing a presentation on creative problem solving using USIT was a challenge. I decided to try to get the students to see some interesting things about the mental process of problem solving, to see the role of a structured methodology for making progress after brainstorming, and to see how we can consciously seed both brains for generating solution concepts. The unifying element in this presentation was the use of metaphors – both verbal and graphic. The opening slide had a pair of such metaphors next to the title of the lecture.

I began with an admittedly circular explanation of what creative problem solving means. This was an intentional dodge from (an anticipated student expectation of) rigor to assuage their probable nervousness after just hearing that they would be participating in applying what I would be lecturing on. The ambience, the name of the building, and the depth of technical knowledge represented by the staff members they were meeting can be a bit intimidating to some high school students.

Objects, attributes, and an unwanted effect were defined and their role in a well-defined problem statement demonstrated. A problem situation was illustrated first: "My tire went flat, and the spokes are bent, and it won't run straight, and how am I going to get to band practice on time? (And what'll I tell my mom?)" This illustrated an ill-defined problem. The rules for a well-defined problem were then explained and a well-defined problem was created. "My tire went flat. It has a slit in the side wall that let the inner tube poke through and burst letting the air out and causing the tire to collapse because the inner tube provided no support." A graphic for the problem was included (see the presentation slides).

"Now," I said, "we're ready to apply heuristics – thinking aids – that lead us to finding fruitful thinking paths to investigate." <u>Simplify</u> and <u>iterate</u> were illustrated first as important heuristics for creative thinking.

To illustrate the simplify heuristic I used a variation of a puzzle given several years ago by the Click and Clack brothers on their Saturday morning PBS radio program*. It goes like this: A long hall has 10,000 electric lights all turned on. A person is sent down the hall and asked to turn off every other light. One by one he pulls the chains of #1, #3, #5, and so on. Then a second person is given the same task of pulling the chain to turn off every other light. She pulls the chains of #2, #6, #10, and so forth. Then a third, a fourth, a fifth person, and so on, continue the procedure until all of the lights are turned off. How many people are required to turn off all of the lights?

Of course, this problem is much too large to get one's brain around. So we simplify it. The redundancy of lights suggests to minimize the number. So I suggested to try one. In this case the problem is trivial. It takes one person. What about two lights? It takes two people. And three lights? Hmm, look at that, it takes two people again! Doesn't look too promising does it? We'd hope to see a pattern forming. Well there surely is one to be found but it obviously isn't going to be a simple arithmetic progression.

Now the problem becomes finding a way to search for a pattern. A spreadsheet is an ideal approach. Label columns by light number and rows by person number and then proceed to check the boxes for the lights each person turns off. At this point, I apologized to the students for the level of mathematics I was leading them into. But first I pointed out that the spread sheet works and a person acquainted with spread sheets can attack this problem directly.

But this is where the beauty of mathematics becomes apparent. By starting with the spread sheet one begins to see a pattern, of sorts, forming after some rows of the table have been laid out for a few dozen lights. This presents an opportunity to set the spread sheet aside and play with expressions for a mathematical series that can predict the remaining pattern. "I know you have not had this type of mathematics yet, but I want to assure you that it's easy to learn and fun to apply. I encourage you to look forward to learning such powerful methodology in your future courses. The power of such a series is that it is predictive for any number of lights, even for so many that there aren't enough people in the world to turn them all off!" (6,774,025,729 people – estimated world population for 1 January 2008 – could turn off $4.588742458 \times 10^{19}$ lights. This is a side remark not used in the class.)

From here we moved to the class exercise in invention. The exercise was presented as a need to invent a better picture-hanging kit; better than the current one our company sells, which consist of a nail, two screw eyes, and a string. Several possible unwanted effects were suggested and one selected (by me to save time): 'picture becomes crooked'.

The value of this exercise, to my way of thinking, is for the students to see how easily they begin to brainstorm and how readily they become trapped in that mode of thinking and can't get out of it. Given the short time we had for this exercise it was necessary to let them brainstorm for only a few minutes and then introduce another heuristic to illustrate how to create thinking paths. Here I discussed how a point of contact between two objects is the location of one or more functions. So find a contact containing the problem and start there by identifying attributes of the two objects that support the unwanted effect. Next create metaphors for describing what is happening here and see what your brains discover.

To start this line of reasoning, I suggested looking at the wall-to-nail contact, then the nail-to string, then string-to-screw eye, and finally the screw eye-to-frame contact. The consecutive line of supports was obvious, and allowed emphasizing that we want un-common observations; e.g., not the usual engineering force diagrams that every technologist can see. If this happens, look for other functions at a contact.

When we analyzed the nail-to-string contact, it was evident, after some discussion, that this contact had to two functions; to support the load presented by the string to the nail, and, once the string is hung on the nail, to allow it to slip while the frame is aligned. Now we had an entry to a new line of thinking, which introduced another heuristic: namely, to combine functions and (sometimes) eliminate an object.

The ideas generated in the three classes are listed below – note the level of literal brainstorming: i.e., little use of metaphors in the form of generic names.

Student results:

1st Class	1. stronger string
	2. rough nail so string doesn't slide
	3. add clamp to hold string in place
	4. a rough and a smooth section on the nail
	5. incorporate a leveler

2nd Class	1. glue frame to wall
	2. use a sliding track
	3. eliminate wall, set frame on floor
	4. paint the picture on the wall eliminating the hanging kit
	5. hold frame in place with sticky putty
	6. have 'little brother' hold it up all day
	7. tape frame to wall
	8. use a sticky tack
	9. nail string to wall
	10. wrap string on nail
	11. mount screw eyes on wall with eyes horizontal and protruding into a slot in the frame
	12. tape string to wall
	13. put nail through string (to fix it)
	14. notch the nail to hold the string
	15. nail frame to wall

3rd Class	1. use a hook on the wall
	2. add hook to the bottom of the frame
	3. use adhesive (on back of frame)
	4. use clear tape to tape frame to wall (allowing use of front of frame)
	5. put hook at the center
	6. set frame in a niche in wall
	7. prop frame against wall on the floor (from using an infinitely long string)
	8. use a shelf
	9. eliminate frame; tape picture to wall
	10. hold picture

What is seen in these class offerings is common brainstorming that captures the low hanging fruit. You also see some humor being interjected as students begin to test me to see what I will write on the overhead projector. With encouragement, they could begin to see object names as metaphors and find new metaphors for functions (note the 'clamp'). Unfortunately, time was too short for them to experience this in depth. Nonetheless, student feedback about the experience was positive. And only one student was seen napping.

Was this an effective experiment? Who knows? With students this age we plant intellectual seeds and pray for rain.

(*The original Click and Clack brother's problem was discussed in the U-SIT and Think Newsletter – 53 issue in December, 2005. It begins with 20,000 pull-chain lights all turned off. The first person pulls every chain; #2 pulls every other chain, #3 pulls every third chain, while #n pulls every n^{th} chain. The question is, after the 20000^{th} person pulls the last chain how many lights are still on?)

This PowerPoint presentation is available at **www.u-sit.net/HSSTP_Lctr_08Feb.pdf**

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", which further simplifies USIT.

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

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To be creative, U-SIT and think.