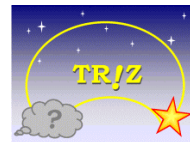
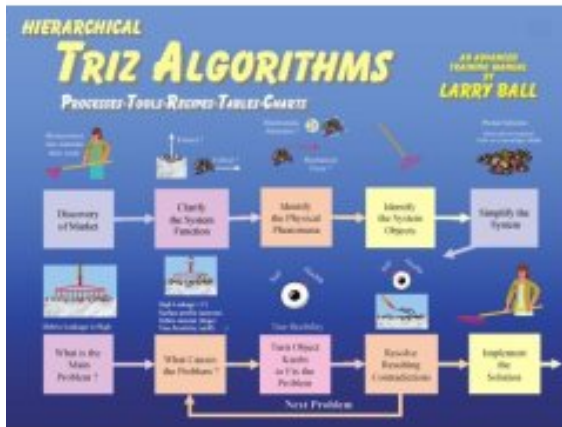


Larry Ball (Honeywell, USA)

Aug. 30 – Sept. 1 2007



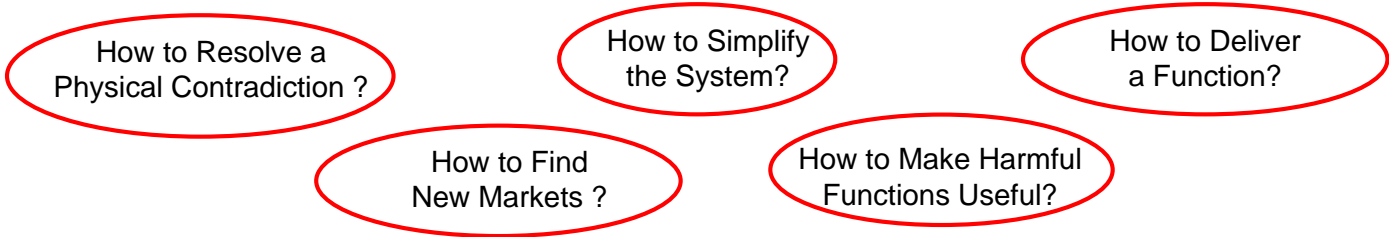
Translated by Toshio  
Takahara and Toru  
Nakagawa for the TRIZ  
Home Page

## Agenda

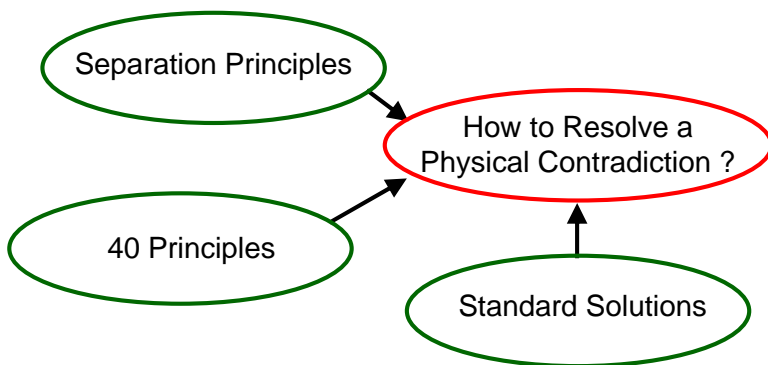
- Clarifying or Modifying TRIZ Theory
- A Hierarchy of Tools
- Solution Directed Causal Analysis
  - Different Forms of Causal Analysis
  - Function / Attribute Centric Causal Analysis
- How to Use the Results of the Causal Analysis
  - Functional Ideal Final Result
  - Discovering / Resolving Contradictions
- Additional Separation Principles
  - Beyond Separation in Time, Space and the Parts and the Whole
  - How to Know When Each is Possible to Use
- Summary

# How Do We Move to the Next Level of Innovation Theory?

- Different types of innovation problems



- Each problem type requires different tools
- Classical TRIZ Tools Overlap



**It is difficult to see patterns with so many duplications and overlaps**

## Clarifying Theory

1. Gather data

15 4 8 27 16 12 21 17 10 20 2 18 23

2. Group into “like” groups

18 4 8 10 12 2 20 16

17 23 21 15 27

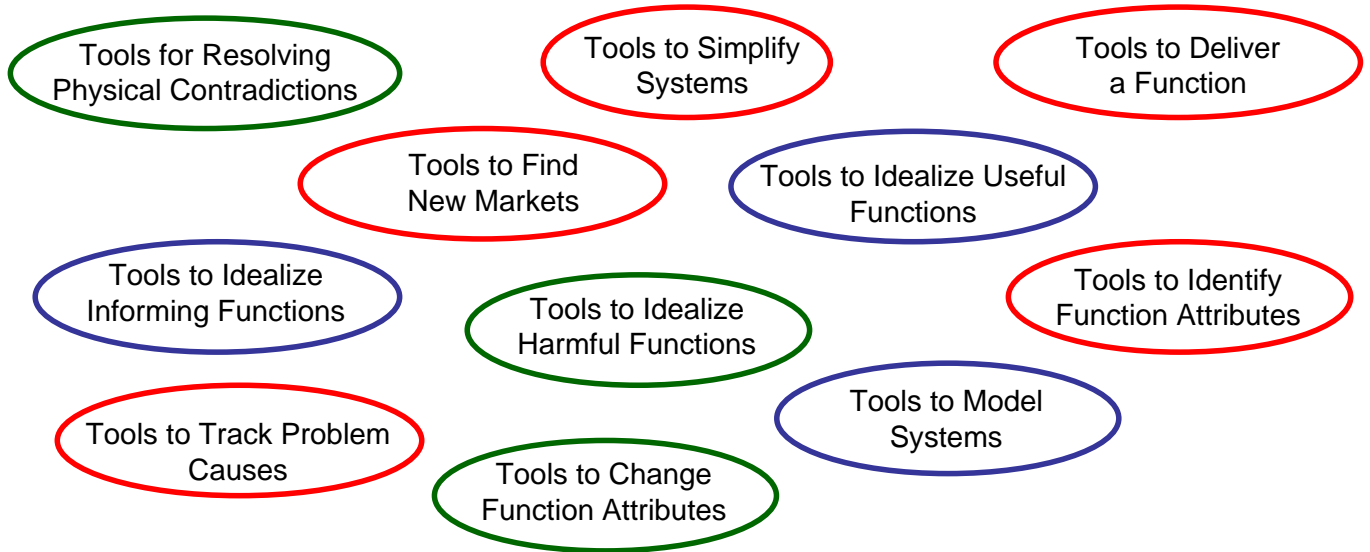
3. Identify patterns and exceptions

2 4 ○ 8 10 12 ○ 16 18 20

15 17 ○ 21 23 ○ 27

# Clarifying Innovation Theory

## 1. Decompose and Regroup into Like tools



## 2. Patterns begin to emerge

## 3. Advantages:



Where Start



Find Home

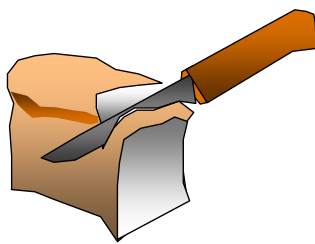


Identify Exceptions



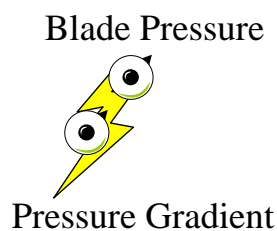
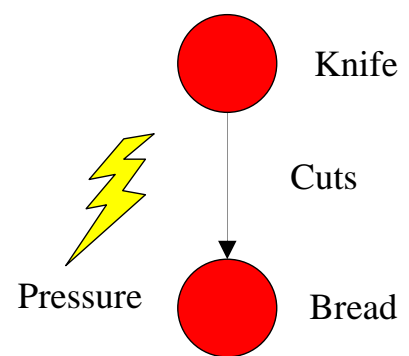
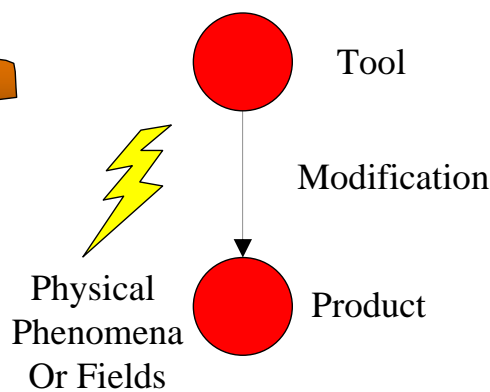
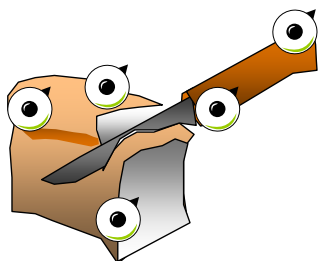
See Weaknesses

# Functional Nomenclature

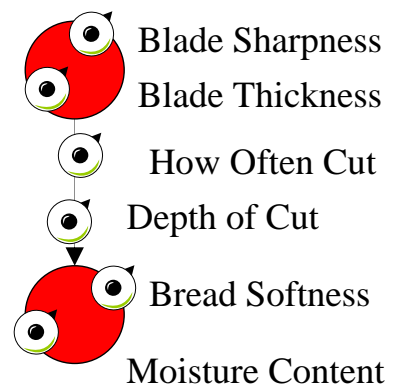


Knobs = Attributes

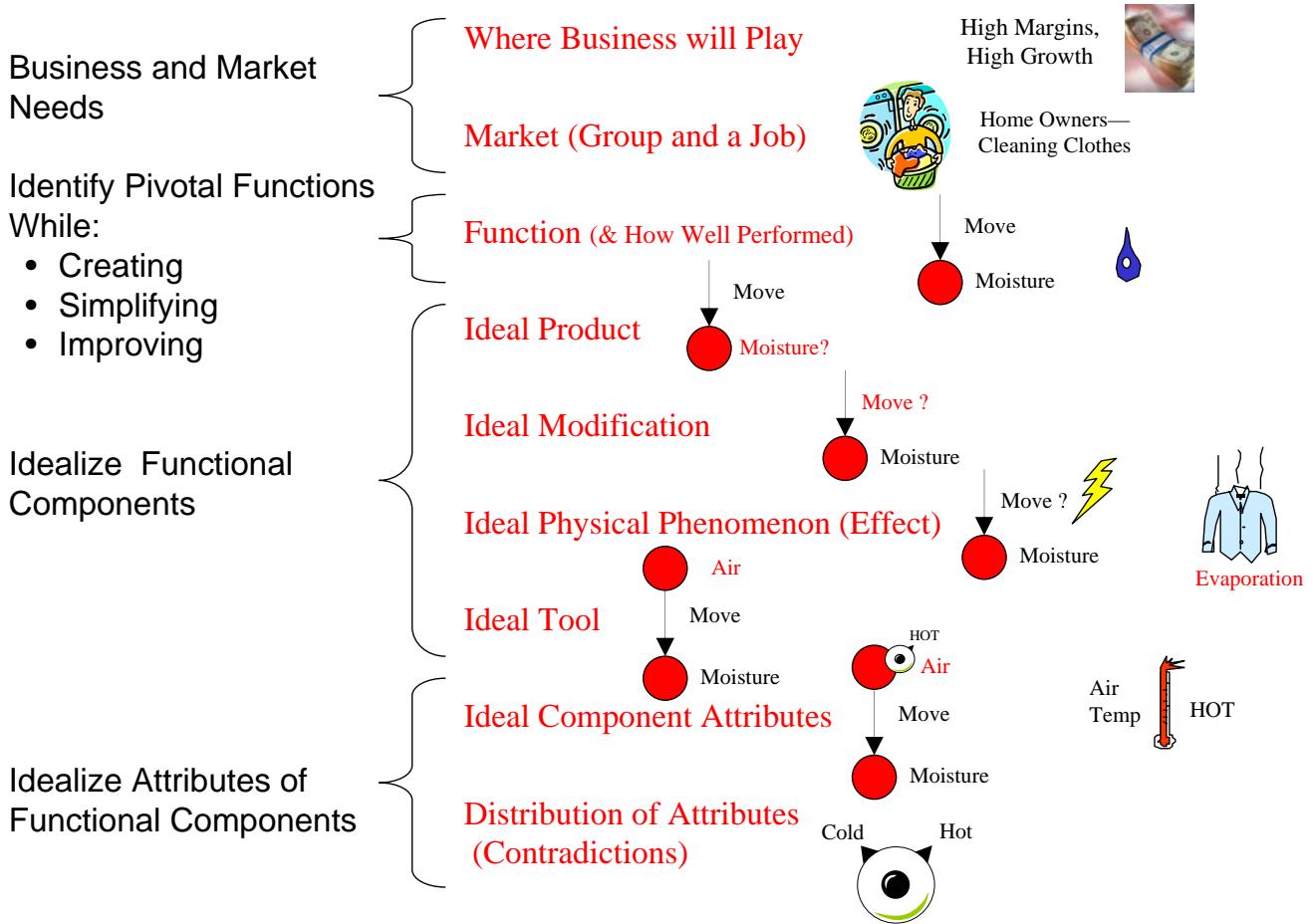
Settings = Level of the Attribute



Pressure Gradient

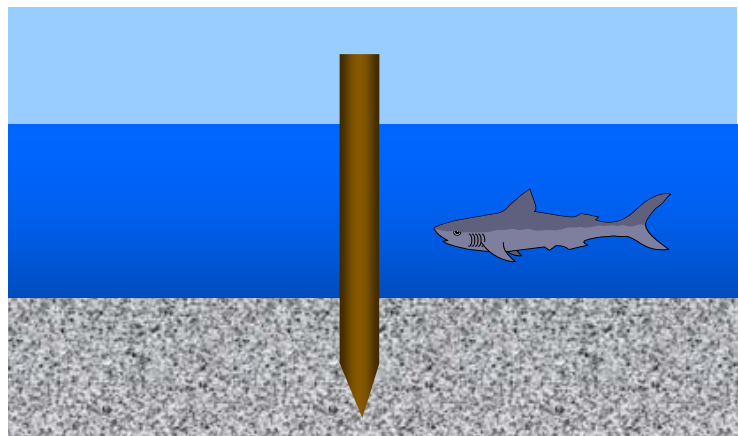


# Hierarchy of Decisions



## Causal Analysis Pile Driving

The driving speed of piles is very slow. Often expensive equipment and personnel wait while driving progresses. How can the driving speed be improved?

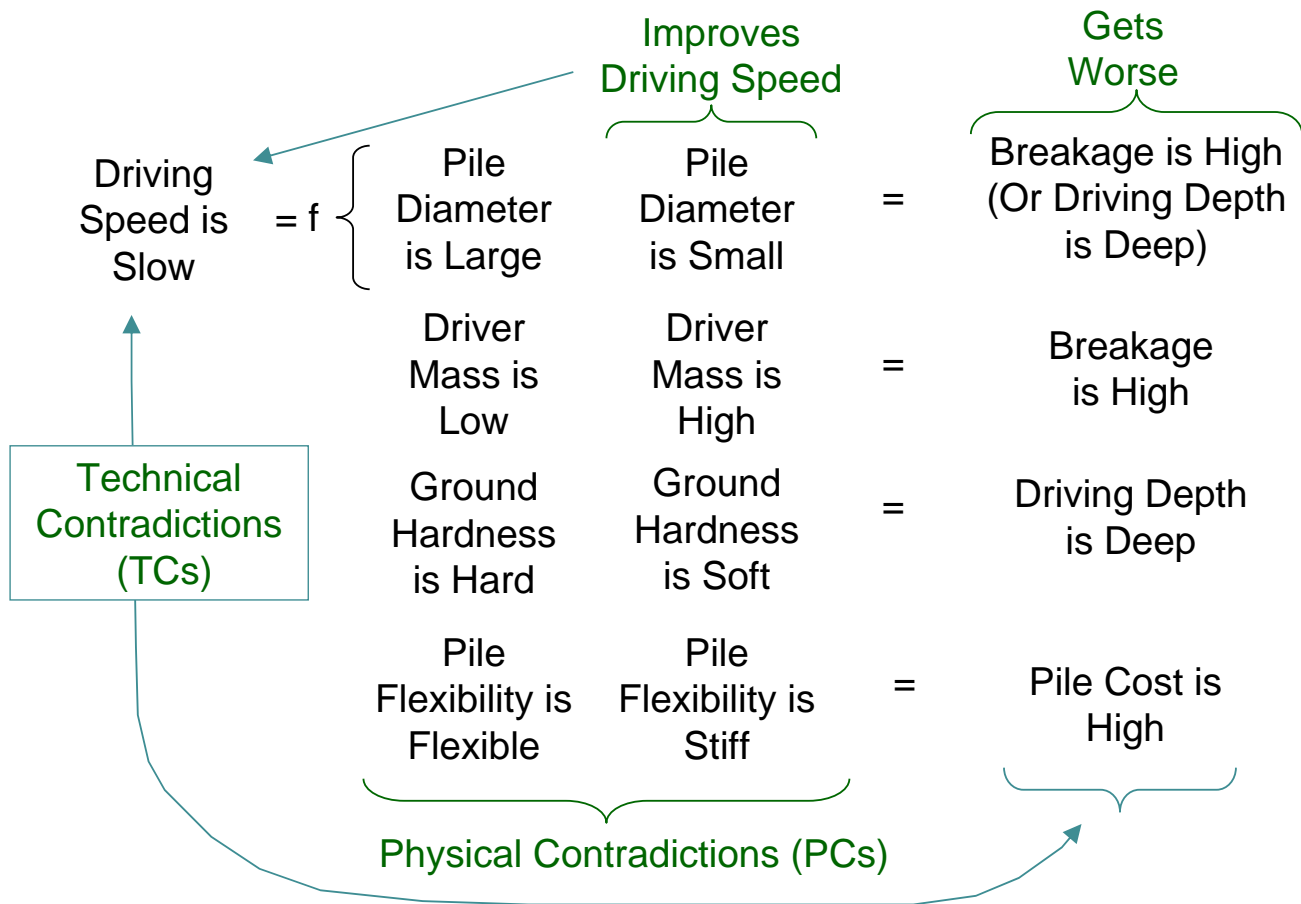


Simple Causal Analysis:  $Y = f(X_1, X_2, X_3 \dots)$

Y = Driving Speed  
What are the Knobs?

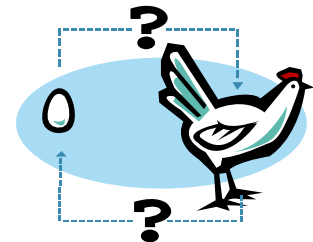


# Simple Way to Find Contradictions Starts with a Simple Causal Analysis



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Which do You Discover First : the Technical or Physical Contradiction?



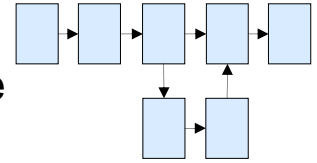
- 1 Driving Speed is Slow = f { Pile Diameter is Large
- 2 Pile Diameter is Small
- 3 Pile Diameter is Small =
- 4 Breakage is High (Or Driving Depth is Deep)

## What about ARIZ ?

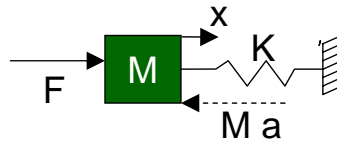
ARIZ Starts by identifying a TC and THEN tries to discover the PCs—The Causal Logic is Incorrect

# Different Types of Causal Analysis

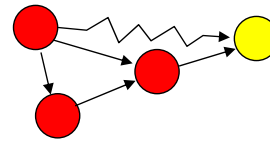
- **Process Centric** (Products are also Processes)
  - Break down interactions finer and finer in time



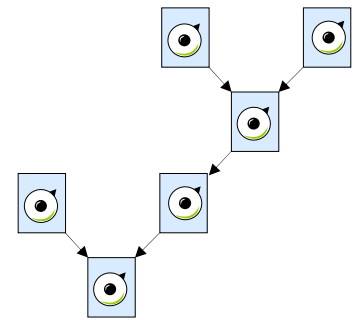
- **Model Centric**
  - Models and Equations
  - Understand relationship of attributes to results



- **Function Centric**
  - Shows Why Objects are required
  - Shows How they Interact




- **Attributes Centric**
  - What causes attributes to be what they are
  - Break down finer and finer showing causes



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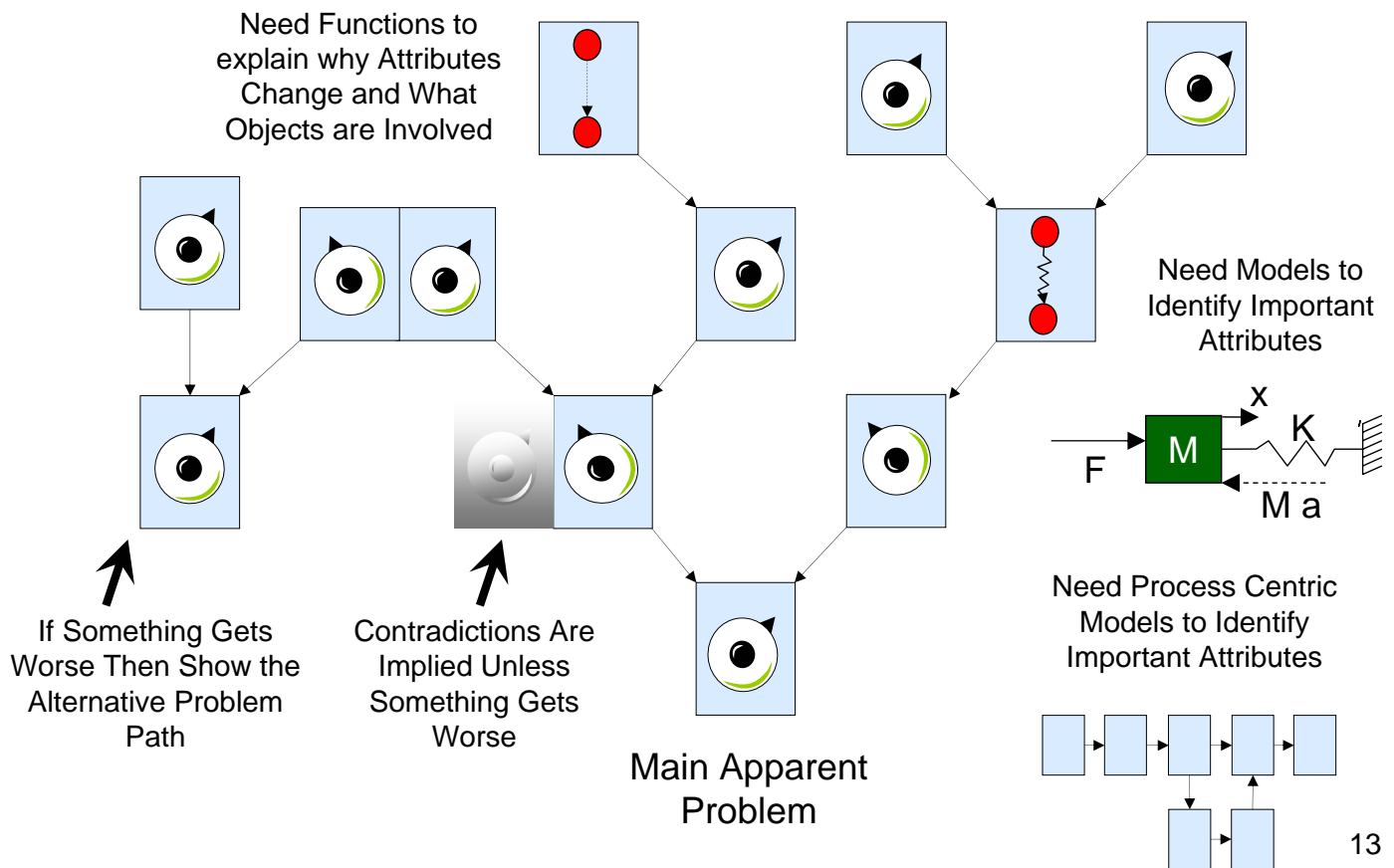
## Higher Levels of Causal Analysis Will Reveal the Following:

- MANY attributes that cause the problem ( $X_1, X_2, X_3, \dots$ )
- The Chain of Causes 
- How the problem progresses in time
- Contradictions
- Alternative problems (Solve these instead)
- How evidence matches theory

Understanding is Incomplete  
Without Any of These

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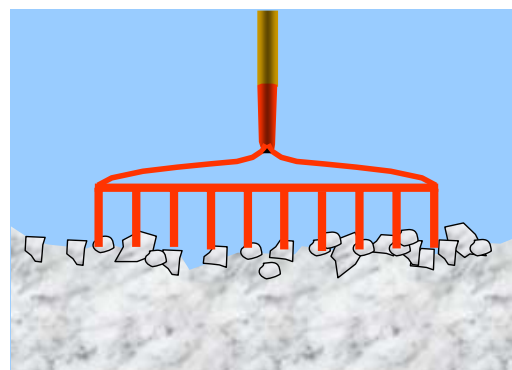
# Function / Attribute Centric Model (Compact Version)

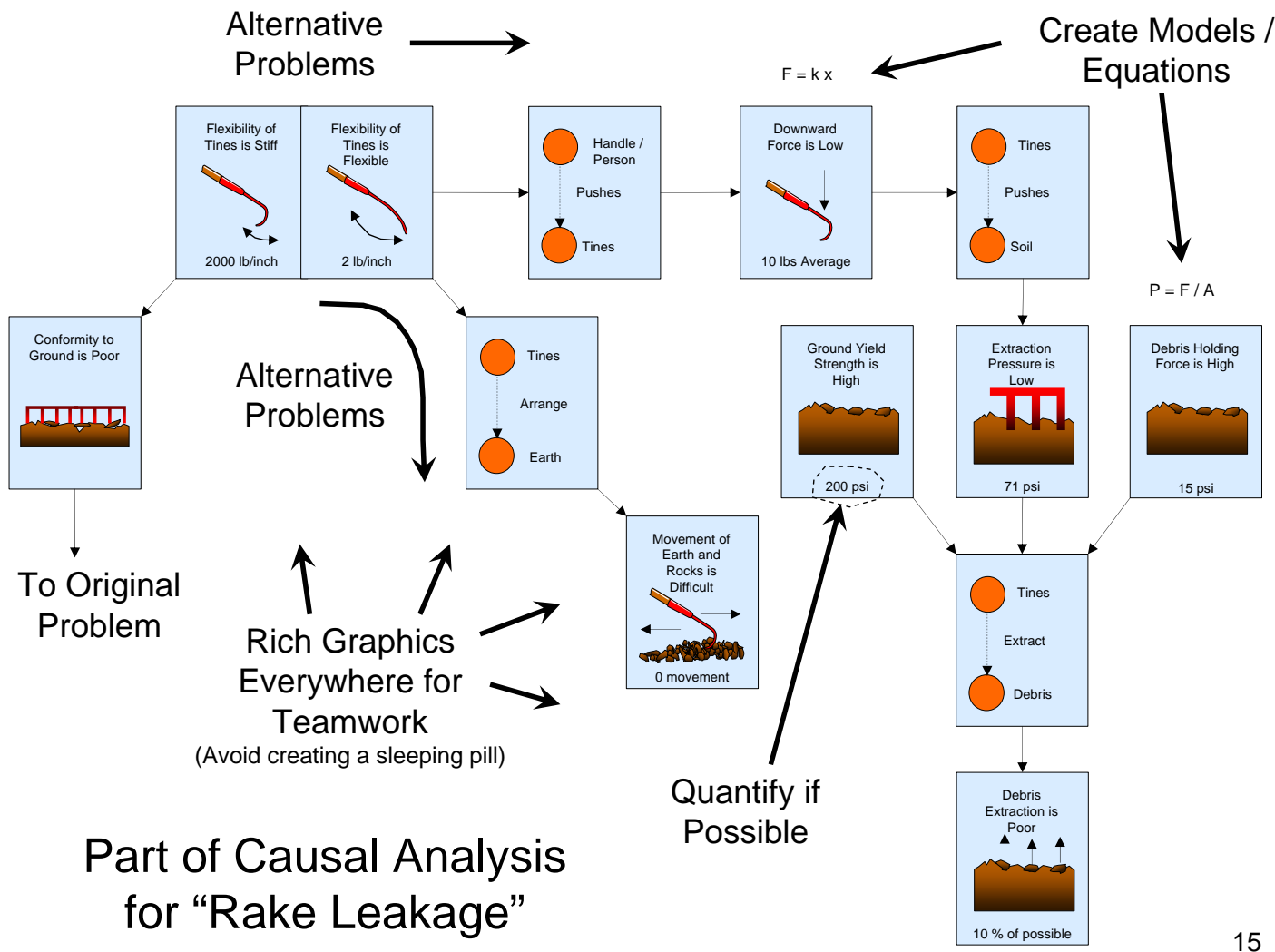


## Causal Analysis

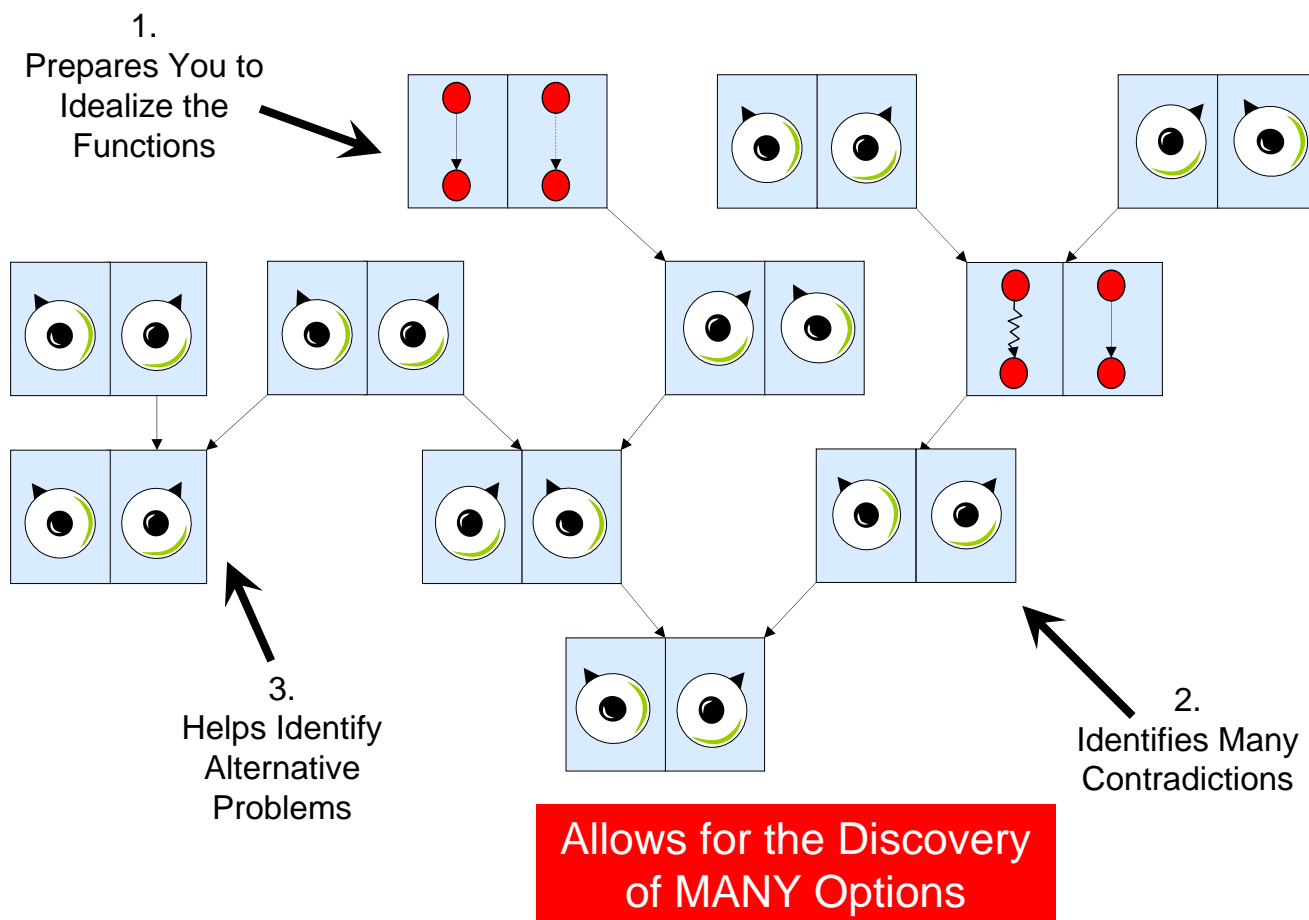
Rake problem: Formal Causal Analysis can be Downloaded from the TRIZ Home Page in Japan

How to reduce the amount of debris that escapes under and through the tines as raking occurs



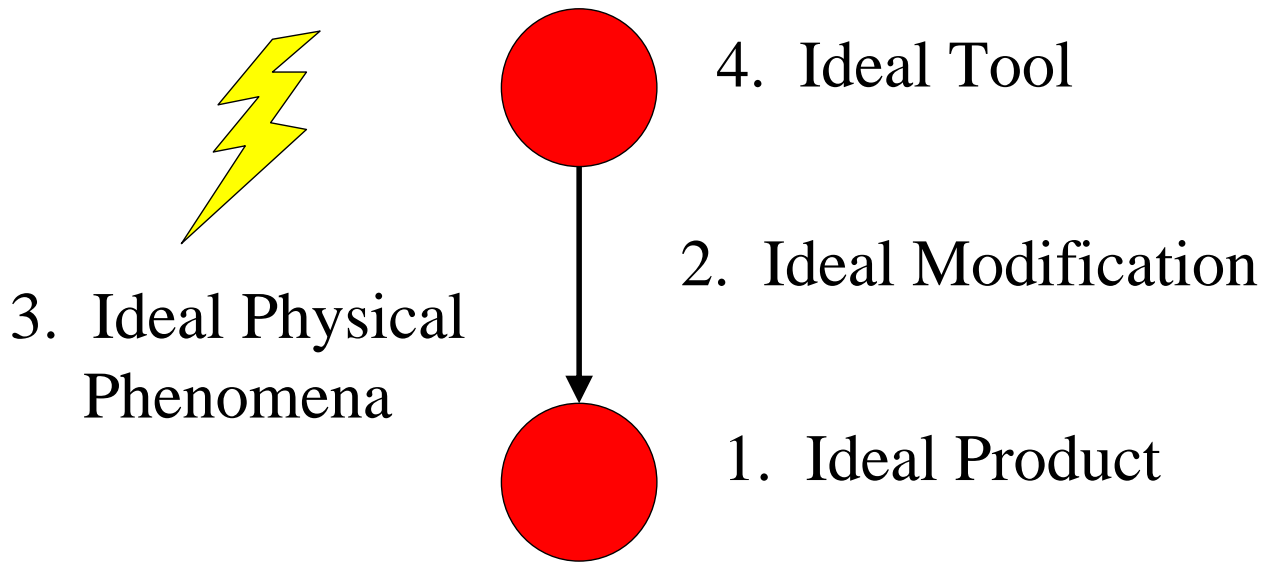


# Why Function / Attribute Centric ?





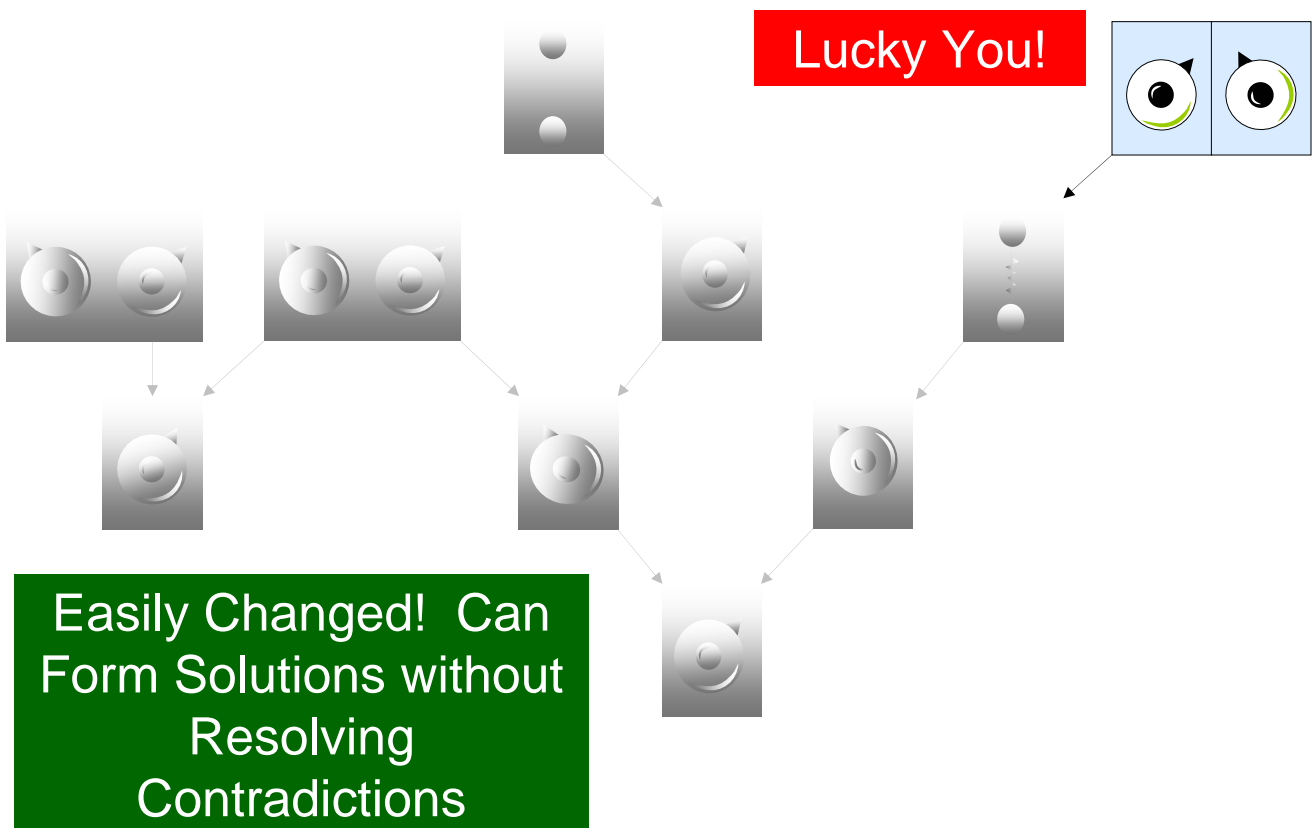
# Functional Ideal Final Result



Functional IFR is more Powerful than the Generic IFR—Many Tools Yield More Options

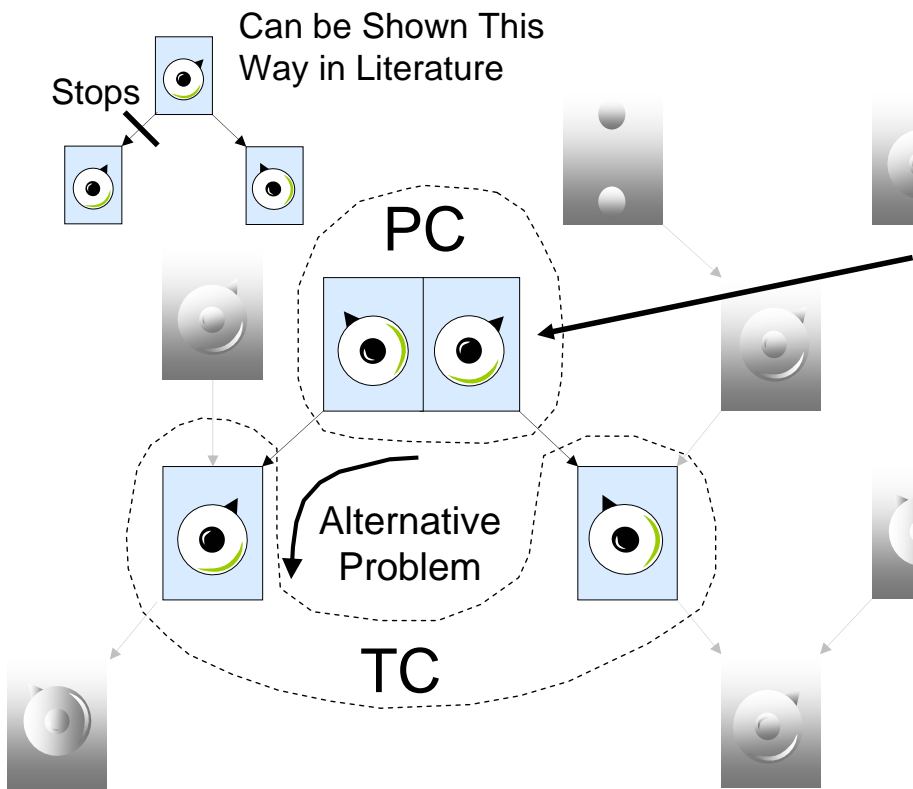
17

## No Problems Turning Some Knobs



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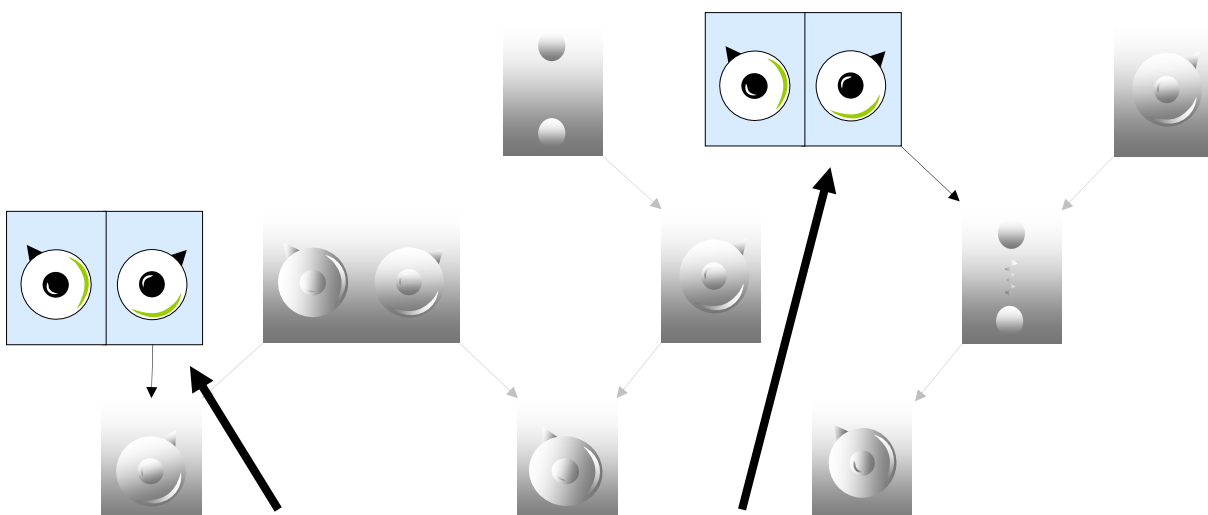
# Creation of Alternative Problems



1. Requirements are not Causes: When you change a design parameter, something gets worse
2. Alternative Problems always start with a physical contradiction
3. If you can't resolve the contradiction, then try to solve the alternative problem

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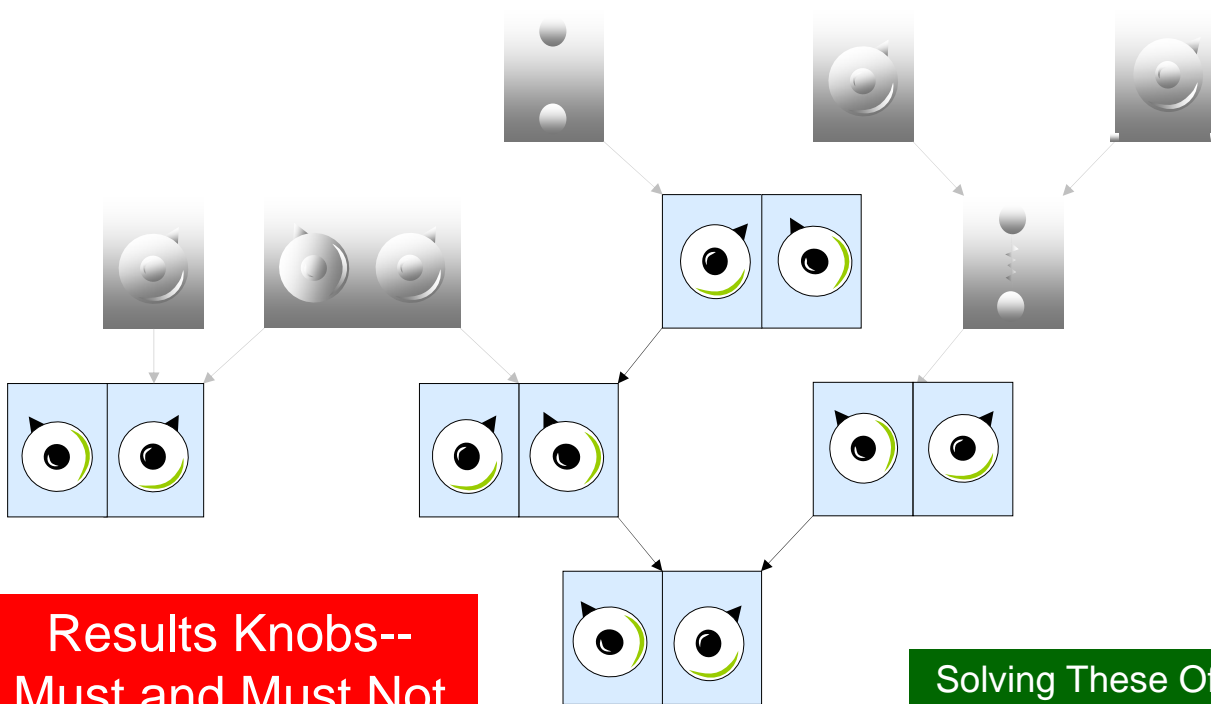
# Contradictions Where Nothing Gets Worse



1. Nothing gets worse when you change some parameters.
2. They only come in one flavor or are unpredictable.
3. It cannot be changed, yet it must be changed!
4. Notice no Technical Contradiction is mentioned

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# When Something Must and Must not be Flawed



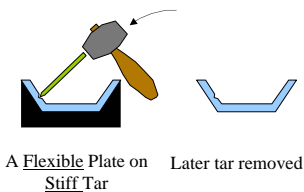
Results Knobs--  
Must and Must Not  
be Flawed

Solving These Often  
Yield Good Results

## Separate in Time

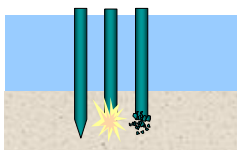
When are the conditions that both properties must occur?  
It must be (prop #1) when (Condition #1) Example: It must be (hot) when (at high altitude)  
It must be (prop #2) when (Condition #2) Example: It must be (cold) when (at low altitude)  
May these critical conditions be separate (not overlap) in time? If "yes" then attempt to separate in time

### Disposing of Carrier



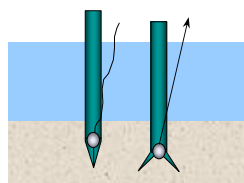
A Flexible Plate on Stiff Tar Later tar removed

### Segmenting



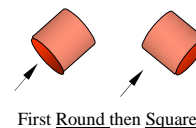
First a Sharp pile, then a Blunt Pile

### Rearranging



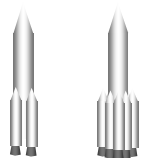
First a Sharp pile, then a Blunt Pile

### Changing Direction



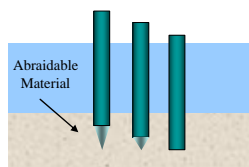
First Round then Square

### Adding / Subtracting



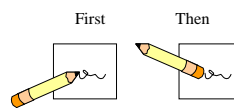
First Low Thrust then High Thrust

### Transformable States



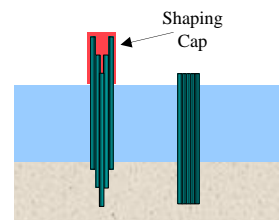
First a Sharp pile, then a Blunt Pile

### Reorienting Attachments



First Write, then Erase

### Nesting



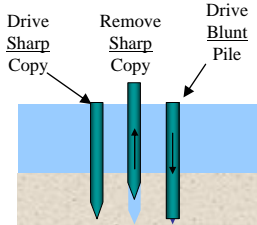
First a Sharp pile, then a Blunt Pile

### Excessive Action



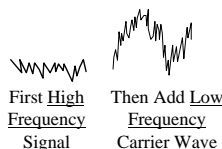
Painted Grossly then Detailed

### Copy or Facsimile



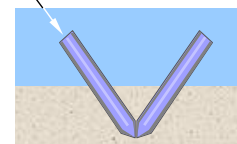
Drive Sharp Copy Remove Sharp Copy Drive Blunt Copy

### Adding Carrier



First High Frequency Signal Then Add Low Frequency Carrier Wave

### Prior Counter Action / Cushion



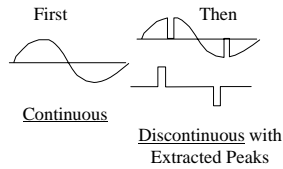
First a Sharp pile, then a Blunt Pile

### On Condition

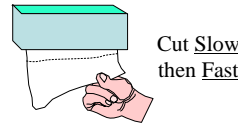


Constrains water when upright and Flows water when Pressing

### Extraction



### Prior Action

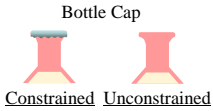


Cut Slow then Fast

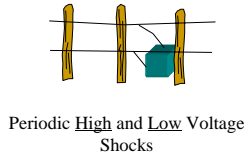
### Non Uniform (Local Quality)



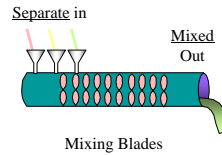
### Discarding



### Adding Fields & Periodic Action



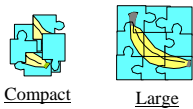
### Input / Output



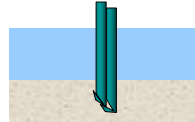
### Unrolling / Stretching



### Interacting

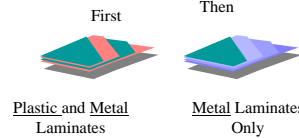


### Merged Interaction

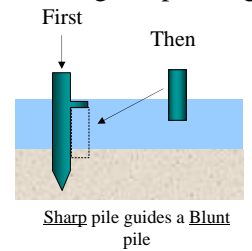


Added sharp piles push on lip of previous pile making it blunt

### Mixing / Eliminating



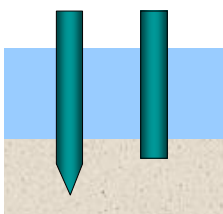
### Touching / Separating



## Separate in Space

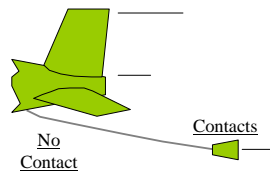
1. May each property exist in separate entities? If "yes" then attempt to Separate in Space
2. Assume that both properties occur in the same entity  
**Where** are the conditions that both properties **must** occur?  
 It must be (prop #1) where (Condition #1) Example: It must be (hot) where (cooking occurs)  
 It must be (prop #2) where (Condition #2) Example: It must be (cold) where (hands are)  
 Identify (draw) **where** each property **must** occur (there is a requirement). May the properties be separate in the same entity? If yes then separate by making the component Non-Uniform

### Two Objects

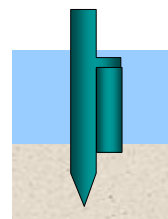


Sharp & Blunt

### Extraction

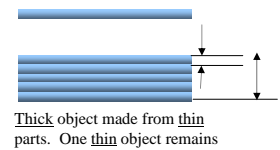


### Guided / Nesting

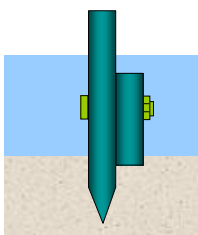


Sharp pile guiding a Blunt pile

### Part is Merged



### Attached



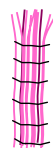
Blunt & Sharp

### Part Carried



Flexible fibers bound in in Stiff sheath--some of the fibers extend and are Flexible

### Part Interacts



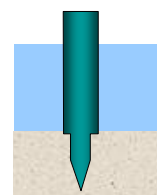
Flexible fibers partially bound in Stiff bundle--some of the fibers extend and are Flexible

### Mixture



Conductive Fiber and Insulating Fiber

### Non-Uniform (Local Quality)

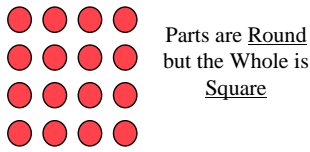


Blunt & Sharp

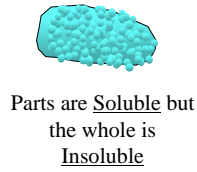
# Between the Whole and the Parts

Must the entity only comes in a "flavor" which is undesirable? If yes then try to separate between the whole and the parts

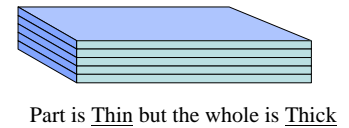
## Multiplication



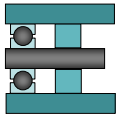
## Segmentation



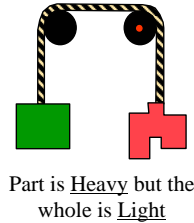
## Merging



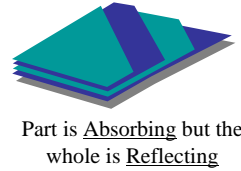
## Cushion



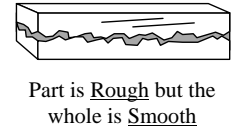
## Countering



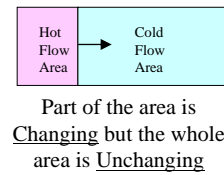
## Mixture



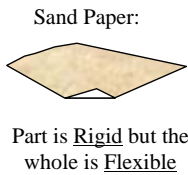
## Hiding



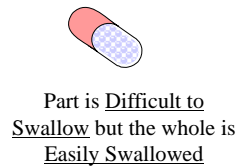
## Coordinated Parts



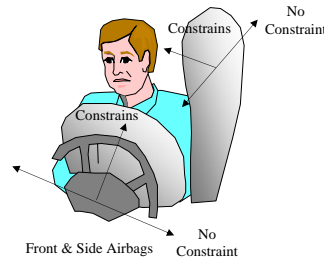
## Carrier



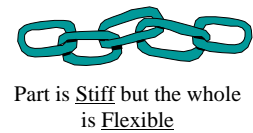
## Nesting



## Complimentary Directions



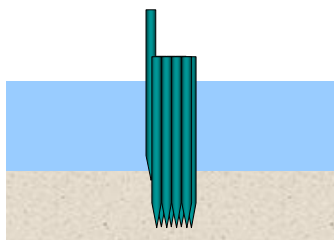
## Interacting Parts



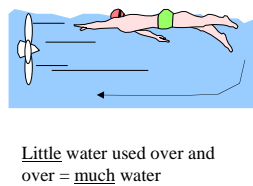
# Separate Gradually

Can one of the properties additively build up or decreased until you get the opposite property? If "yes" then attempt to Separate Gradually.

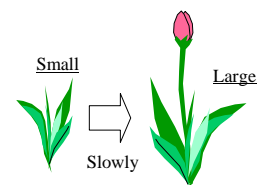
## Gradually Merge



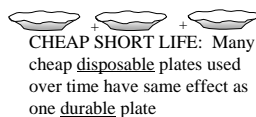
## Repeated Use



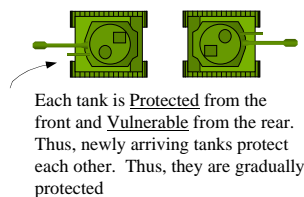
## Maturing / Proliferation



## Separate Use

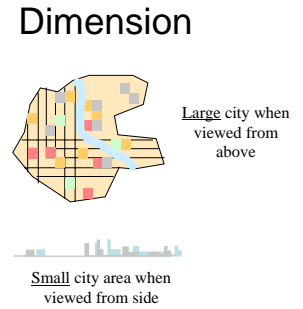
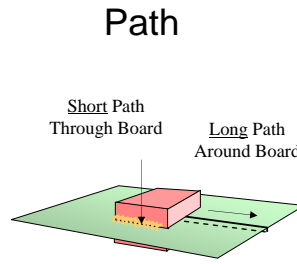
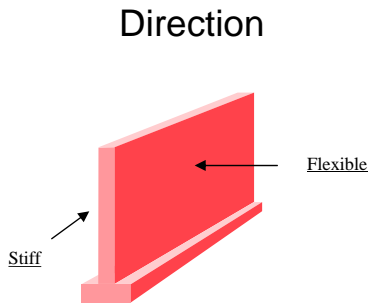


## Gradually Hidden / Exposed



# Separate by Direction, Path or Dimension

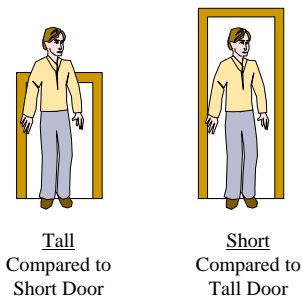
Does one of the conflicting properties already exist in a different direction, path or dimension, or can it be changed to do so? If yes, then attempt to solve the contradiction here.



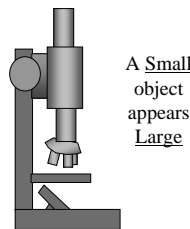
# Separate by Perspective

Is the **appearance** of having either of the conflicting properties sufficient? If "yes" then attempt to resolve the contradiction here.

## By Comparison



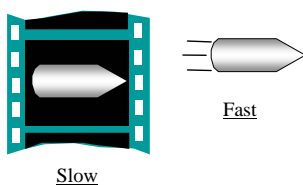
## How you Look



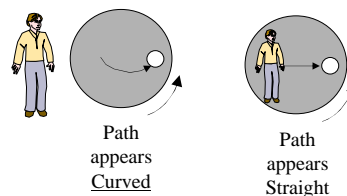
## Using Paint / Fake



## Facsimile / Copy

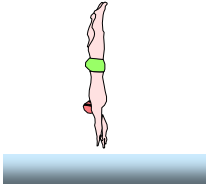


## Frame of Reference

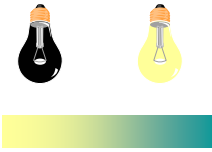


# Separate by Response to Field

## Frequency / Speed / Energy



At High Speed Water is Stiff. At Low speeds it is Flexible.

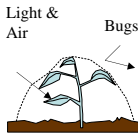


Fluorescent material: Dark with Low frequency light, Glows with high frequency light.

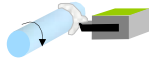
## Transparency



**HINGED ELEMENTS:**  
Selectively passes solids in motion. May stop gasses and liquids and small objects.



**MECHANICAL FILTERS** (Sieves, Fabrics, Filament wraps, Molecular Sieves): passes liquids or gasses



Evolved gasses are stopped by foam during machining

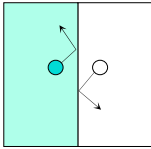
**FOAMS, LIQUIDS, FLOATING SOLIDS, FLUIDS IN MOTION:**  
Selectively passes solids in motion. May stop gasses, other liquids, and very small objects. Especially consider inert materials



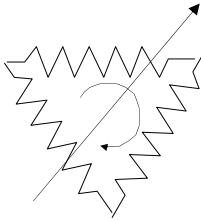
Light bulb passes light of certain frequencies but not air and selected light frequencies

**TRANSPARENT MATERIALS AND COATINGS (INCLUDING PAINT):**  
Selectively passes physical fields. May be solids, liquids or gasses. May selectively pass certain frequencies. (Remember that all substances are transparent to gravity)

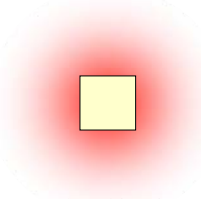
# Separate Between Substance and Field



The Gasses are Unmixed, but the Heat field is Mixed



The Coils are Stationary, but the Field Generated by the Coils appears to Rotate



The Object is Square, but the emanating heat field is Round

# Summary

## Progressing from

Causal Analysis → Idealizing Flawed Functions → Resolving Contradictions

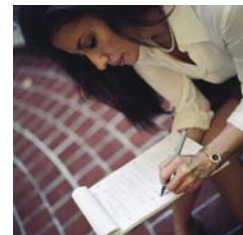
## is Very Powerful

- More Natural than ARIZ (Easier to Teach) –The Causal Logic is Corrected
- Can effectively attack *very difficult* or *entangled* problems
- Can use on problems never encountered—No obvious TC
- Provides MANY solution paths

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## A Challenge

- Write Down What You Are Doing Now



- Keep it Visible



- Use it Everywhere



- Experiment and Improve Regularly



- Get Feedback



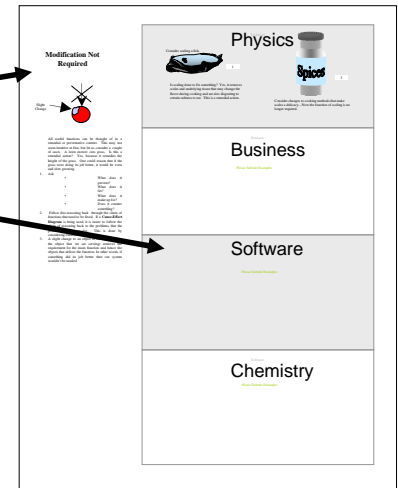
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# Invitation to Become a Coauthor

## 1. Each Page is an Innovation Tool

- Step-by-step use of tools
- Examples: Physics, Business, Software, Chemical ... Many Blank spaces! (Currently 570 Pages)
- Algorithms give structure



## 2. Currently & Always Sold “As Is”

## 3. Uses a Wiki for Editing (password protected)

## 4. Proceeds go to humanitarian aid

## 5. Coauthors can use for own works

## 6. <http://trizalgorithms.jot.com>