U-SIT And Think News Letter - 71

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**

Dear Readers:

. "Two Brains are Better", a short series on using both cognitive hemispheres as tools for innovation, is continued in this issue of the newsletter. Feedback has been very favorable. Some people worked the problem. One didn't because he already knew the answer, having heard the problem as a joke. He was quite surprised on reading the rest of the material to learn that the 'joke' was a legitimate problem.

Mini USIT Lecture – 71

Two Brains Are Better – II

Did you catch it?

In the closing of the last mini-lecture a rather questionable assertion was made:
" *Furthermore, that the answer "1" and its rationale, "hearing birds flew away", were spontaneous, having no obvious dependence on logic, is an example of spontaneous intuition solving a problem independently of the logical hemisphere.*" The point being made was the spontaneity of finding the answer and its rationale. But it included the assertion that the discovery did not involve the logical hemisphere. However, on examination the assertion may raise questions about being independent of the logical hemisphere, since the rationale is logical. It is logical to assume that hearing birds would be frightened away. And it is logical to assume that the logical hemisphere had some role in this assertion.

Mental quandary such as this is created when we toy with trying to rationalize the "unseen" actions of the intuitive hemisphere. Rationalization is the work of the logical hemisphere. It is brought into play after the fact; i.e., after the spontaneous appearance of an idea. Hence, the assertion of independence refers to the instant of discovery not to later description of the discovery where rationale thickens.

Who does the assuming?

In the Five-Birds problem you were asked to list assumptions that justify the rationale supporting your numerical answers. My experience was that identifying assumptions required more logical reasoning than did listing rationales. For the most part, my numerical answers and their rationales seemed to come to mind together. An assumption, on the other hand, came to mind following logical concentration on a rationale, and included logical wording and rewording to produce a satisfactory answer. In each case, rationale was thought of and stated without first thinking of assumptions.

It looks like, in this instance of introspection, that the logically-thinking brain hemisphere at least organizes and verbalizes an assumption. It could be that both hemispheres contribute subconsciously to discovering its makeup.

My last answer, zero, resulted as a forced condition arising from taking the numerical value to extremes (a heuristic). Five had already been used, so zero was the remaining extreme. Thus, the problem was shifted from finding a numerical value to finding a rationale to support the assumed value. This created a new thought path. (See Thought Paths, p. 67 ff, in Heuristic Innovation.)

Here we have a heuristic for solving a problem: "Assume an answer then discover its rationale." But how can that be done?

This is reminiscent of a mathematical method for testing a derived equation's ability to predict a known. One inserts a parameter's value into the equation and compares the modified equation's prediction with the known. The difference, if any, or a portion of it, is use to correct the parameter's value producing the next modification of the equation. Iteration of this technique produces any desired accuracy in a converging system.

A role for attributes

An interesting effect that occurs while searching assumptions is how the search begins to broaden the problem with newly identified attributes. These can bring to mind more objects and more functions. In my case several attributes surfaced: Birds went from being *alive* on a wire, to being *aloft* (flying), to being *hearing*, to being *frightened*, to being *deaf*, and to being *inert* (decoys). This demonstration illustrates how attributes can inspire subconscious thought paths – presumably, for seeding both hemispheres.

To see this in action, let's revisit the 5-bird problem. This time we'll start with the answers and our problem will be to discover assumptions. Seeding will be done with attributes. The problem is given with only two objects; birds and wire. Here are some attributes to consider. You may think of others.

birds		**wire**	
alive	inanimate	metallic	insulated
animate	asleep	vibrating	ice coated
deaf	short	slippery	rusty
edgy (nervous)	tall	non-metallic	braided
endangered	singing	non-slippery	frayed
fat	calling	swaying	
hearing	sick	robust	
inert	healthy	frail	
kin (as in birds-of-a-feather)		sagging	
messy		taut	
noisy		thick	

Notice that the attributes were not selected to be relevant to the problem. They were simply thought of randomly by trying to imagine the objects doing something or being in use. Determining their relevance provides new thought paths.

Notice also that having just thought of, critiqued, and written these attributes they are freshly planted seeds. I can move now to the problem and give no further specific attention to them, they are at work. Once spontaneous answers are found, the list of attributes can then be examined and each attribute in turn considered as a thought path.

The problem posed is, given the number of birds left determine a plausible rationale for the number. Later we will consider assumptions.

There are five birds on a wire. If you shoot one how many are left?		
Ans.	Rationale	Assumptions
0	Shot didn't kill any	5 flew away.
1	4 flew away	Hearing birds flew away. Dead bird was unable to flee.
2	One is shot, one remains to give aide, three give chase after the shooter.	Birds are inanimate. Birds is the name of a sports team.
3	Shot bird falls off the wire. Reaction vibrates wire knocking off a second one leaving 3 on the wire.	Birds are inanimate targets in a shooting gallery.
4	Four decoys remain after a live bird was shot.	A hunter's ruse – decoys attract a live bird.
	Four birds are left of one or more to their right.	Left can refer both to space (left-hand) and time (remaining).
5	1 dead + 4 deaf	Deaf birds were not disturbed.
	5 decoys	No deaths or disturbance from fear

My rationales for answers of 0, 1, and 5, from the last mini-lecture, are shown in light print.

This exercise came to mind while writing the last mini-lecture: *"My parting thought was a question to myself, wondering if one could write a rationale for each number, 0 through 5, as plausible answers?"* I didn't know that it would be so easy to find six answers. Two brains do work.

Try your hand at all six values. In the process, see if by introspection you can detect which brain hemisphere is doing something and what it is doing. Obviously, the value of the exercise is the subsequent introspection and what you learn from it.

Two readers responded: Thomson Graeme noted, "There is only one that is LEFT all the others are to his RIGHT". I am always impressed with the variations of images and rationale different brains can generate from the same information. Rich Kucera noted, "5 [birds remain] because the wire went through the birds, they were decoys"

The thinking path being used here is a heuristic from USIT: start with an answer and work back to the problem. From a logical perspective, this may seem to produce 'contrived' answers. Nonetheless, this path produces new insights.

Images of imagination

For me, images played an important role in this 5-bird problem. From the beginning I imagined 5 birds sitting on a wire. It was a subconscious assumption that they were alive. Later the idea that they might not have to be live came to mind. This produced images of decoys on a river and targets in a shooting gallery. A shot bird produced an image of a bird falling. Fleeing birds were imagined as flying away in different directions.

In the process of listing random examples of attributes for birds and wire I had an image of each attribute. On recognizing that images had been formed before using the list, I felt confident that they had already become seeds for this problem situation.

Images arise spontaneously from objects, attributes, and effects; they arise from their language representations, spoken, heard, and thought. Visible attributes may be included in images of objects. Sometimes invisible attributes may be evident such as facial and body expressions that characterize a mental state of a person. The object-to-image link is the strongest and is a useful heuristic for seeding the subconscious (to be discussed later).

The five birds on a wire problem has served as a simple exercise to enable, by introspection, examination of our personal thinking. It was an attempt to make evident how problem concepts and take form in three stages: pure intuition, intuition and logic, and pure logic. These stages have blurred boundaries.

---------------- Two brains are better – and more fun ----------------

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.

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To be creative, U-SIT and think.

U-SIT And Think News Letter - 72

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Dear Readers:

. A workshop on Heuristic Innovation based on USIT is in development. Suggestions for material to be covered to aid better the understanding and practice of these methodologies would be appreciated.

. This newsletter continues the brief series on using both cognitive hemispheres as tools for innovation.

Mini USIT Lecture – 72

Two Brains Are Better – III

A mid-stream correction
On the wall in my study hangs a poster picture of Albert Einstein with part of one of his quotes: "Imagination is more important than knowledge." (www.einsteinyear.org/facts/physicsFacts/) I like it because it seems to excuse some daydreaming in the midst of study – a favorite pastime of mine. But I've been caught short with too much imagination and need to do some explaining.

This series of mini-lectures began by examining personal mental reactions to three questions regarding birds on a wire. The initial idea was to present a query that would elicit instantaneous intuitive reaction based on an image forming as words were being read. Deducing intuition at work, in this case, is based on its speed. By comparison, logical reasoning, with its dependence on processing of words, would necessarily trail intuition. Presumably, both intuitive and logical hemispheres could produce *a numerical answer*, but logic should be delayed by more mental processing required to generate a concept.

The italicized phrase is where I slipped in reasoning. I offer the following quote to set things straight. "You have two brains: a left and a right.

Modern brain scientists now know that your left brain is your verbal rational brain; it thinks serially and reduces its thoughts to numbers, letters, and words … . Your right brain is your non-verbal and intuitive brain; it thinks in patterns, or pictures, composed of 'whole things', and does not comprehend reductions, either numbers, letters, or words." (* Bergland)

Thus my allusion to the intuitive brain using numbers is incorrect. I apologize for that and will make corrections as appropriate.

As Bergland confirms it is appropriate to consider the intuitive brain as using and providing images while the logical brain uses and provides language. That makes the reading and visualizing of the five birds on the wire problem the more impressive. As we read the words, “five birds on a wire”, intuition instantly paints the picture – a different picture for each of us. The number idea (5) is now implanted in the logical brain. In the next sentence the phrase, “shoot one of them”, introduces potential changes for both intuition and logic to handle. Logical thinking produces the trial numbers used mentally to test answers for the problem.

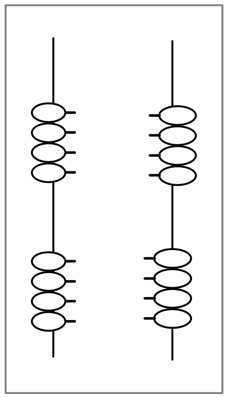

Figure 1

Image clues

Not all cues are reacted quickly by either hemisphere. Metaphors, which I argue are the more creative thinking cues, can be slow in developing meaning. (Has the stylized logo I drew for the website announcement of the heuristic innovation textbook and for this series of mini-lectures caught your attention?) We experience graphic metaphors long before we become professional problem solvers. As children seeing faces in the clouds, the man in the moon, and many others, we are reacting to accidental graphic metaphors. We mentally *make something from nothing*. This is an important observation for it is a clue to intentionally forming effective metaphors to use in problem solving. It fits the concept of the intuitive brain seeing whole things; i.e., making sense of them – making something from nothing.

The sketch in Fig. (1) above is a graphic metaphor from my early school days. It’s a drawing of a bear climbing a tree from the other side. You probably knew that. But can you now associate the cartoon with any other images?

Difficult, isn’t it? Why is that? I think, in part, it’s due to being overly drawn for the proposed image, which is now ensconced in our minds. It leaves little for further imagination. Little else comes to mind as needed to complete the cartoon. That is, unless you are familiar with bears and your logical hemisphere complains for lack of realism in the sketch of a bear’s paws. However, on first reading that it was a bear on the back side of a tree, you probably visualized the short black bars as claws and the groups of four as equivalent to hands grasping from the other side, and then accepted the idea.

If I take off the claws (Fig. 2, p.3) do ideas come to mind for new meaning to the cartoon? Think a moment and try to make something out of the cartoon before reading mine. It seems that less detail in the cartoon offers more freedom to make associations from experience.

(It made me think of an abacus; children seen from above queuing at a two-sided lunch counter; four caterpillars; and spider egg-cases on a board.)

Graphic metaphors

Where and how are graphic metaphors introduced into problem solving? I use graphic metaphor to represent all visual information except language. Initially, when we set out to solve a problem, we collect a variety of physical objects, photographs, engineering drawings, graphic data, models, and sketches needed to assemble the facts. These can be inspirational toward generating solution concepts as one studies and understands them. But they have only moderate metaphorical value because they are over defined.

As we begin to analyze a problem we find it convenient to make sketches of select components. These become useful reminders of the more complex things they represent. Already we are using the golden heuristic of problem solving – simplify! We are creating graphic metaphors. Our sketches are hints, suggestions, and approximations that are sufficient to remind us of the real objects. They’re analogous to the abbreviated notes we take at a lecture.

While problem solvers understand their value, and use them when provided, they often do not introduce their own sketches. Or they make detailed engineering drawings having little value as metaphors. I think Betty Edwards** may have put her finger on the problem when she studied the difficulties children have trying to draw. Up to ages nine to eleven children often develop limited skills and then quit learning. They carry these limited skills into adulthood with no further improvement, but wishing they could learn to draw. Essentially children start out with the goal of creating realistic drawings. When they become dissatisfied with their efforts they give up.

These same children become technologists who still have difficulty making satisfying sketches. When working in problem-solving teams they often are too self conscious or embarrassed to offer their own sketches. Instead they defer to a volunteer within the group.

If the value of metaphors lies in their ambiguity, which I hold is true, then sketches should not be of engineering drawing quality but should be simple line drawings. They should not be subjected to artistic criticism. Presumably, the details of accurate drawings and models have already been assimilated upon beginning analyses of a problem. Personal sketching brings one face-to-paper with decisions of what is important and what is not, what do I understand and what do I not. With less logical criticism maybe we can capture some of intuition’s whole-picture imagery.

"Chinese proverb" from a streetcar advertisement. The quotation has wrongly been translated as: A Picture Is Worth One Thousand Words**.** In fact, the literal translation is: A Picture's Meaning Can Express Ten Thousand Words**.*****

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* From *The Fabric of Mind*, Richard Bergland, New York, Vicking Press, Inc. 1985, p.1. and cited in

** *Drawing on the Right Side of the Brain*, Betty Edwards, Penguin Putnam Inc., New York, 1999.

*** http://commfaculty.fullerton.edu/lester/writings/letters.html

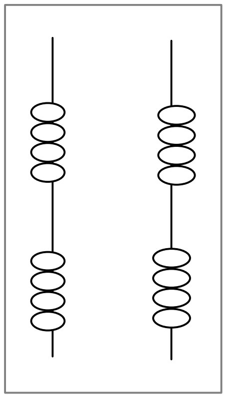

Figure 2.

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Dear Readers:

. This newsletter continues the brief series on using both cognitive hemispheres as tools for innovation.

. The "Two Brains Are Better" lectures began with logic-oriented thinking and its suppression of intuitive thinking. In the last lecture images were the initial focus. This orientation is continued here.

Mini USIT Lecture – 73

Two Brains Are Better – IV

Think you've seen everything?
I'm always impressed, when working problems in qroups, with how many different perspectives participants have from the same initial information. Here's a fresh view of an image in the last mini-lecture, sent in by Matt Smith.

> "In this most recent issue, another interesting occurrence: my brain saw figure 1, and was trying to process it in accordance with the text above it, which is what I was reading when I spotted the figure. I didn't wait until the text got to the place where it said "in figure 1…" Instead, I tried to imagine what relevance the figure would have to the current discussion, which up to that point had not included anything vaguely related to bears or trees. I thought the vertical lines were wires, each oval a bird, and the little lines (claws) were the beaks. I was desperately trying to figure out why there were now 16 birds, in four groups of four, on two different wires!"

This is an ideal lead-in to the current lecture (thanks Matt). I propose to begin with images having no introductory verbiage in order to give our intuitive brain hemispheres a head start over their logical counterparts.

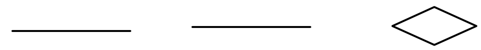
Give your intuitive hemisphere some respect
You will be shown three sketches, in three exercises, and given no further information. Allow yourself only 3 minutes, per exercise, to ponder the sketches and make something of them, anything or things. Give a sketch and an explanation of what you make. Please do each of the three exercises without reading further into the lecture. Write your ideas and then do the next one.

1) 

****

2) 

****

3) 

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Please send me your ideas for these three sets of sketches. I will try to compile them for us to see the variety of reactions our brain hemispheres provide. Please do not change any of your ideas or add new ones after reading the rest of this lecture. Comments on how you reacted to each exercise would also be of interest.

Creative Cognition

I hope you have worked the above three exercises and will share your results with the rest of us. This is my attempt to test our reactions to ambiguity in graphic metaphors.

I got the idea for doing the above exercises while reading the book "Creative Cognition – Theory, Research, and Applications" by R. A. Finke, T. B. Ward, and S. M. Smith., The MIT Press, 1996. In this book, the authors describe their well-defined laboratory experiments for testing people's ability to be original and creative in thinking of uses for simple shapes. From the results of these experiments they drew conclusions about inventiveness. Their experimental procedure was well defined and their results clearly explained. However, I had some skepticism that bothered me regarding the relevance of their work and what we as technical problem solvers do when solving technical problems.

What bothered me was a question lingering in my mind regarding authenticity of problems concocted by cognitive psychologists having relevance to real-world problems that scientists and engineers are trained to solve. Part of the time I gave them the benefit of the doubt and part of the time I didn't . Here's why.

They begin their chapter on creative invention with an example from an earlier study in which object parts and categories of application were limited. I like this – it sounds like an engineer's closed world.

> "The initial experiments tested the idea that creativity would be enhanced whenever one is forced to use unusual sets of parts or to interpret the resulting objects in unconventional ways."

An example result was shown in Fig. (1).

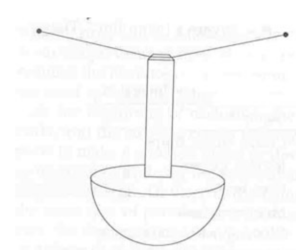

Figure 1. "The hip exerciser, constructed using the half-sphere, wire, and rectangular block, an example of an object that was classified as a creative invention. By shifting one's weight from side to side while standing on the half-sphere, one can exercise one's hips. (From Finke 1990.)"

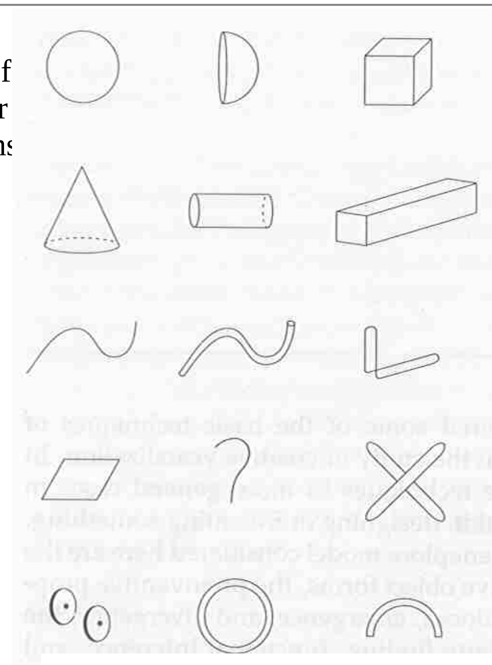

Figure 2. Set of object parts in experiments on creative invention.

Note that in their experiment, and this example, the subject was given three sketches and told what they represent; “a half sphere, wire, and a rectangular block”. This made me wonder if such information is necessary for creative thinking. It seems to me, but not proven, that application of the heuristics learned in USIT could accomplish similar results.

In their later experiment on creative invention they used fifteen objects, shown in Fig. 2. The objects were identified as sphere, half-sphere, cube, cone, cylinder, rectangular block, wire, tube, bracket, flat square, hook, cross, wheels, ring, and handle. “At the beginning of each trial, the experimenter named the three parts, and the subjects closed their eyes and imagined combining the parts to make a practical object or device. They were never told to be creative in doing the task but simply to think of an object that might be useful. All three of the named parts had to be used, even if the same type of part was named more than once. The subjects could vary the size, position, or orientation of any part but could not bend or deform the parts, with the exception of the wire and the tube, which had been defined as bendable”

The problem I have with this experiment is the naming of the sketches and assigning them attributes in addition to their shapes (size, position, orientation, flexibility). I see this as biasing the mind toward logical thinking and away from intuitive thinking. My preference would be to provide the sketches with no names or attributes, just the illustrated shapes. This would allow both brain hemispheres to be involved using their different protocols of thinking. As shown above the problem is over defined, in my opinion.

As a student, and as a teacher, I have always enjoyed more, and learned more from, problems that give only sufficient information for solving them. These are especially inspirational when you find no obvious starting point but must make one or more assumptions. What follows is both rapid generation of intuitive ideas and logical filtering of ideas that violate the assumptions.

I’ve probably mentioned this in the past, but a favorite problem of mine is: “How far can a goose fly?” This is not a joke, but a tractable physics problem that requires a number of reasonable assumptions. You may not be able to do the mathematics for this problem but with a little thought you can imagine a series of logical assumptions needed to reach a reasonable answer. That, in itself, is a masterful bit of creative thinking.

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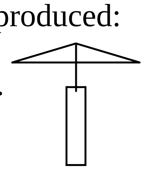
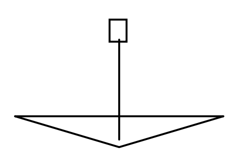
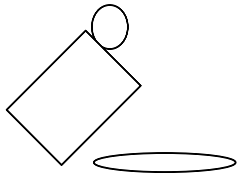
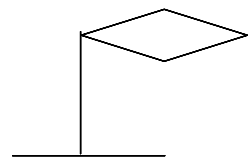
My three-minute exercises produced:

1) A cover for a bird feeder.  and a tilting, rotating toy for a child to stand in, hold the handle, and rotate himself around the center. 

(The latter was obviously influenced by earlier reading.)



2) An inclined box from which to roll an egg to test the height it can fall without breaking.



3) A mooring post for a trapezoidal blimp.

The object of this exercise is not to find overwhelming invention, but recognition that without words to inspire logical thinking, simple shapes can inspire intuitive thinking.

I found three minutes too brief to actually reason using USIT heuristics. Did you?

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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.

U-SIT And Think News Letter - 74

Unified Structured Inventive Thinking is a problem-solving methodology for creating unconventional perspectives of a problem, and discovering innovative solution concepts, when conventional methodology has waned. Heuristic Innovation is an extension of **USIT**.

Subject Keys

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

Dear Readers:

. This is the last lecture in the series "Two Brains Are Better". In subsequent lectures I'll address specific heuristics and problem-solving issues.

. The last mini-lecture dealt with intuitive images generated without the bias of verbal characterizations. Some results are discussed here.

Mini USIT Lecture – 74

Two Brains Are Better – V

Recap: Mini-lecture IV ended with this, somewhat nostalgic, sentence:

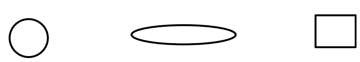
> *"The object of this exercise is not to find overwhelming invention, but recognition that without words to trigger logical thinking, simple shapes can inspire intuitive thinking."*

For me the nostalgia came as recollection of a most creative childhood pastime; that of playing with toy blocks, having no verbal characterizations, from which one could create anything including whole new worlds. I wonder: could this be our first laboratory experiments in creative problem solving?

The last mini-lecture began with three exercises. Construct something from these three groups of shapes:

1) 

****

2) 

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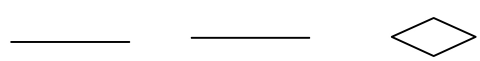
3) 

- -

Results from Mini USIT Lecture IV

Here are some examples from readers. As you will see, in these results, minimal information can spark wonderfully creative thinking.

1. Michel Lecoq wrote (see figures on previous page) …
For 1)

I see a motorcycle climbing the left side of the triangle then gaining speed by descending the right side of the triangle and then with full gas climbing the oblique line to jump over the rectangle

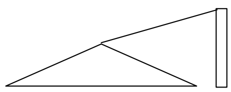
For 2)

I have to squeeze the circle into an oval to put it thru the square

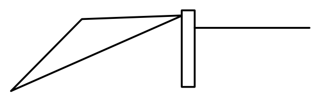
For 3)

the letter G in the Morse alphabet - - . (bar, bar, dot)

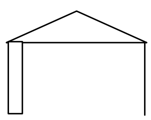
2. Mark Smith sent the following (I reworked his freehand sketches) …
For 1)



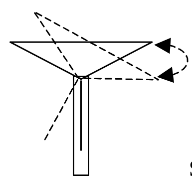
bicycle ramp



rabbit trap



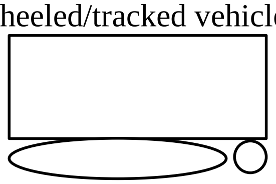
picnic pavilion



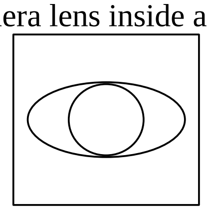
scale

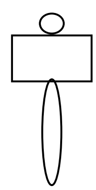
For 2)

wheeled/tracked vehicle



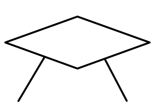
camera lens inside a box





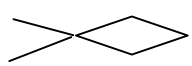
lighted sign (lots of construction work on my way to work these days)

For 3)

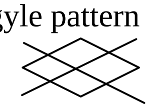


lunar lander

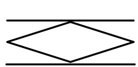
fishing lure



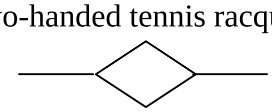
ink stamp to create argyle pattern



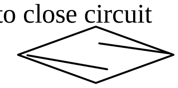
flywheel (point contact to top and bottom constraining surfaces reduces friction)



two-handed tennis racquet



some sort of electrical contact switch – contacts deflect under acceleration or temperature change to close circuit



Comments

I find these to be fascinating examples of creative thinking. They were done with the same time constraints used by Finke, et al (see Mini-Lecture IV), but without the constraints of object and attribute names.

What appears to happen when faced with this kind of challenge is that one makes assumptions, albeit, often subconscious assumptions. Such subconscious assumptions, having no conscious verbiage, are likely the product of our intuitive hemispheres. They occur and are used as trial-and-error tests to see what they may produce. They are thought-provoking seeds.

One reader agreed with me that three minutes was not enough time to consciously consider using USIT heuristics in these three exercises. This may be one's unconscious deference to intuitive thinking – we want to brainstorm ideas quickly before losing them. We know that we can then proceed in a logical manner to exercise learned methodologies for generating ideas. This supports my practice when teaching to have students do a "mental dump" of all known and suddenly realized solution concepts before exercising any structured methodology.

But why do we loose ideas if they are not recorded as quickly as they come to mind? I suspect this is another clue, or bit of evidence, that intuitive, non-language thinking is at work. Our intuitive ideas initially are more image than they are verbal description. Creating verbal description, hearing it, seeing it, and writing it produces multiple tags for later recall. Until that is done, intuitive ideas are too easily misplaced in our minds.

Conclusion of Two Heads Are Better

The richness of thinking resources we bring to bear on a problem is evinced in verbal heuristics for the logical hemisphere and graphic images for the intuitive hemisphere. The effectiveness of our use of these resources is evinced in the creativeness of ideas generated. As we inculcate two-brain thinking into our natural mode of problem solving we begin to reap intellectual pleasure in our capabilities.

To be creative, we sit and think.

(When I retired from Ford Motor Company the SIT Team presented to me this copy of François-Auguste-René Rodin's "Le Penseur", "The Thinker". It sits on my desk stirring my imagination.)

Other Interests

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3. eBook "Heuristics for Solving Technical Problems – Theory, Derivation, Application" -- HSTP	English	Ed Sickafus (author)	www.u-sit.net
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U-SIT And Think News Letter - 75

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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.

******

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

Other Interests

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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." Simplify and iterate 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

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

To be creative, U-SIT and think.