A Simple Theory Underlying Structured, Problem-Solving Methodologies – ASIT, TRIZ, USIT and others

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Abstract:

Structured problem-solving methodologies, such as ASIT, TRIZ, USIT and others, are made easier to learn and practice through a simple theory. Such methods have a common basis in creative thinking but engage various forms of structure to achieve their goals. They have a common starting point – an unsolved problem. And they have a common end point – innovative solution concepts. Furthermore, they use the same machinery to advance from one end point to the other – our two cognitive engines (our brain hemispheres). This talk is not about variations in methodology. It is a theoretical discussion of how we think as we progress along the path from problem definition to innovative solution concepts. It will be seen that our two brain hemispheres provide near instantaneous insights that are both logical and intuitive. By understanding their fortes we can best use our cognitive resources. Some surprising insights are presented. The theory is relevant to understanding and practicing all problem-solving methodologies.

We are not logical thinkers

To be effective in applying structured problem-solving methodologies (SPSM) we need to understand our natural mode of thinking and to recognize that it is not logical. This makes the application (and therefore the experience) of SPSMs complex.

By understanding our natural means of thinking we discover resources for problem solving that may go overlooked. We will examine natural thinking, thinking resources, innovation, and their relation to how we mentally execute structured problem solving.

Complexity in structured problem solving methodologies

SPSMs have varying degrees of complexity relevant to their learning, practicing, and teaching. Complexity of older methodologies has been addressed by newer methodologies. This will continue. The usual tactic is to find ways to simplify former structure. However, root causes of complexity in structured methodologies have not been addressed.

It is assumed herein that one plausible root cause of complexity is the mismatch between idealization of SPSMs and our natural way of thinking. The former are logical and organized, as expressed in their structural heuristics and their teaching, the latter is not.

Mental problem-solving resources

Our mental problem-solving resources lie in our two brain hemispheres. Both perform reasoning, remembering, communication, and problem solving. But they do them differently and share their results. For example, one is better at logic and the other is better at intuition.

The left- and right-brain hemispheres (LH and RH) receive the same sensory information simultaneously but process it according to different protocols. Each is aware of the other through their adjoining corpus callosum. How they think is unknown.

LH controls language and logic in most individuals. Technologists are influenced more by their LHs and artisans more by their RHs. RH is better at visualization of spatial relationships and the use of metaphors. Having no language, RH is at a disadvantage to LH. LH may veto RH ideas. (Note, LH and RH traits are reversed in some individuals.)

History has many tales of technologists being stymied by a problem for long periods, then discovering the answer metaphorically in a dream. Is this RH finally being heard?

RH analyzes spatial information but can't verbalize its results.

> Try describing a spiral staircase while sitting on your hands. (David Galin)

Natural thinking

We often ascribe the "gift" of problem solving to creative people. But what is a creative person? "[It is] someone who can process in new ways information directly at hand – ordinary sensory data available to all of us". (Betty Edwards) This equates to "a person having a new point of view."

Herein, thinking refers to the conscious and subconscious processes used in problem solving. We are aware of the conscious but we cannot know the subconscious. However, we can, through introspection, make useful deductions about thinking and use them to engage best practices for innovation. This requires language, an LH trait.

Introspection reveals that our natural thinking is unorganized and uncontrolled. It is at times logical, at other times illogical. It can be rational and whimsical. It jumps

uncontrollably between different topics interrupting concentration. It pulls together unusual objects and functions creating wholly new concepts.

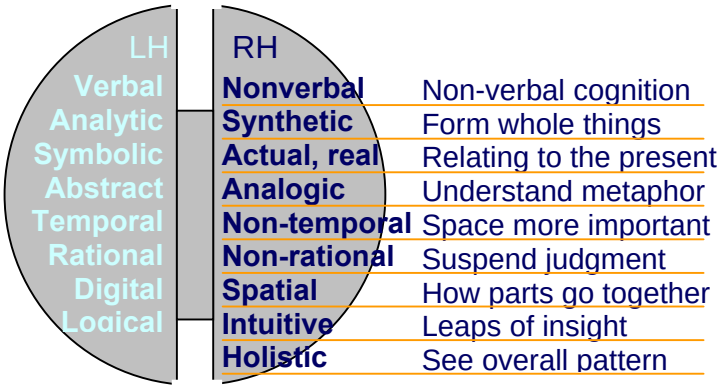
Our communication of problem solving is orderly; like this, Definition – Analysis – Solution. However, thinking while problem solving is not orderly but jumps in random ways between these three phases of problem solving. Typically, we begin with an instantaneous, intuitive, solution concept. It is tested and modified iteratively as necessary for acceptance or rejection. From this observation we deduce that in our natural mode of thinking, while problem solving, the **content** of structure is important not its **order**. Consequently, flowcharts can be avoided.

Effective communication

By comparison with our natural thinking, our communication must be organized and logical to be effective. Organization is a heuristic for communication not for thinking.

Thinking traits

Several types of thinking traits have been identified with tendencies for LH and RH preferences. RH-traits are emphasized here since, as technologists, we already have well-developed LH-traits.



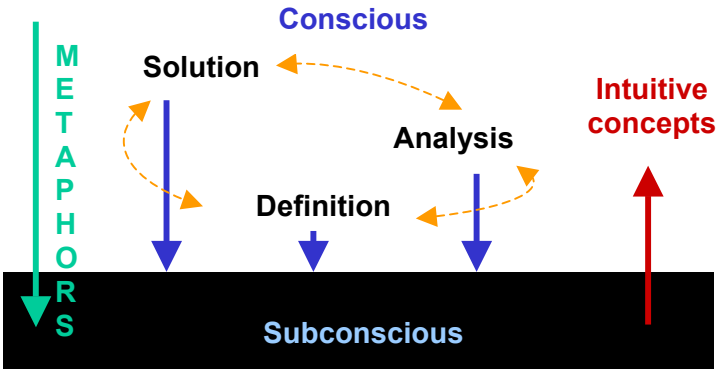
Effecting innovation

To maximize our creative thinking (not communication of our thoughts) we need to subdue LH's logical reasoning while encouraging RH's metaphorical thinking. Structure and language are the tools of logical communication. Image and metaphor are the tools of creative thinking.

Structure can work against effective innovation. A flowchart, for example, is not needed to innovate, it is too organized and works against unregulated random thinking – our natural mode of innovation. A simple model of consciously seeding the subconscious can be used instead.

A model for innovative thinking

A simple model of consciously seeding the subconscious in an iterative fashion can be used instead of structure. One focuses on the generation and regeneration of metaphors during solution, definition, and analysis phases of mental problem solving (without concern for their order). Regeneration of metaphors means their gradual generification to allow multiple versions an opportunity to seed the subconscious. Seeding causes intuitive concepts to rise to the conscious.



Intuitive concepts in innovative thinking are of two types: instant recall of past experience – known problems, and recall of experience that approximates the given problem or contains similarities. Innovation requires new and unusual assembly of parts with leaps of insight.

Let us turn now to opportunities for metaphors in problem definition, analysis, and solution strategies. These will be couched in terms of the USIT proforma model of a well-defined problem.

Problem definition

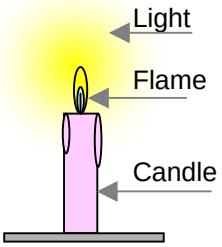
Problem situations arise as collections of objects, attributes, functions, unwanted effects, causes, and extraneous information, which we must identify, sort, cull, and minimize – logical thinking. The first step is simplification, which leads to identification and elimination of extraneous information. The goal of definition is to reduce a problem situation consisting of objects, attributes, functions, unwanted effects, extraneous information, and images to a well-defined problem. Two heuristics aid this process, simplify and generify. The next heuristic is to construct the well-defined problem into a graphic metaphor based on sharp focus at the interaction of two objects (a single point of contact).

O – A
\
U – A_m – O
/
O – A

Metaphorically, emphasis is placed on two casual attributes (A) of an unwanted effect (U) and the affected attribute (A_m). Now the goal is to identify root causes of the unwanted effect through its underlying phenomenology. In this process we find new and effective insights.

Problem analysis

A heuristic for analysis is the plausible root-causes tool that forces our thinking to the cause-effect links from a causal attribute to the unwanted effect. For example, consider the following problem situation: Our Company makes candles. It is loosing market share and needs a better product in order to compete.

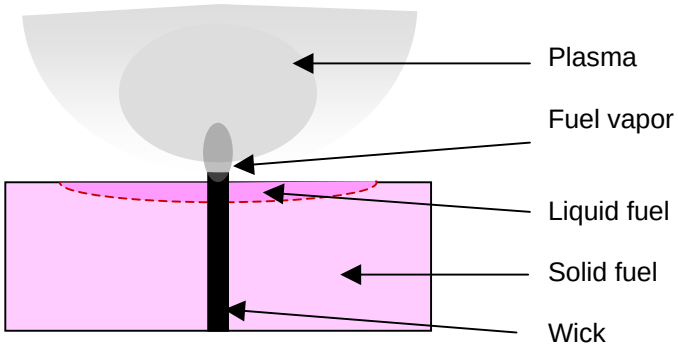


In order to invent, we can either improve an existing function or add a new function. In either case we couch the problem in terms of an unwanted effect: for example, “insufficient light”. This choice reduces objects to two: flame and candle. Now we are focused on the point of contact of two objects: molten fuel and flame (a high temperature plasma) – both new metaphors.

Flame – **Temperature**
\
Insufficient light – Visibility – Table
/
Fuel – **Rate of combustion**

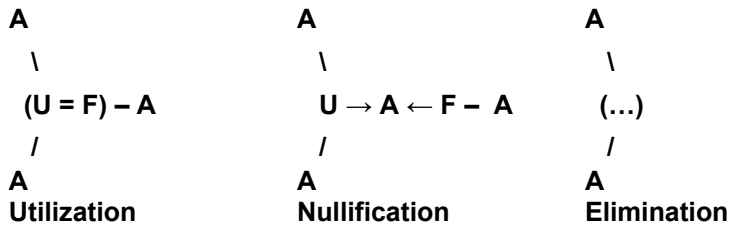
As we probe phenomenology the obvious question to ask is what determines light intensity? Rate of combustion seems an obvious answer. This raises new images of our point of focus.

In this manner, problem analysis takes us through stages of metaphor formation and the generation of new seeds for sparking intuitive concepts.



Solution strategies

Solution strategies need to be simple, graphic, and metaphorical with minimum structure and expressed generically. There are three strategies for resolving an unwanted effect: utilization, nullification, and elimination.



In utilization, U becomes a useful function, F. In nullification, U is countered by a new function. In elimination, U disappears.

Mental attitudes for simplifying problem solving

- Recognize that order and logic can encourage LH-logic versus RH-intuitive thinking.
- Use structure as a heuristic not as a necessity.
- Components, not order of structure, are important.
- Use simple sketches to engage RH metaphorical thinking.
- Match verbal descriptions with graphic expressions.
- Suspend judgment of ideas in order to encourage intuitive leaps of insight.
- Simplify a problem to a single unwanted effect and minimize the number of objects in order to enable a holistic view of a problem.
- Seed the subconscious with verbal metaphors.
- Start with solutions.
- Iterate between solution, analysis, and definition in steps rather than complete one before moving on.
- Search concepts at every step.
- Follow your inspiration.

The goal of a methodology is to spark new concepts from new viewpoints.

Conclusion

By understanding how we think, and by motivating metaphorical participation of both brain hemispheres in problem solving, we can learn, practice, and teach problem solving with innovative effectiveness.

With language we search the depths of our rational thinking.
With metaphor we search the depths of our imagination.
Together they inspire insight and innovation.

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– ASIT, TRIZ, USIT and Others

Ed Sickafus, PhD

Second TRIZ Symposium in Japan

Aug. 31 - Sept. 2, 2006 -- Suita, Osaka, Japan

They way we think during structured-problem solving differs from the way it is taught.

Understanding this difference and how we use our mental resources can aid our innovative application of any structured methodology.

Structured problem-solving methods are logical and organized while our natural thinking is not.

Assumption

A cause of methodology complexity is its logical idealization as compared with our natural method of thinking.

Although neither organized nor logical, natural thinking has resources often overlooked.

Assumption

Our innovative problem-solving skills can be improved with more natural thinking and the use of all our thinking resources.

We will examine

- natural thinking,
- thinking resources
- innovation ,

and their relation to how we mentally execute structured problem-solving.

Two halves of our brains think

Both perform reasoning, remembering, communication, and problem solving. But they do them differently and share their results.

Example:

One is better at logic and the other better at understanding metaphors.

LH and RH simultaneously receive the same sensory information but process it by their own protocols.

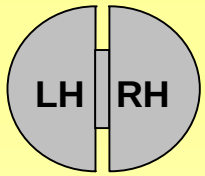
Each is aware of the other through the joining corpus callosum.

How they think is unknown.

LH usually controls language and logic.

Technologists are considered to be influenced more by their LHs and artisans more by their RHs.

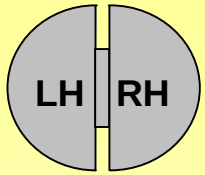
RH is better at visualization of spatial relationships and use of metaphors.



Problem solving in dreams

History has many tales of technologists being stymied by a problem for long periods, then discovering the answer metaphorically in a dream.

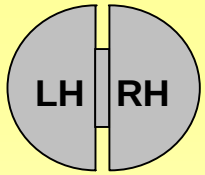
Is this RH finally being heard?



RH analyzes spatial information but can’t verbalize its results.

Try describing a spiral staircase while sitting on your hands.

Psychologist David Galin



Definition of a creative person

“ … someone who can process in new ways information directly at hand – the ordinary sensory data available to all of us.”

Betty Edwards, PhD

= one having a **new point of view**.

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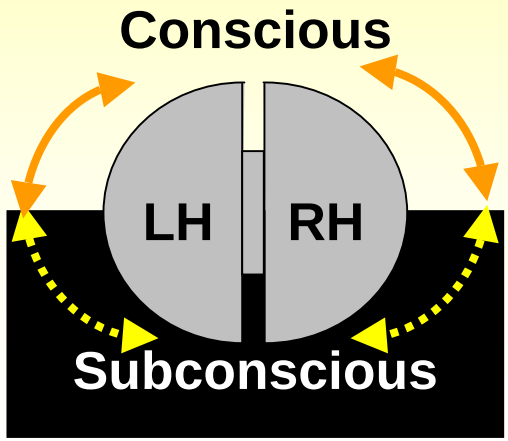
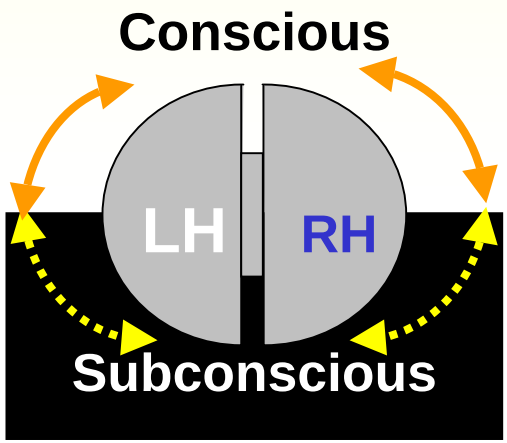


We are aware of the conscious, we cannot know the subconscious.

While we cannot know the activities of our subconscious we can, through introspection, make useful deductions about thinking and use them to engage best practices for innovation.

This requires language – an LH trait.



Our natural thinking is unorganized and uncontrolled.

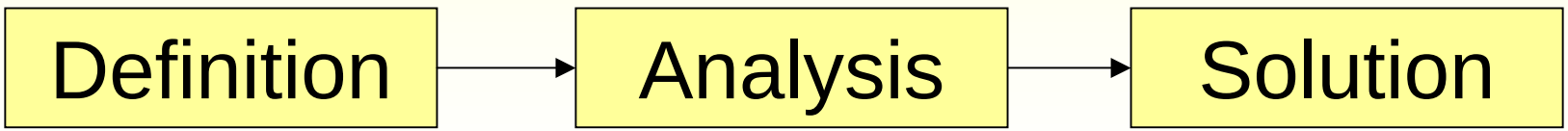
It is at times logical, other times illogical. It can be rational and whimsical.

It jumps uncontrollably between different topics interrupting concentration.

It pulls together unusual objects and functions creating wholly new concepts.

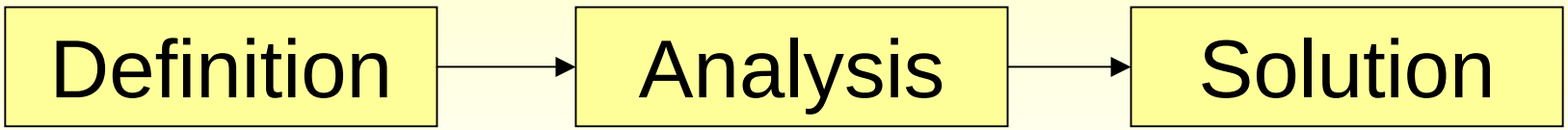
Communication of problem solving is orderly,

like this …

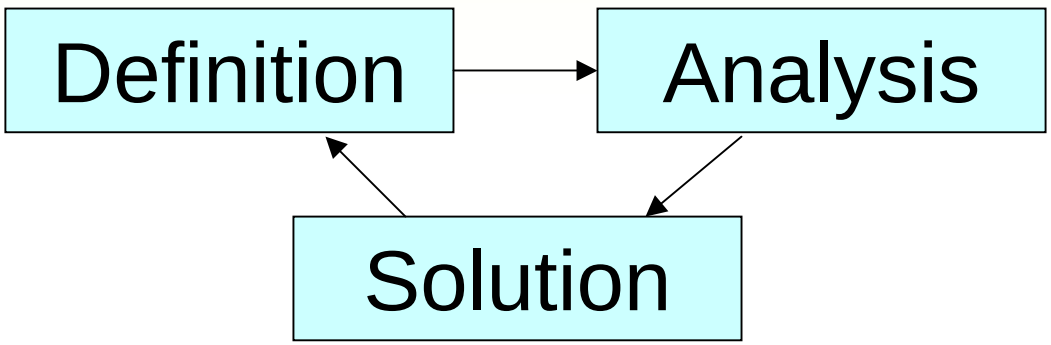


Thinking while problem solving is not orderly.

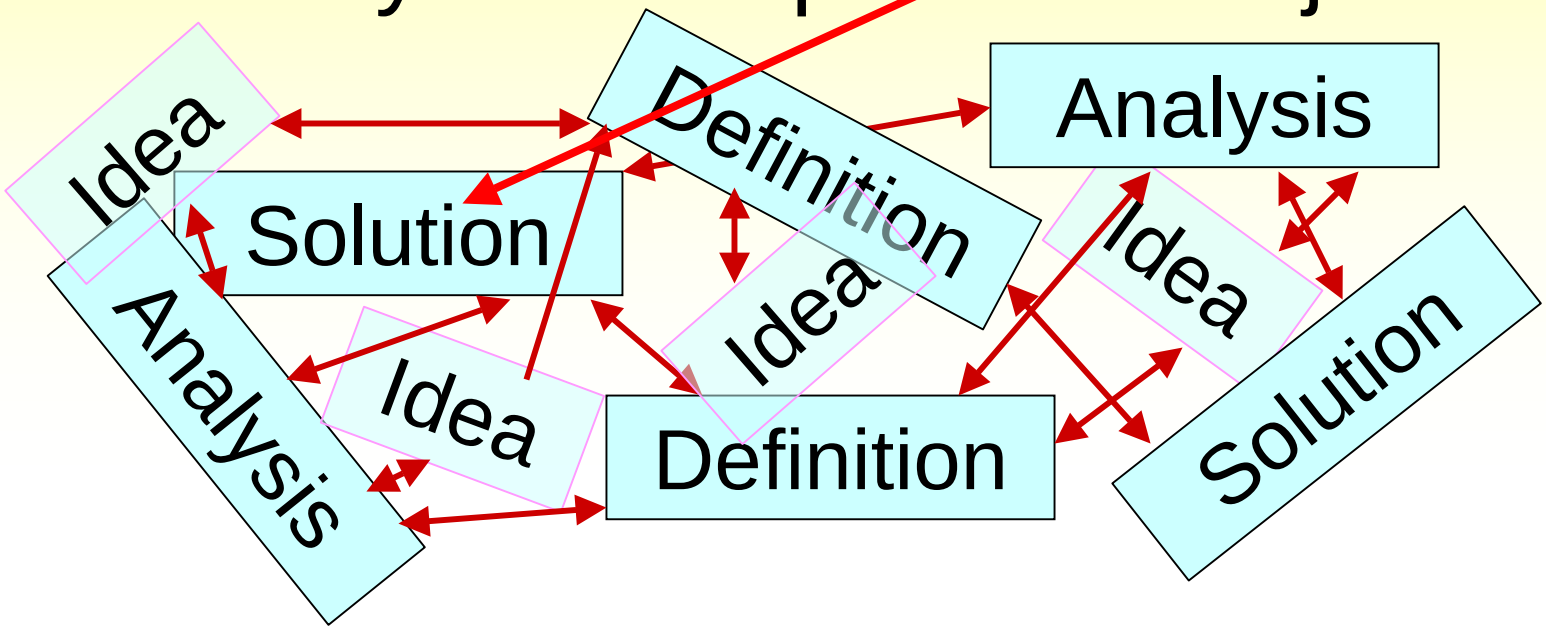
It is not like this …



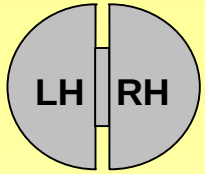
nor this …



Typically, we begin with an instantaneous, intuitive, solution concept. It is tested and modified iteratively as necessary for acceptance or rejection.



Definition simplifies / Analysis clarifies



From this observation we learn that in our natural mode of thinking, while problem solving,

the **content** of structure is important not its **order**.

Communication must be organized

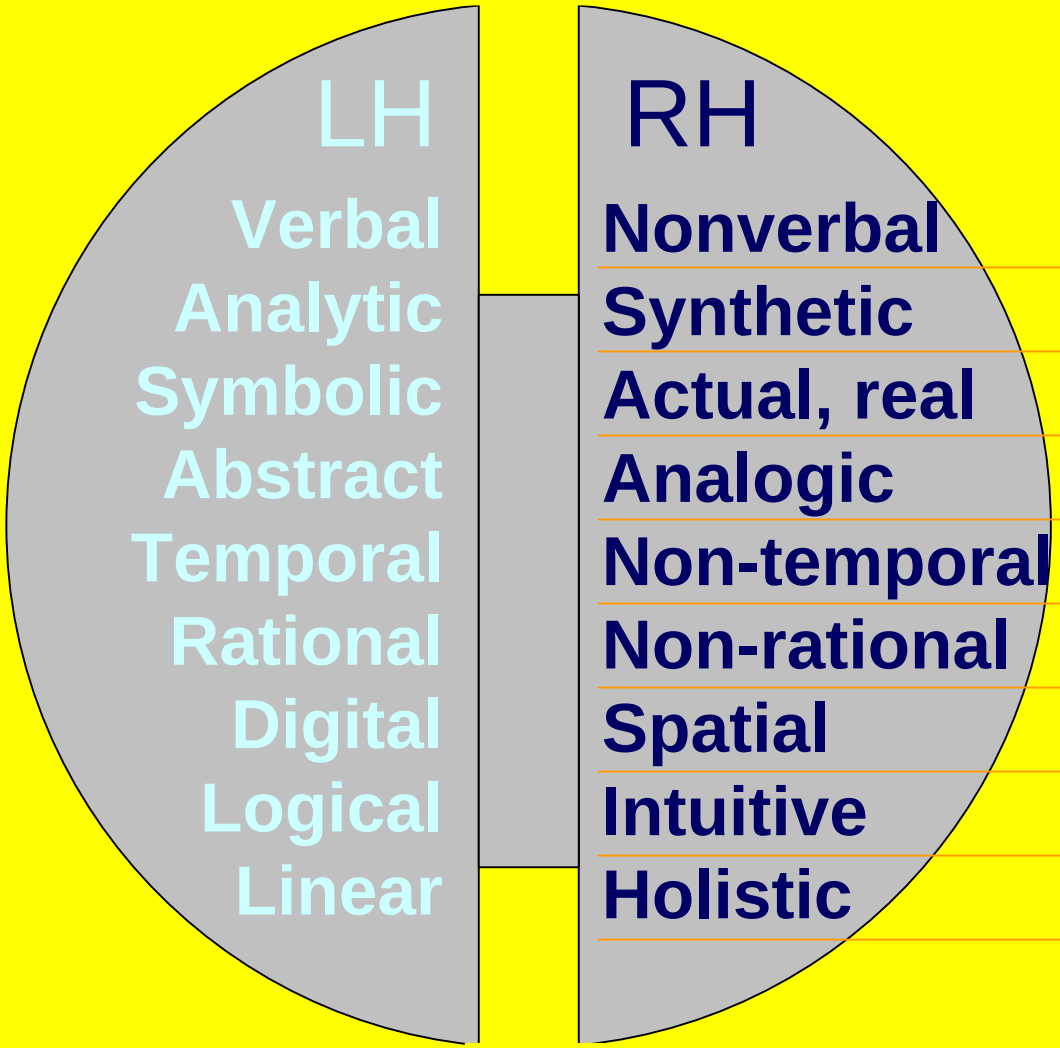
Organization is a heuristic for communication not for thinking.

We think disorganized thoughts but must organize them for communication – a tedious process.

Several types of thinking have been identified with tendencies for LH and RH preferences.

Left Hemisphere	Right Hemisphere
Language skills	Copying of designs
Skilled movement	Discrimination of shapes
Symbolic relationships	Reading faces
Higher-order mathematics	Music
Keeping time	Understanding metaphors
	Holistic processing
	Experiencing & expressing emotions

Summary of our thinking traits



Non-verbal cognition
Form whole things
Relating to the present
Understand metaphor
Space more important
Suspend judgment
How parts go together
Leaps of insight
Sees overall pattern

To maximize our creative thinking (not communication) we need to subdue LH's logical reasoning while encouraging RH's metaphorical thinking.

Structure and language are the tools of logical communication.

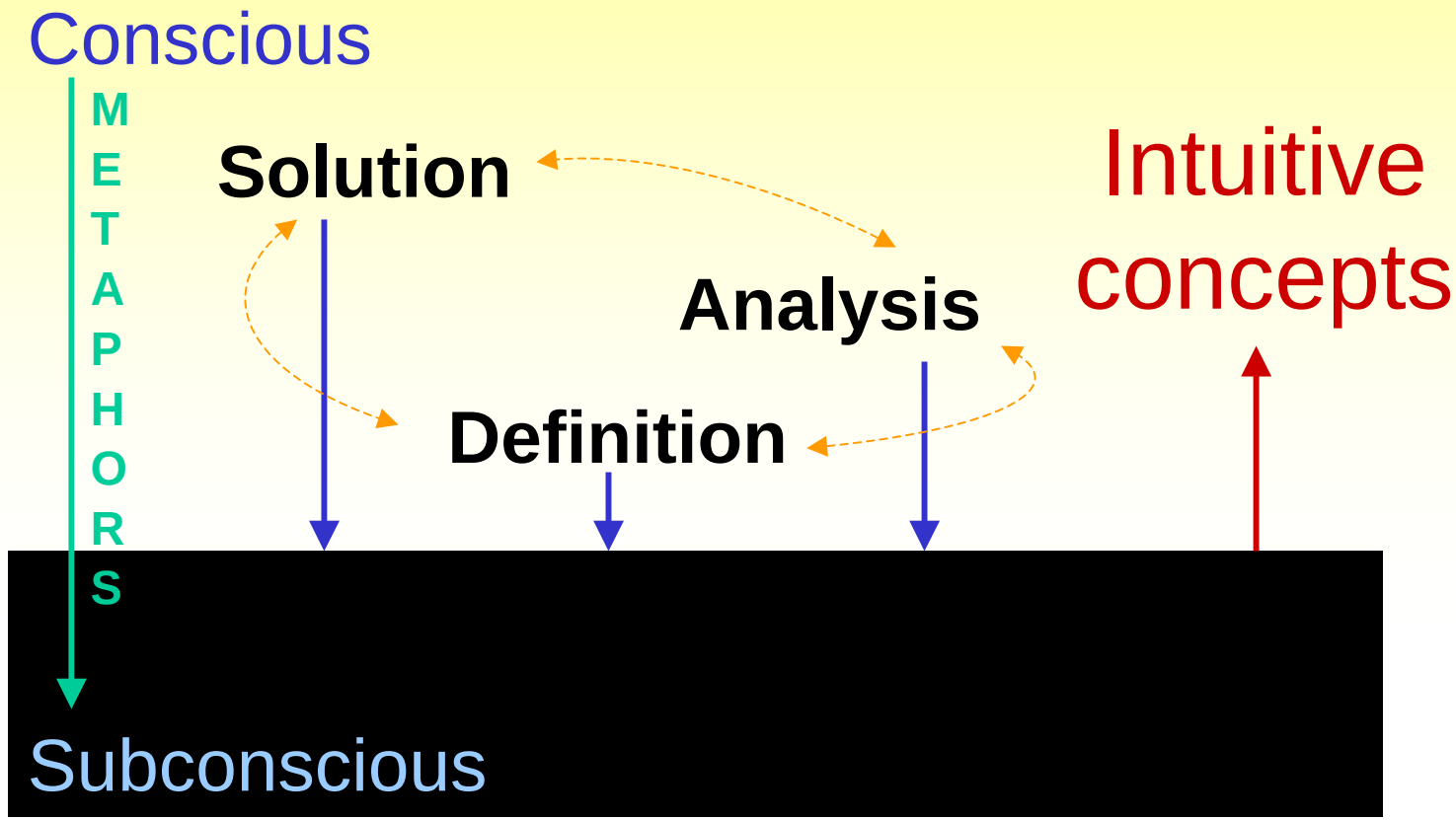
Image and metaphor are the tools of creative thinking.

A flowchart is not needed for creative thinking, it is too organized and works against unregulated random thinking.

A simple model of consciously seeding the subconscious can be used instead.

A model ➔

Consciously seed the subconscious with verbal and graphic metaphors

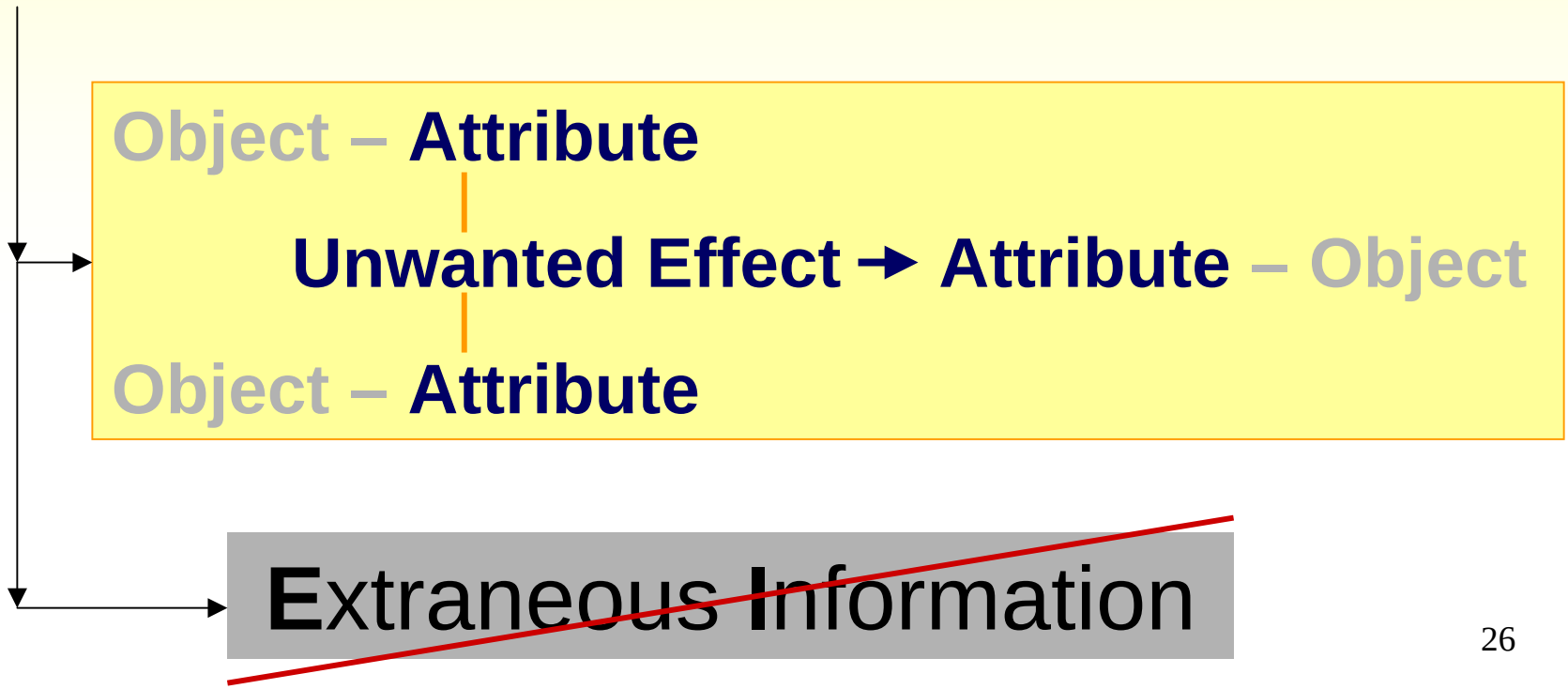


Intuitive concepts are of two types:

- Instant recall of past experience -- i.e., known problems;
- Recall of experience that approximates the given problem.

Innovation requires new and unusual assembly of parts with leaps of insight.

Problem situations arise as collections of objects, attributes, functions, unwanted effects, causes, and extraneous information, which we must identify, sort, cull, and minimize – logical thinking.



Goal of DEFINITION

… to reduce a problem situation consisting of objects, attributes, functions, unwanted effects, extraneous information, and images …

to a well-defined problem

DEFINITION

Input:
Objects, Attributes, Functions, Unwanted effects, Extraneous information, Images

Simplify:

Sort, cull, and minimize

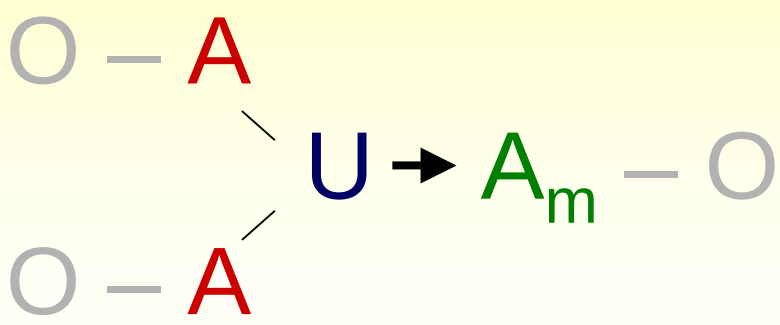
Well-defined problem -- rational and logical

Generify:

Use verbal and graphic metaphors.

New perspective innovative insight

Graphic of a well-defined problem:



One **U**,

Two causal **A**'s,

One affected **A_m**,

Subdued **O**'s

Two active attributes support a function or an unwanted effect.

Goal of ANALYSIS is …

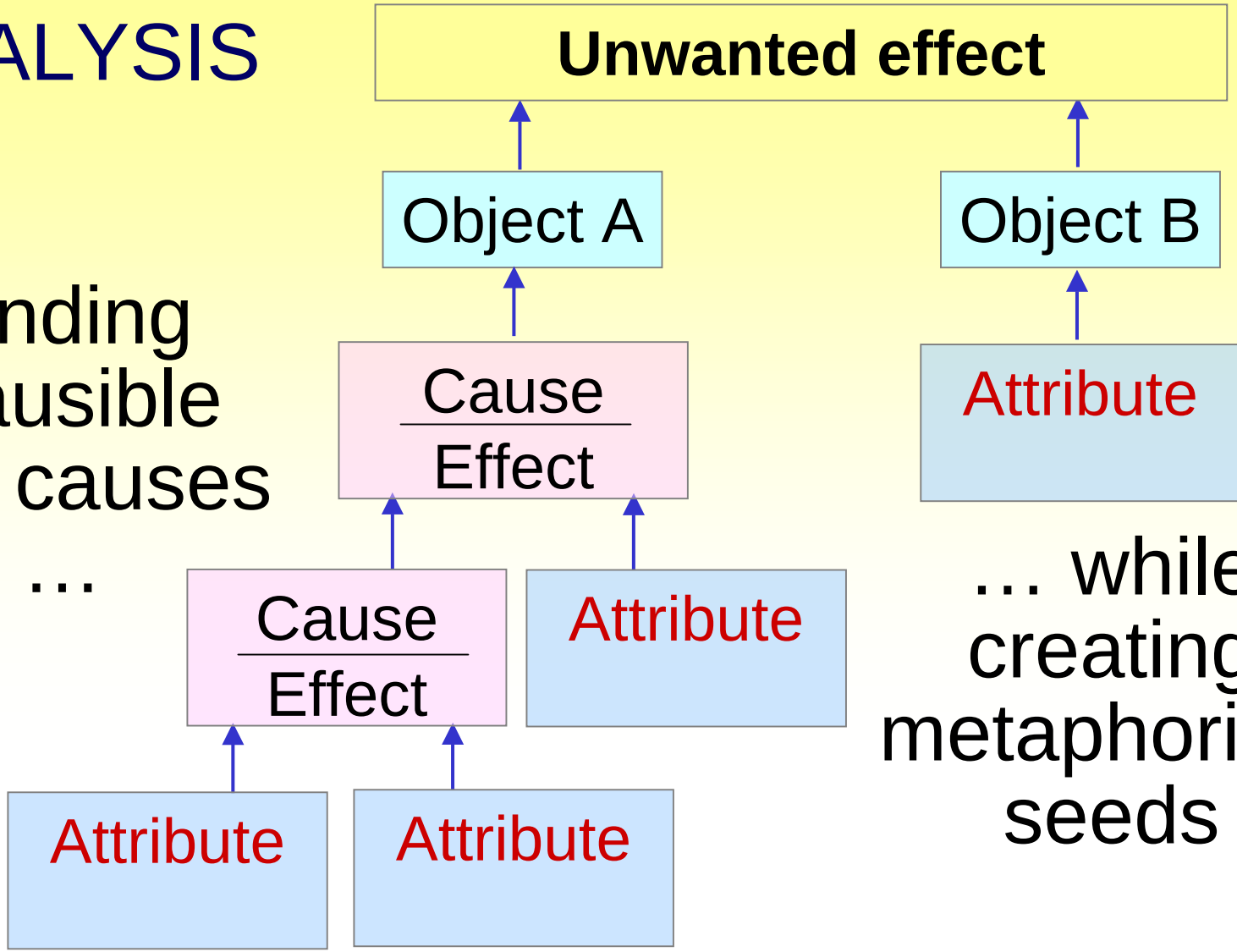
… to identify root causes for clarification of a problem through its phenomenology.

… and to generate
new and effective insights.

A – **(Root Causes)** – U

A tool ➔

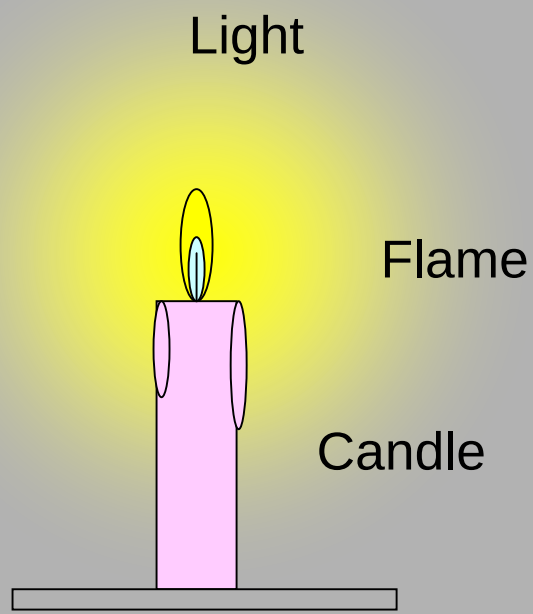
ANALYSIS


Unwanted effect
Object A
Object B
finding plausible root causes
…
Cause
Effect
Attribute
Cause
Effect
Attribute
Attribute
Attribute
… while creating metaphorical seeds

Problem Definition and Analysis

Problem Situation

Our Company makes candles. It is loosing market share and needs a better product in order to compete.



A simple model for how to invent ➔

Pick an unwanted effect,

it defines the problem

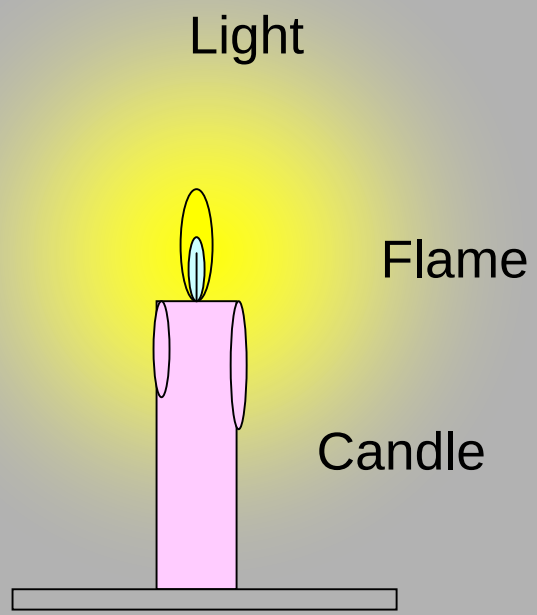
An Unwanted Effect

- an improved function

or

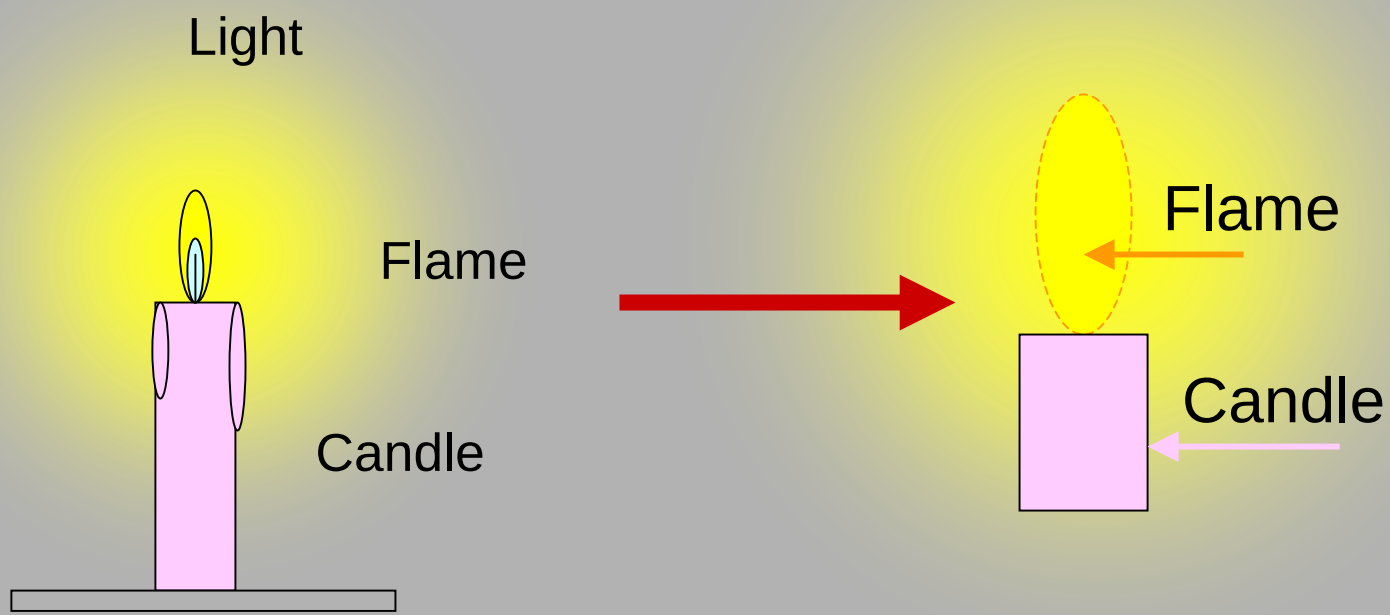
- a new function

UE = “Insufficient light”



Simplify to two objects in contact containing the problem

UE = “Insufficient light”



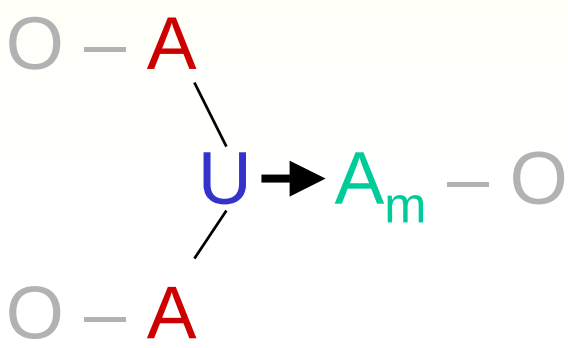
Analyze & model for clarity ➔

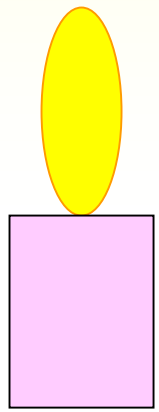
Simple model:

Flame – Temperature

Insufficient light → Visibility – Table

Fuel – Rate of combustion





Two objects

Flame

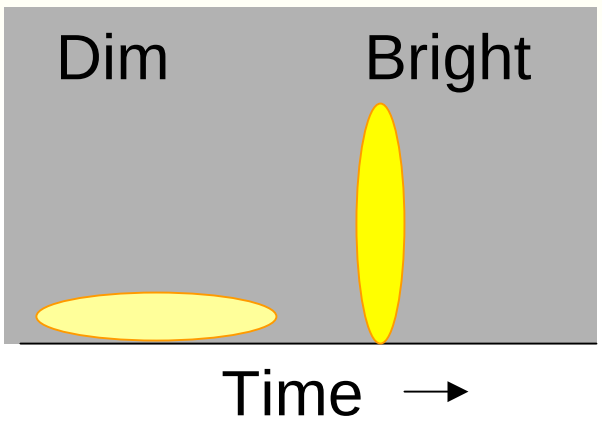
Fuel (generic name for candle)

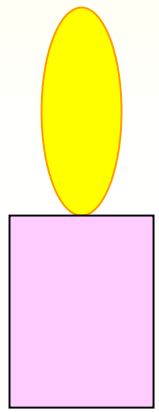
Analyze & modify

Plasma – Temperature

Insufficient light → Visibility – Table

Fuel – Rate of combustion





Two objects

Flame

Fuel

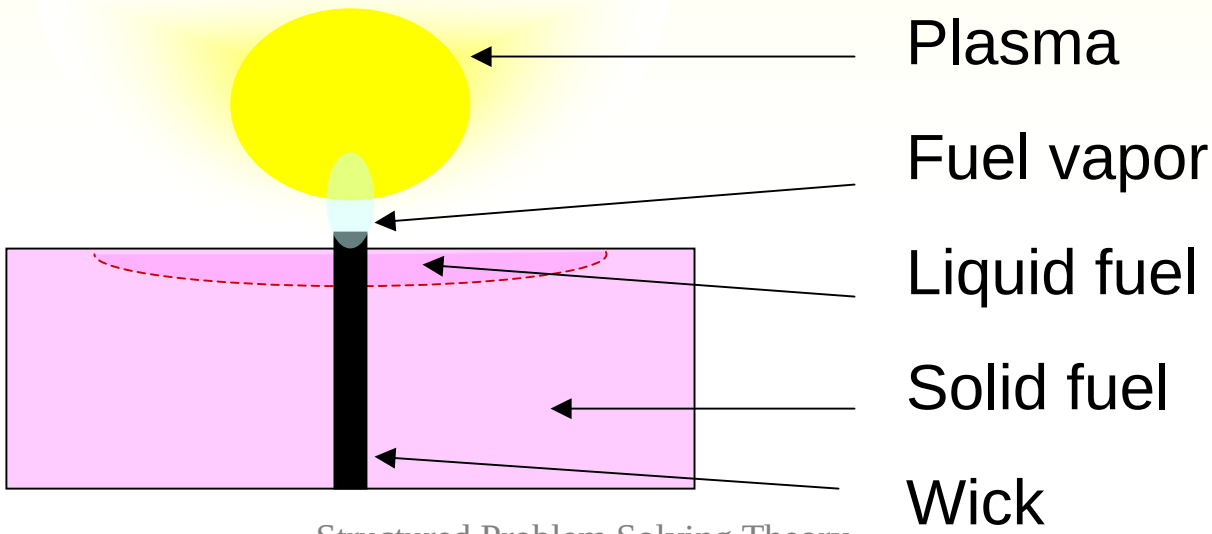
Analyze & modify

Plasma – Tempera

Insufficient ligh

Fuel – **Rate of combustion**

Attribute raises question of what determines rate? Takes us to the next level of insight.



Solution strategies need to be

- simple,
  - graphic, and
    - metaphorical with

minimum structure,
and expressed generically

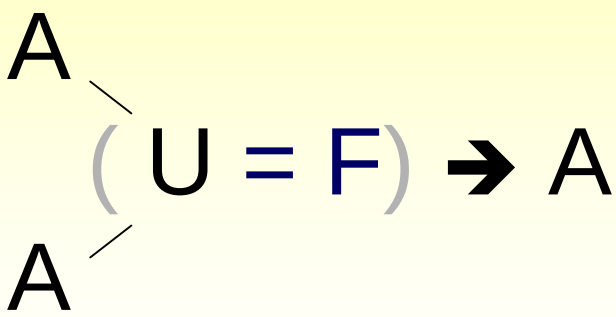
Goal of SOLUTION
Is to resolve an unwanted effect.

There are 3 solution strategies

- Utilization
  - Nullification
    - Elimination

The 3 Generic Solution Strategies:

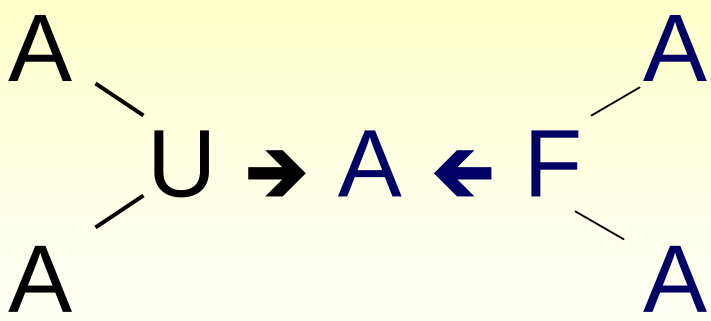
1. Utilization



U becomes a function, F

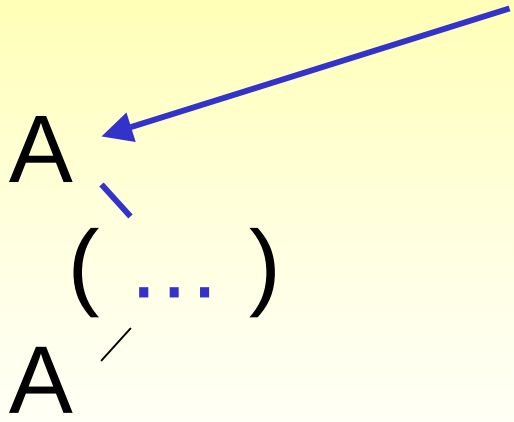
(Examine space/time dependence)

2. Nullification



A new function is introduced, F, to counteract U.

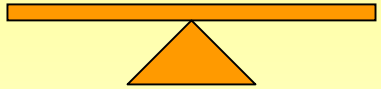
3. Elimination



Deactivation of a causal attribute

(Decouple interaction of objects)

LH⇔RH Heuristics



METAPHORS

Mental attitudes for simplifying problem solving and encouraging more innovative solutions by engaging RH metaphorical resources …

METAPHORS

- Recognize that order and logic can encourage LH-logic versus RH-metaphorical thinking.
- Use structure as a heuristic not as a necessity.
- Components not order of structure are important.

METAPHORS

- Use simple sketches to engage RH metaphorical thinking.
- Match verbal descriptions with graphic expressions.
- Suspend judgment of ideas in order to encourage intuitive leaps of insight.

METAPHORS

- Simplify a problem to a single unwanted effect and minimize the number of objects in order to enable a holistic view of a problem.
- Seed the subconscious with verbal metaphors.
- Start with solutions.

METAPHORS

- Iterate between solution, analysis, and definition in steps rather than complete one before moving on.
- Search concepts at every step.
- Follow your inspiration.

The goal of a methodology is to spark new concepts from new viewpoints.

By understanding how we think, and by motivating metaphorical participation of both brain hemispheres in problem solving, we can learn, practice, and teach problem solving with innovative effectiveness.

With language we search the depths of our rational thinking.

With metaphor we search the depths of our imagination.

Together they inspire insight and innovation.

Ed Sickafus
2006

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To be creative

U-SIT

and think

Integrate logic and metaphors

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