

Seminar Presentation  
Faculty of Chemical Engineering  
CASE Western University

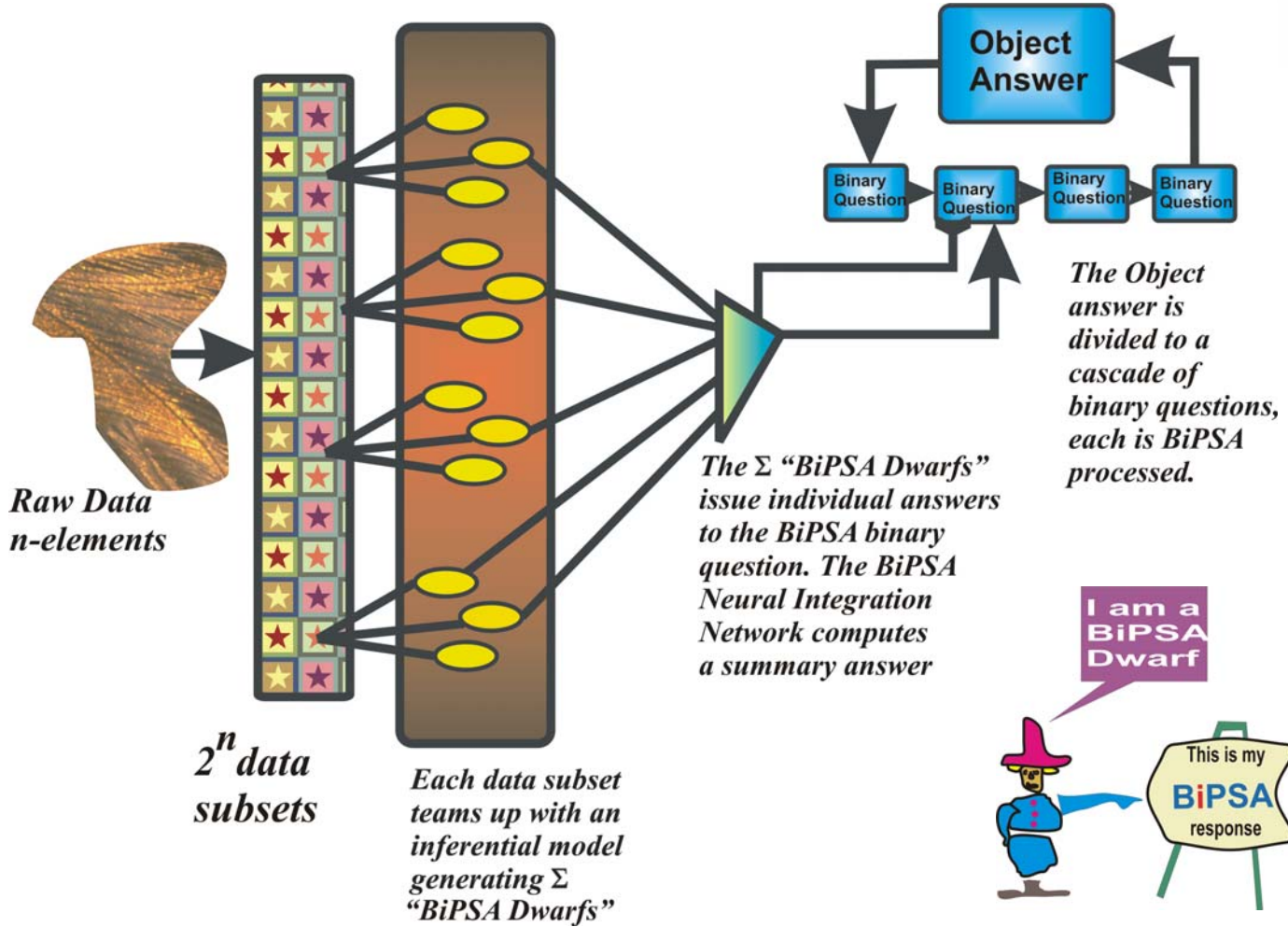
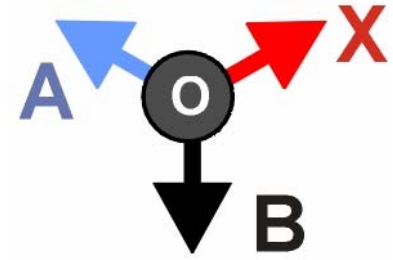
Gideon Samid

# Towards a Universal Theory of Innovation

R&D Binary Cascade: The Innovation Turing Machine

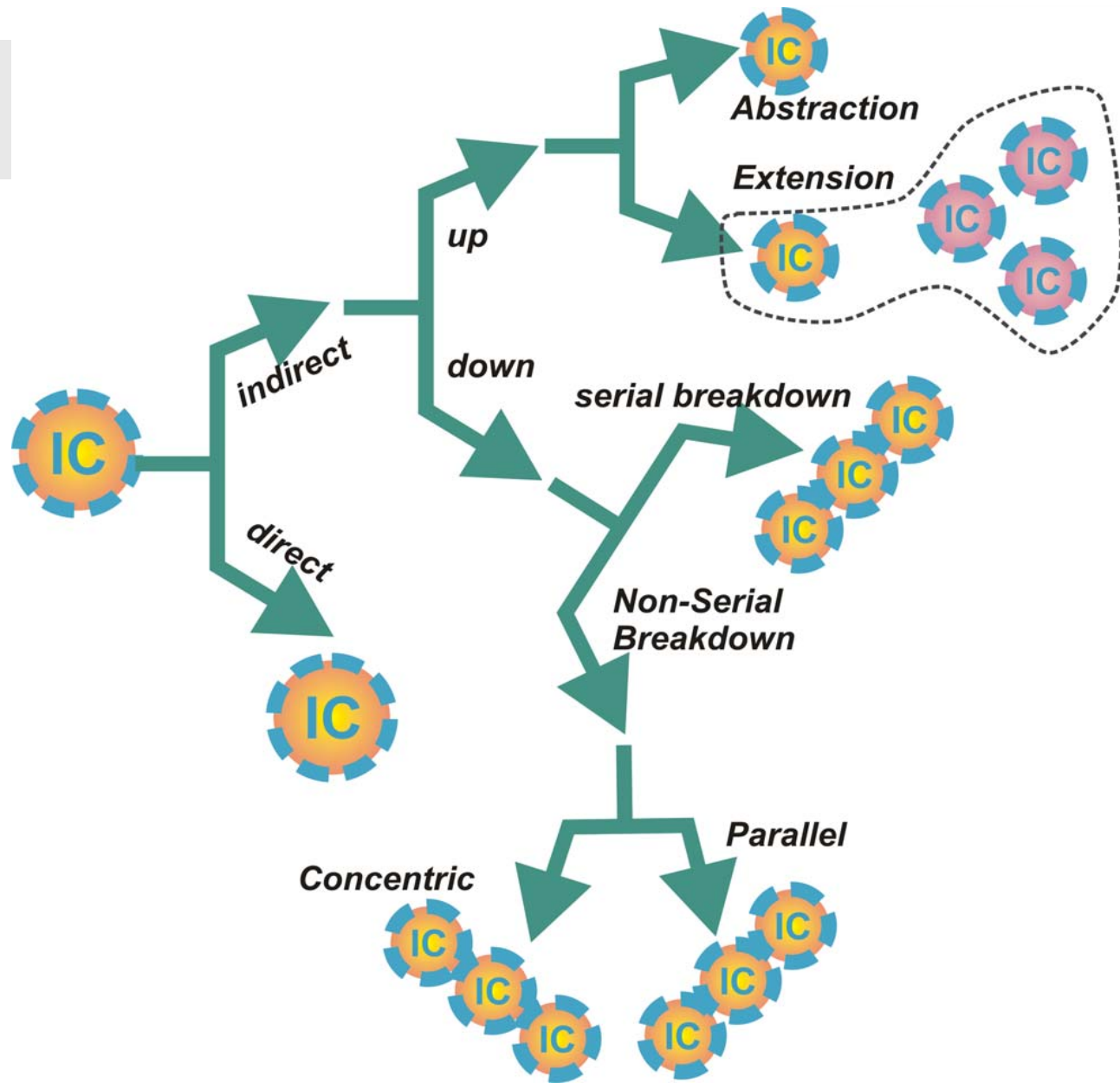
**NOVEMBER 2006**

# The BiPSA Way



# “Binarization” of R&D Challenges

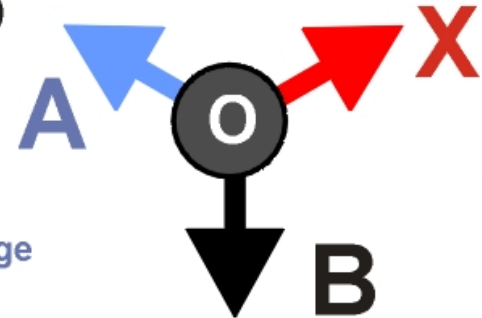
- A Generic and Comprehensive Framework for handling Innovation Challenges (ICs)



## The Innovation Turing Machine

# The Innovation Turing Machine

Every R&D challenge (the root challenge) may be handled four ways. One is direct resolution. The other three are:

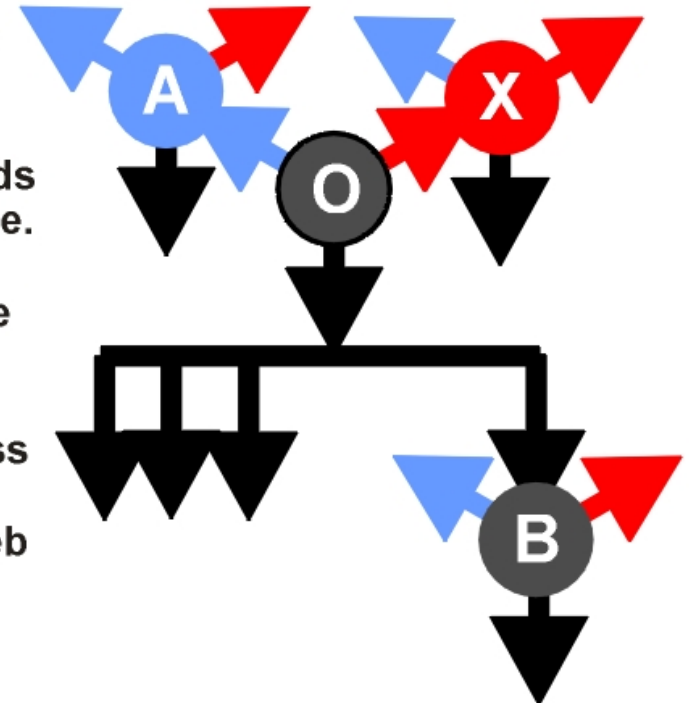


1. Breakdown (B) into components.

2. Abstraction (A): redefining the challenge with greater abstraction.

3. Extension (X): combining the challenge with similar ones into a larger challenge.

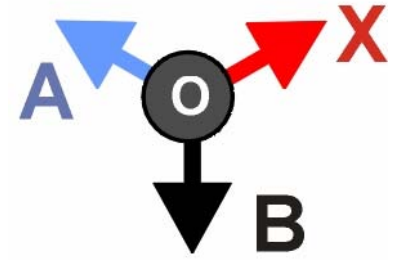
Breakdown leads to two or more component challenges; abstraction and extension each leads to a single new challenge. Each of the new challenges may again be handled four ways.



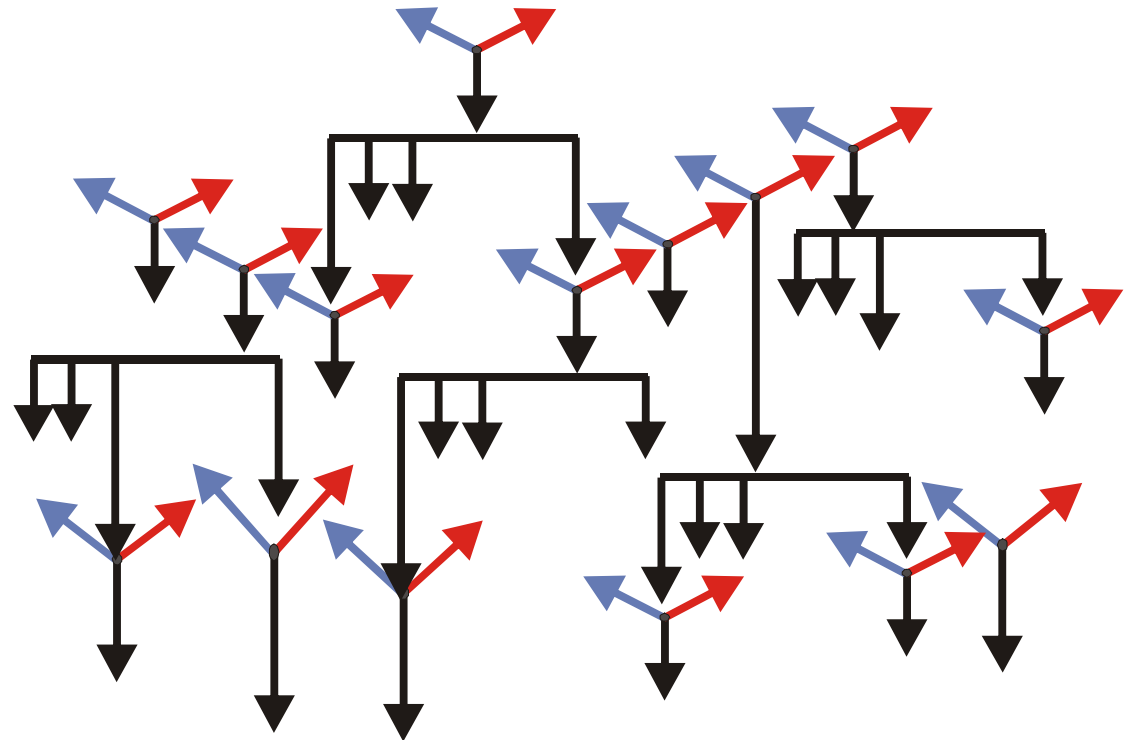
By repeating this process one constructs a Universal Innovation Web that may express any innovation process.

- ITM:  
Recursive  
Definition of  
an R&D  
challenge

# The ITM Web



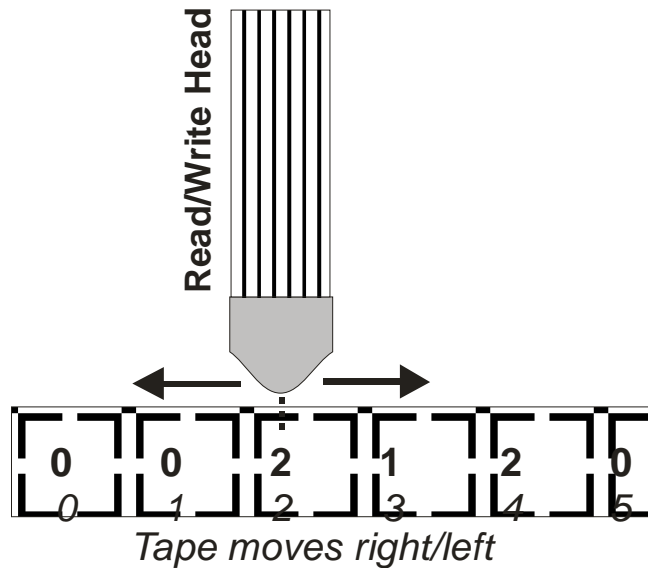
- Each IC leads to several possible emerging ICs. Applied recursively one builds an ITM-Web, which serves as the **Innovation Roadmap**.



# The Innovation Turing Machine

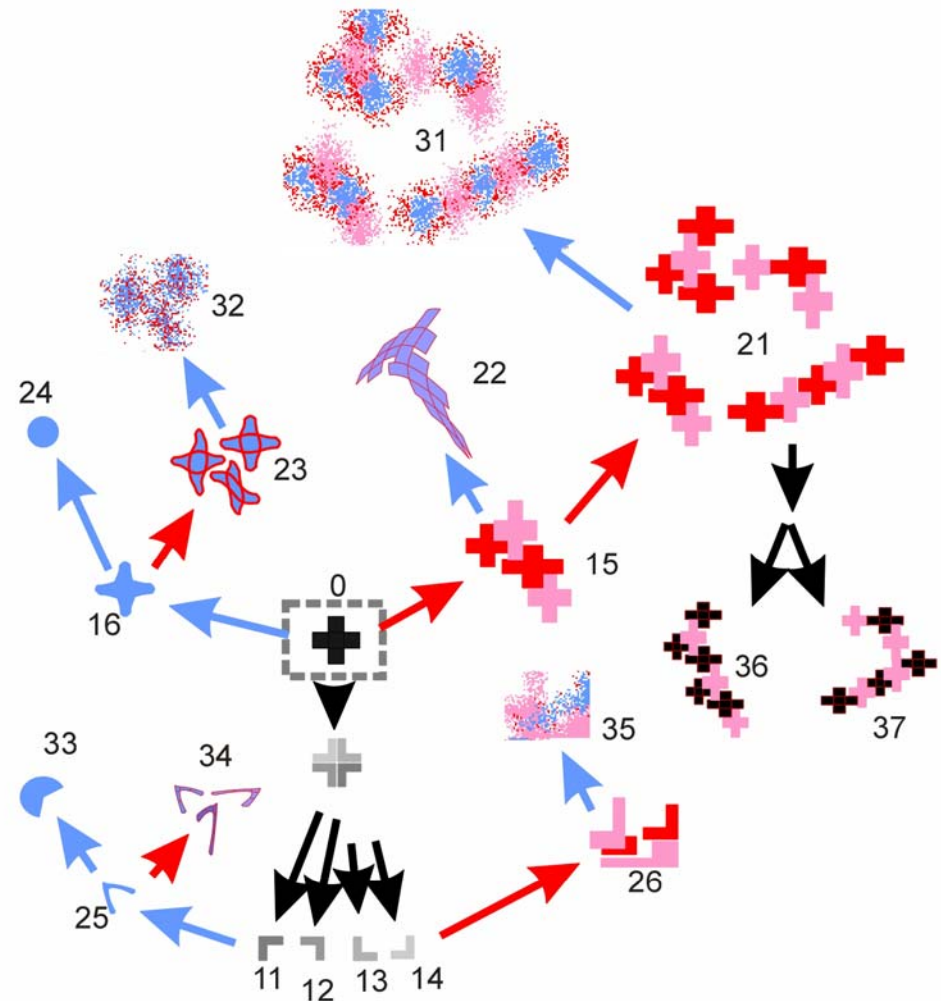
## The Turing Inspiration

### Innovation Turing Machine



If the head writes a higher number on a given square, the tape moves to the right one square, if not, it moves one square to the left. The starting values of all squares is zero. The program terminates successfully if the head writes "1" on the first square.

The squares express set of derives R&D challenges. The first square on the tape represents the original R&D challenge.



The Original challenge 0 is broken down to four components: 11,12,13, and 14. It is also abstracted into challenge 16, and extended into challenge 15. Challenge 11 is abstracted into challenge 25, which in turn is further abstracted into challenge 33, and extended into challenge 34. Challenge 14 is extended into challenge 26, which in turn is abstracted into challenge 35. Challenge 16 is abstracted into challenge 24, and extended into challenge 23, which in turn is abstracted into challenge 32. Challenge 15 is abstracted into challenge 22, and extended into challenge 21, which in turn is abstracted into challenge 31, and broken down to 36, and 37..

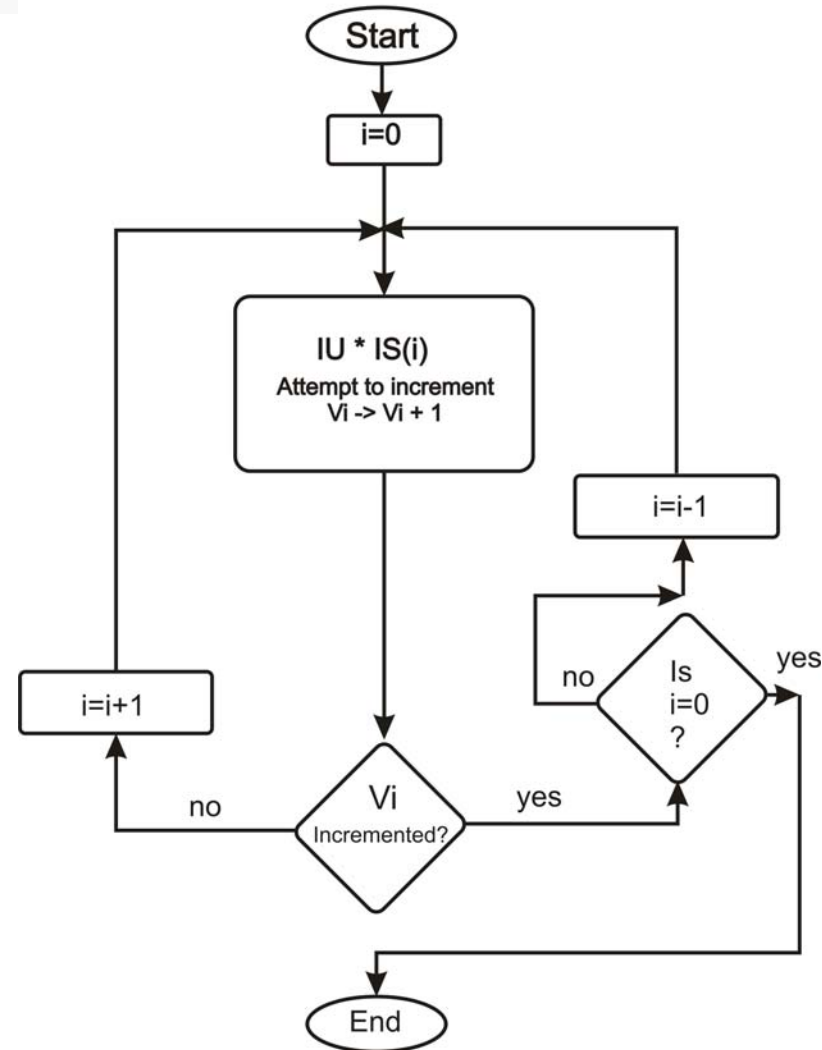
# The Overall ITM Procedure

One tries to resolve any IC within a generation. If successful, retreats a generation. If not, moves forwards to the next.

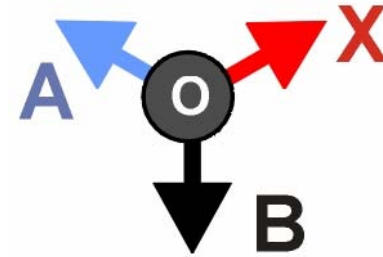
After some up and down, the attention reverts to the original challenge, which is by then duly resolved.

## The Innovation Turing Machine -- Main Procedure

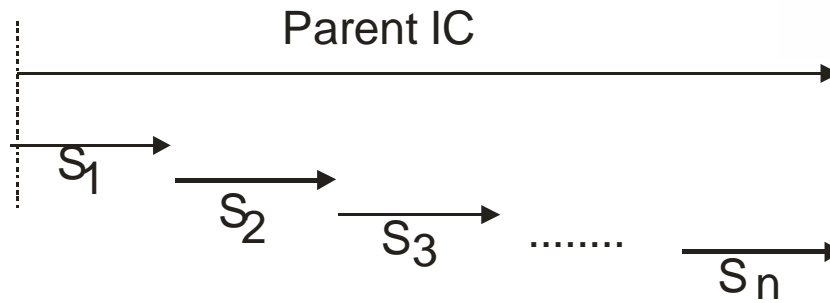
Attention shifts between innovation sets based on the result of the effort to increment the value of the current set. If successful, the lower set is focused on, otherwise, the next-upper set becomes the target. Intractable innovation challenges would entail a "trip" to many higher-up sets before the zero-set (the original challenge) is resolved.



# IC Breakdown

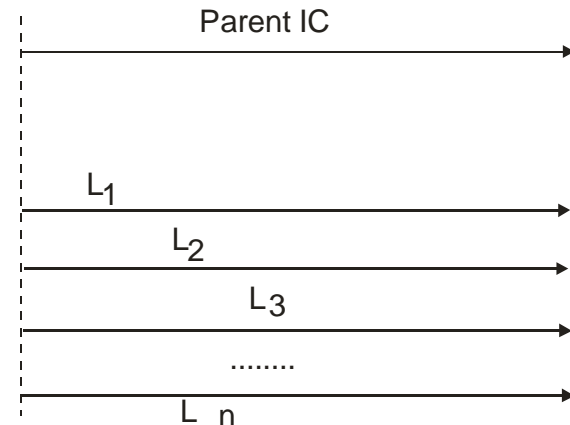
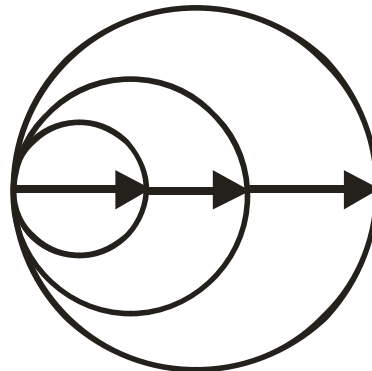


- Serial, Parallel, or Concentric



IC Serial Breakdown

All components must be accomplished for the parent IC to be done.



IC Parallel Breakdown

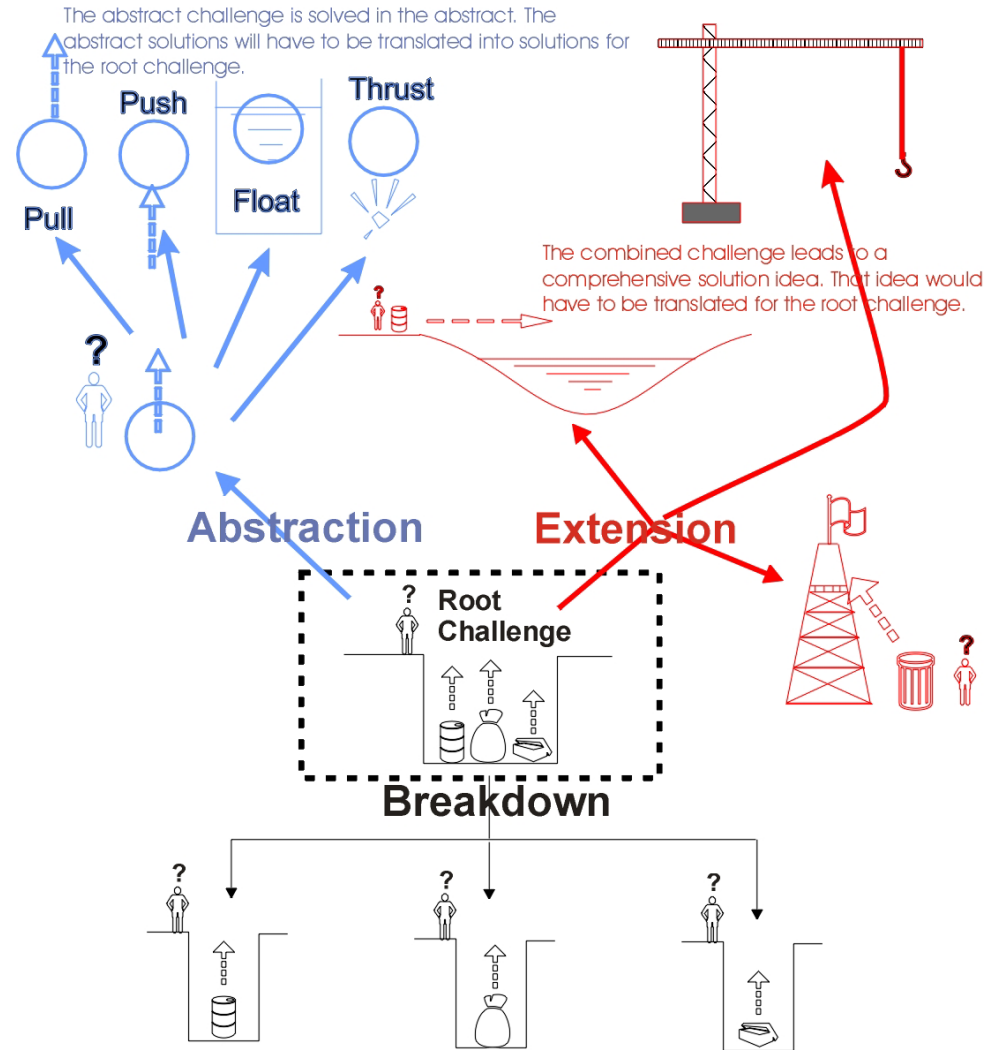
If any component is accomplished then the parent IC is done.

# ITM Illustration

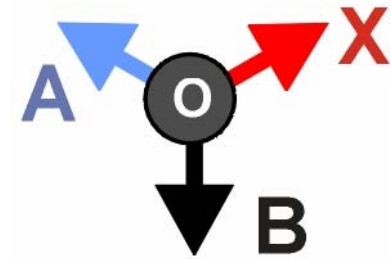
The root challenge can be “attacked” three ways: breaking down to serial elements, re-defining the subject with greater abstraction, combining the challenge with similar ones.

## The Innovation Turing Machine

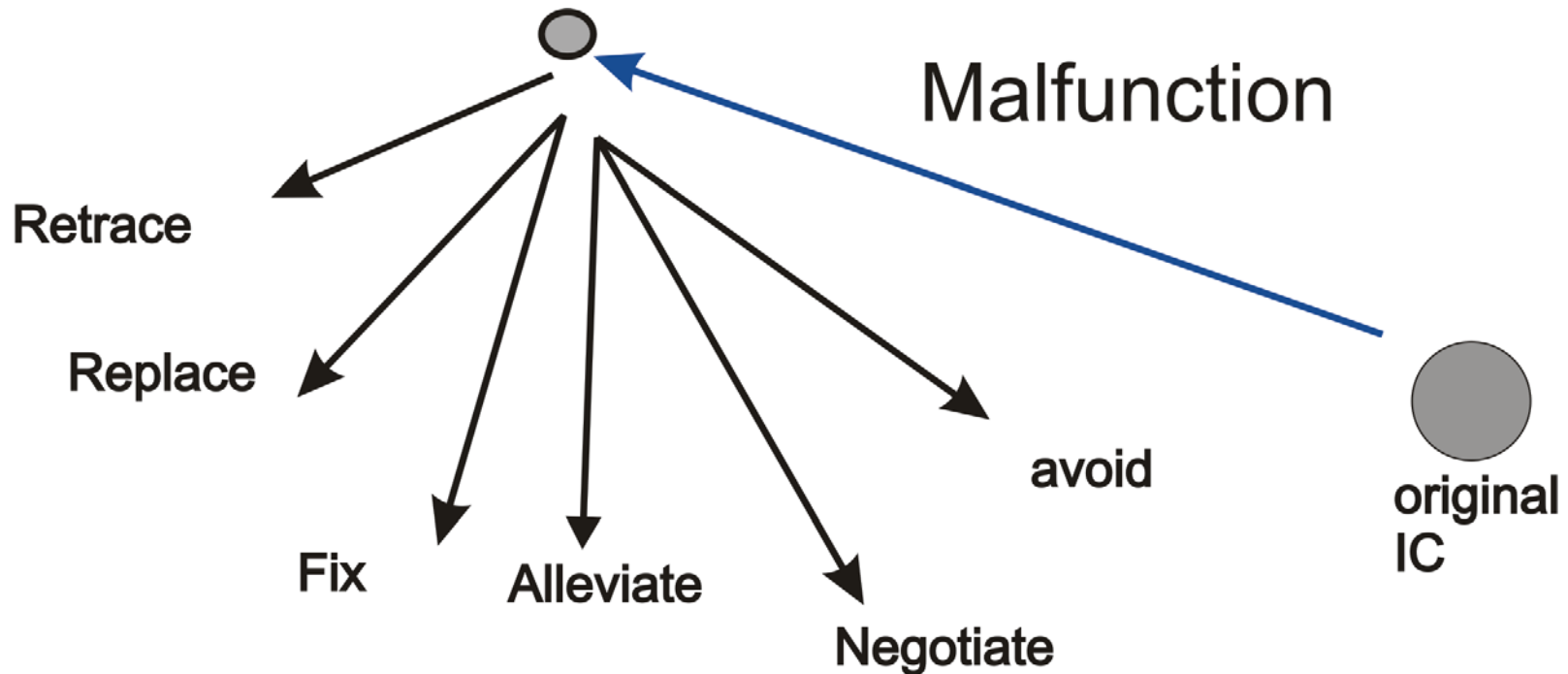
The Root Challenge may undergo a “breakdown” to components; it may be redefined with greater abstraction, or it may be extended with similar challenges to a larger challenge.



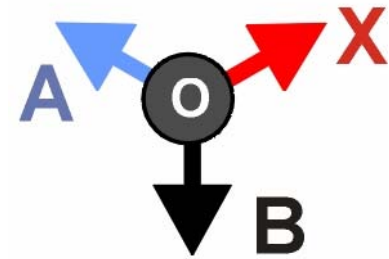
# Malfunction



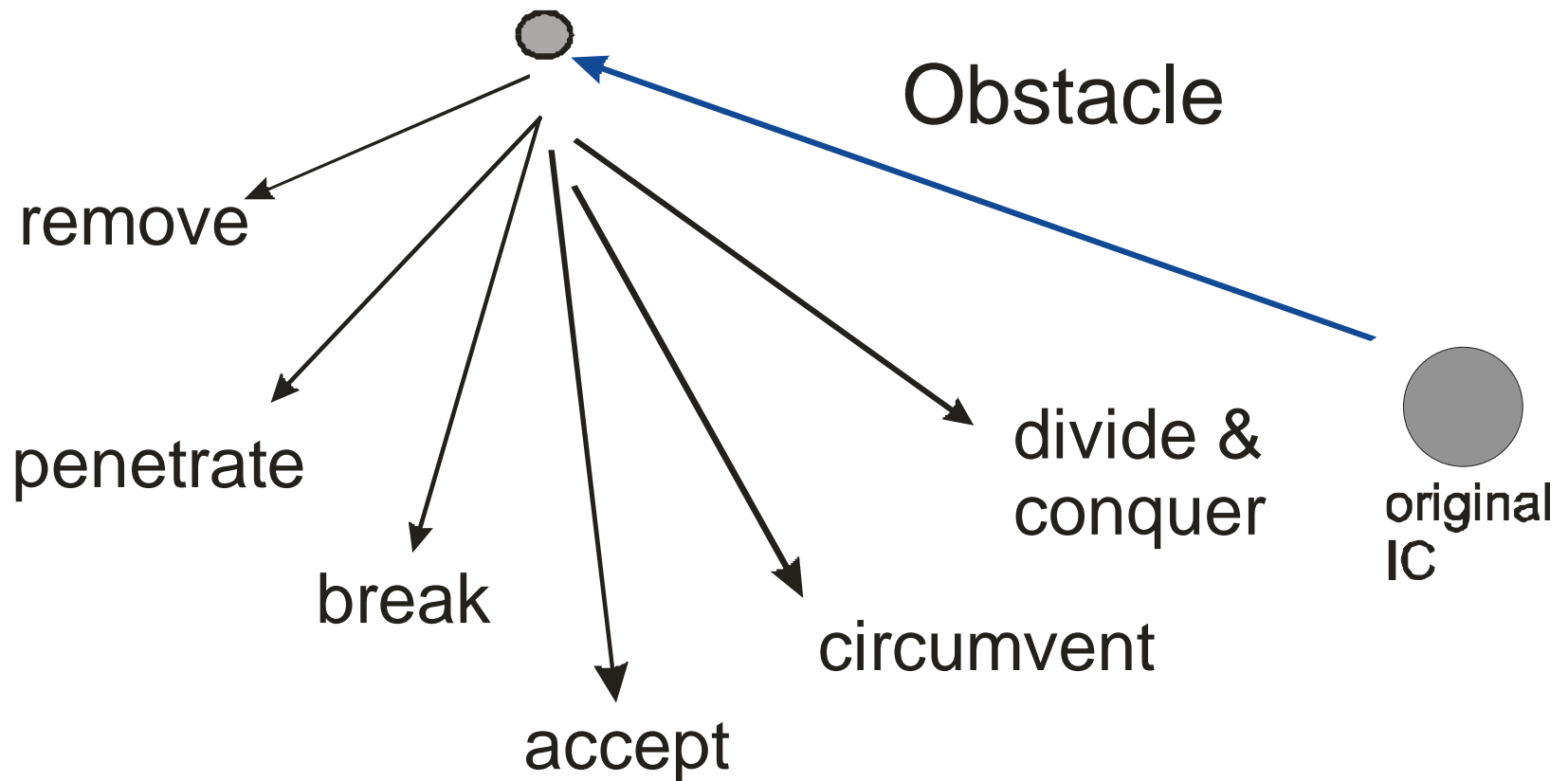
- Abstraction followed by parallel breakdown.



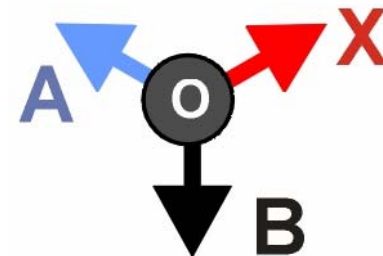
# Obstacle



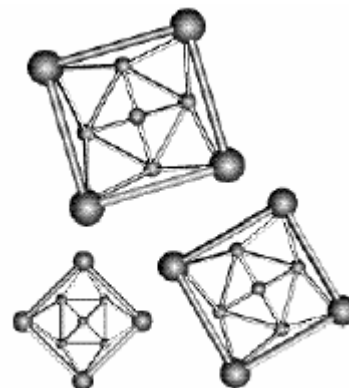
- Abstraction followed by parallel breakdown



# Chemistry Innovation



- Process – Tailored
- Search – Compound

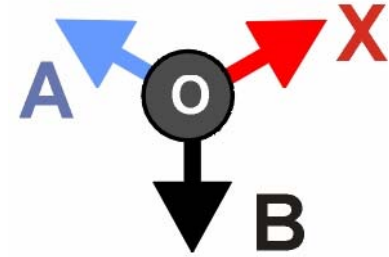


**General Sequence:  
Extension-Abstraction-Concentric Breakdown**

**Minimize physical experimentation through  
theory and modeling.**



# Process

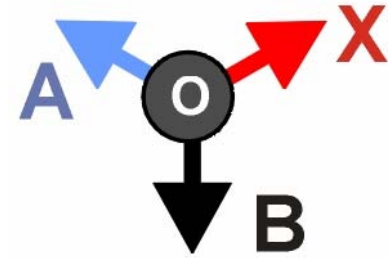


- Assemble similar challenges, and perform an abstraction over the set, followed by a concentric breakdown.

## *Typical Issues:*

- Equilibrium
- Pace
- Side Effects
- Discrimination

# Process Abstraction

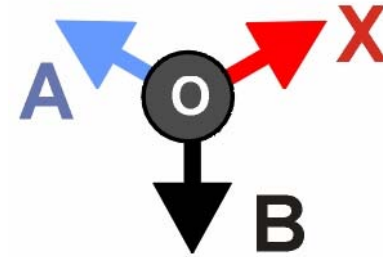


- $A \Leftrightarrow A^*$
- $A \Leftrightarrow B$
- $A \rightarrow B; A \rightarrow C; \dots$
- $A + B \rightarrow C + D$
- $A \rightarrow B + C + D + \dots$
- $A + B + C + \dots \rightarrow Z$

## Solutions:

- ✓ Add feed
- ✓ Remove product
- ✓ Remove necessary side
- ✓ Add competing side
- ✓ Excess and winnow
- ✓ Minute and Extraction
- ✓ Parametric Optimization

# Process Extension

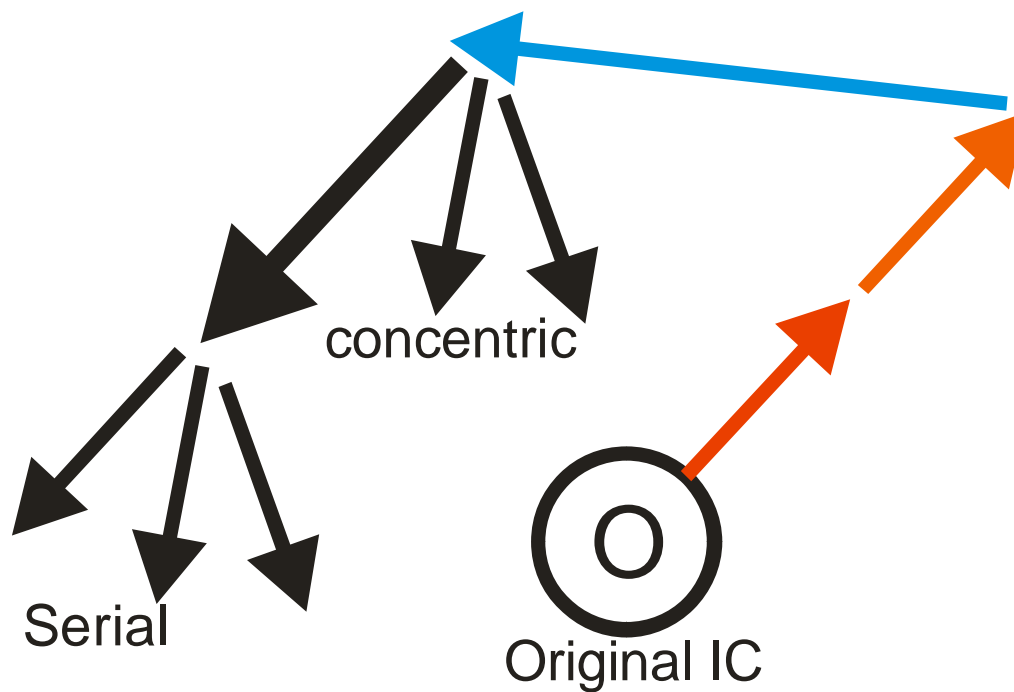
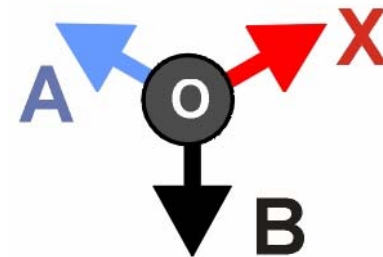


## Build and Abstract an Extension Matrix:

- List parameters of interest
- Rank order the parameters
- Sort extension candidates parametrically
- Define the extension set.
- Abstract the set
- Attack the abstraction

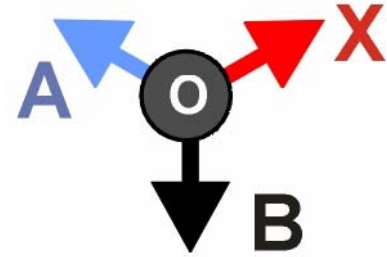
<b>Re-Scaling</b>	Dimension
	Size
	Pace
	Density
<b>Search &amp; Detection</b>	Complexity challenge
	Scarcity Challenge
	Field Size Challenge
	Identification challenge
	Physical target
	Abstract (functional) target
	Guaranteed target existence
<b>Monitoring &amp; Control</b>	Sensory and Reading challenges
	Effecting Changes Challenges
	Control Strategy and Computation Challenge
	Self System Control

# Typical Chemistry ITM Pathway



One or two extension stages, followed by an abstraction step, which is broken down to concentric elements, then to serial ones before backtracking

# Summary



- R&D work may be mapped onto a recursive procedure: The Innovation Turing Machine.
- Every Innovation Challenge, IC, can be handled directly, or broken down to elements, or abstracted, or extended.
- The ITM framework guides the innovation process, and provides for BiPSA to be applied.