Hierarchical TRIZ Algorithms

10th Installment- Feb 2006

Hierarchical TRIZ Algorithms is a how-to TRIZ book. It is designed to assist both beginning and advanced users. Each month, the TRIZ-Journal will publish another chapter of the book. This month's installment includes the eighth step of the 10 step algorithm (shown on the cover):

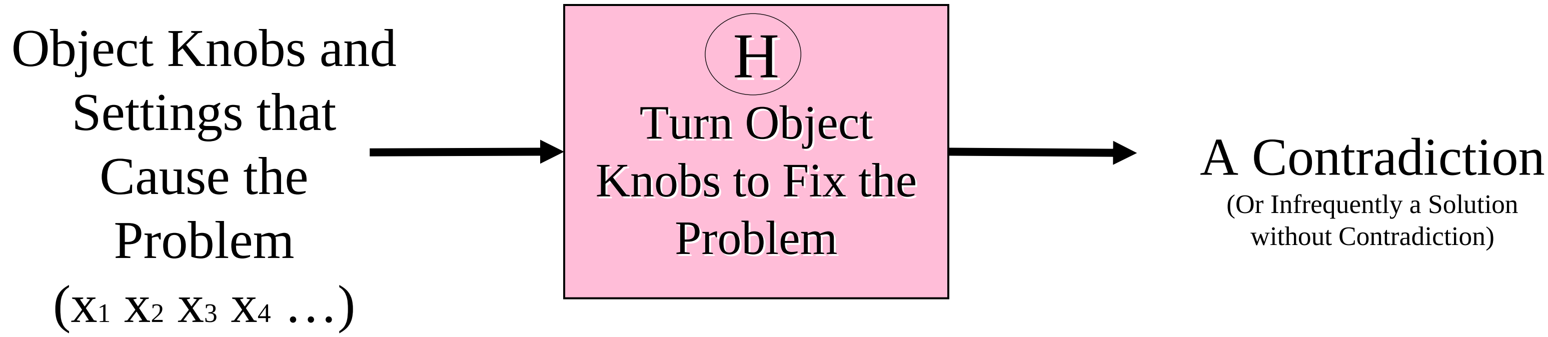
H. Turn Object Knobs (Properties) **to Fix the Problem**

Next month's installation will cover the ninth process step:

I. Resolve Resulting Contradictions

In all, there will be 12 installments. Should you decide to purchase the most current edition of the complete book contact the publisher at:

http://www.3mpub.com/TRIZ/



Introduction

An analysis of cause and effect gives us the knobs and their settings that cause the problem. Now we must turn the knobs to create an enduring solution to our primary problem

For purposes of illustration, let us assume that we are driving piles in shallow waters which will be used to support large structures. Driving the piles is slow and expensive, due to the cost of labor and the cost of renting the pile driver. We would like to improve the speed of driving.

Let's assume that we have already performed the preceding analyses including the cause-effect analysis (not shown here). We learned that the driving speed was slow because: The ground is hard; the required depth was deep; the diameter of the pile was large; the pile sharpness is blunt. . . Now, what if we turned these knobs to very different settings? We know that we could drive much faster if the ground was soft, the driving depth were shallow, the diameter of the pile was narrow or the pile was sharp.

However, in each case, there is a new problem that arises. The ground may be hard, or its hardness may have great variability. (If it did come soft, we would be required to drive it deeper since it gives less support). A deep driving depth is required to support the structure when there are sideward loads which arise from earthquakes or waves. The diameter of the pile must be large in order to hold up the structure. The pile must be blunt in order to carry the vertical loads during earthquakes. Were we to use a sharpened pile, we would be required to drive deeper. (Greater depths give greater supporting forces). Driving deeper defeats the initial gains of being able to drive faster!

Such objections are what stops people from turning knobs as far as they should. Most would rather turn the knob part way and thereby compromise. Unfortunately, compromise *guarantees* risk and leaves the problem to be solved later. There is only one way through this mess. *We must turn the knob far enough to fix the primary problem.* (In doing this, we do not ignore the resulting problems, instead, we will use them to form a clear contradiction that we will later resolve).

There is a natural eagerness to turn some knobs and a reluctance to turn others. This tendency limits us in the range of solutions that are possible. Let's take a closer look at different types of knobs. (See the illustration on the following page). The first type of knob is one that is easily turned. For instance, we could consider getting a larger pile driver. If the piles do not splinter, we could increase the power of the driver until we are satisfied. This solution might work if we started with an under-powered driver.

Another type of knob is one that has little effect when we turn it. The pile has many knobs or attributes which have little or no effect on driving speed. For instance, the color or temperature of the pile.

The next type of knob is usually a design feature that we have control over. When we turn this knob to fix our primary problem, something else gets worse. Examples that we have mentioned are the sharpness and diameter. We have design control over these knobs, but another requirement dictates that we not change these knob settings.

The next kind of knob is one that may only come in limited "flavors". Most people would be very reluctant to turn these knobs. Objects may be required to have certain characteristics because of customer requirements or natural circumstances. A good example of this is the ground hardness where we are driving piles.

The last type of knob is the outcome knob. This is the Y for each equation. In effect, we say that in spite of all the X's and their settings, the Y will be OK. In the pile driver problem, the Y is the speed of driving. The driving speed must be fast in order to increase productivity and it must be slow, because all the inputs will remain unchanged.

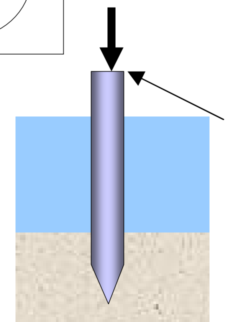
These last three knobs "something gets worse" "one flavor" and "outcome" are the least likely to be turned, but turning them often allows us to find very satisfying but unconventional solutions. Remember, every knob in our cause-effect chain should be tried.

The output of this step is either a solution (if the knob is easily turned) or a contradiction. Going back to our illustration, let us choose one of the knobs, pile sharpness, and insist that the pile must be quite sharp in order to drive faster. Now we form the contradiction: **In order to drive fast, the pile must be <u>sharp</u>. In order to provide adequate support the pile must be <u>blunt</u>.** (Do not worry that this seems impossible. We will overwhelm this contradiction in the next step and resolve it).

5 Types of Knobs

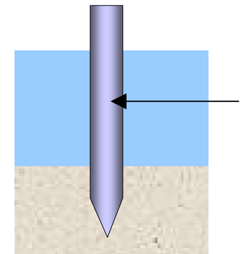
- Easily Turned

  (Full control and nothing else gets worse)



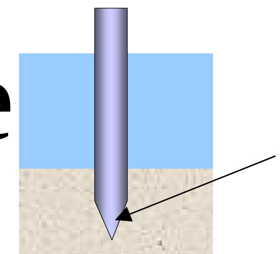
- Little Effect

  (Turning the knob through the full range has little effect)



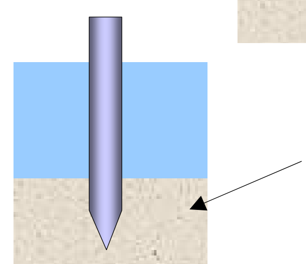
- Something Else Gets Worse

  (Turning the knob makes something else worse)



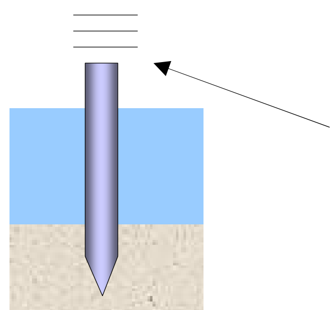
- One Flavor or Setting

  The knob cannot be turned, it only has one setting or the setting is highly variable



- Outcome

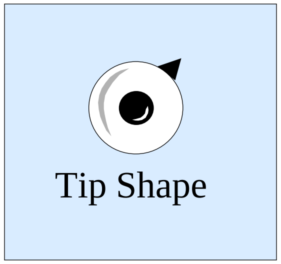
  (The knob cannot be turned. It is dependent on other knob settings)



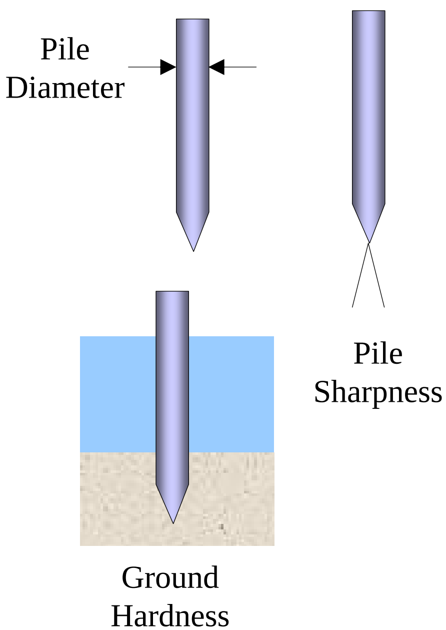
Simplified

Turn Knobs to Fix the Problem-- Create the Contradiction

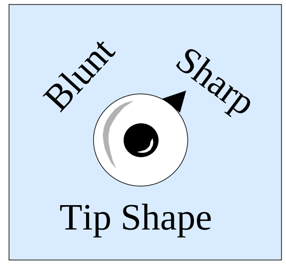
Pick Knobs that will Fix the Problem



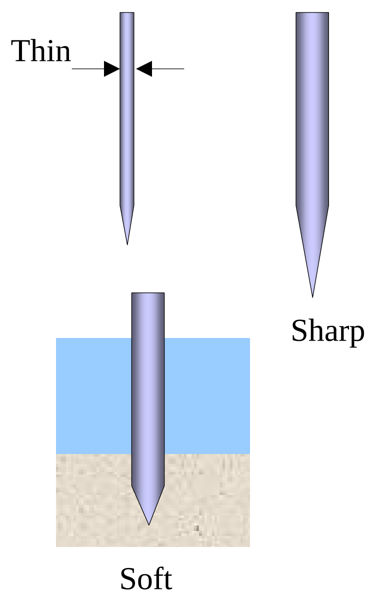
- Only turn knobs that will completely fix the main problem



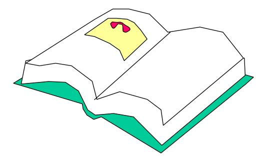
Turn Knobs Far Enough to Fix the Problem



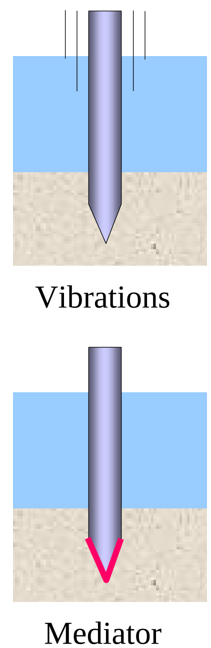
- Turn the knob far enough to give an enduring outcome.
- Temporarily ignore the fact that problems arise or the knob can not be turned.



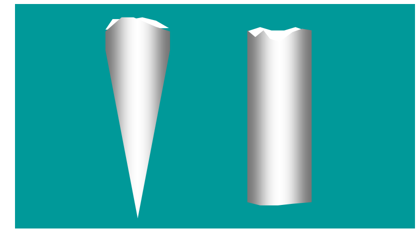
Consult Table of Solutions



- You might have missed some knob turning possibilities. Consult this table for extra ideas.

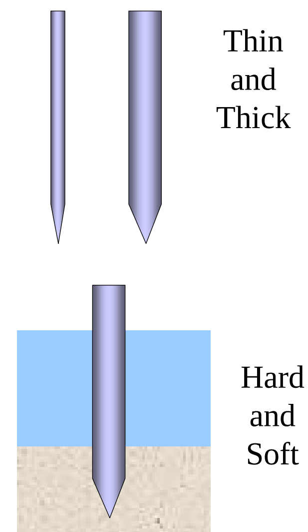


Form Contradictions



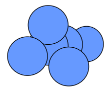
Very Sharp | Very Blunt

- **Draw the interaction zone both ways.** Draw it in the most **ideal or extreme** conditions.
- Form the short-hand version of the **contradiction**.



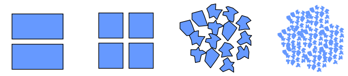
Solutions (Extreme knob turning)

Multiply Elements



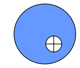
- Multiply the number of original elements
- Reduce the elements in size
- Combine the elements or make interact

1 Segmentation



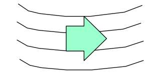
- Independent Parts--Sectional

4 Asymmetry



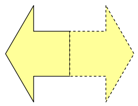
If asymmetric
--Increase asymmetry

12 Avoid Field Gradients



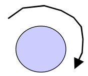
•Avoid Lifting
•Move sideways in fields

13 Do it in Reverse



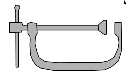
- Present the parts upside down
- Use the opposite action
- Make moving parts stationary

14 Speroidality



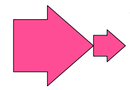
- Curved Shapes-Not Linear
- Rollers, Balls
- Rotary Motion-Not Linear

15 Make Adjustable



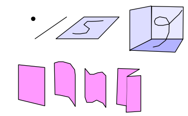
- Make Adjustable for each stage of operation
- Adjusts according to operating conditions
- Immobile objects become mobile
- Make Flexible

16 Perform Excessively



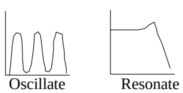
• Then adjust later

17 Transition to New Dimension



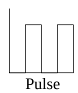
- Tip Things
- Use other side
- Move from linear to Planar to 3-D movement
- Go to multiple levels

18 Vibration



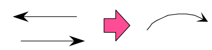
- Introduce Oscillation
- Increase frequency
- Use resonance

19 Periodic Action



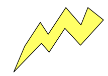
- Change Continuous to Periodic
- Change the period
- Make good use of pauses

20 Continuity of Action



- Replace back and forth w/ rotary
- No dummy runs
- All parts working all the time

21 Rushing Through

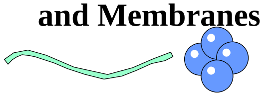


- Perform dangerous or harmful actions at high speed

24 Use of Mediators

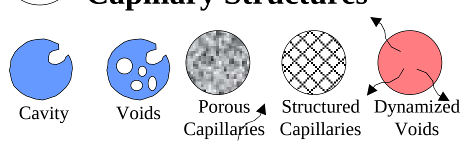
- Mediator is mixture of two interacting parts

30 Use of Thin Films and Membranes

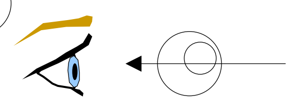


- Solid constructions replaced with flexible membranes
- Isolate objects with thin films
- Use Foam

31 Voids and Capillary Structures

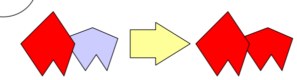


32 Change Color



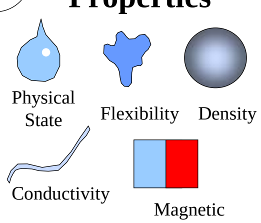
- Make Translucent
- New Color
- Paint

33 Homogeneity

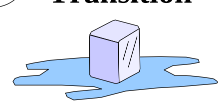


- Make interacting objects out of the same substance
- At least match properties

35 Change Bulk Properties

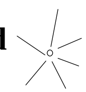


36 Phase Transition



- Operate near critical point

38 Accelerated Oxidation



- Use progressively activated oxygen--From ambient Air to oxygenated air to oxygen to ionized oxygen to ozone to single oxygen molecules

39 Inert Substances

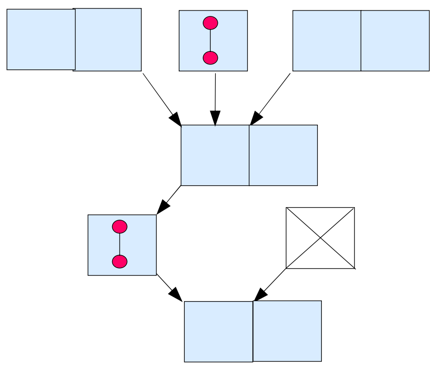
- Introduce inert gasses
- Introduce inert substances
- Use in vacuum

Detailed

Turn Knobs to Fix the Problem--Create the Contradiction

The primary consideration in this step is that the problem solver will be reluctant to turn some of the knobs in the cause-effect chain, or will not consider turning them far enough. It is precisely this reluctance that holds us back from important insights and solutions. Some of the most renowned inventors were legendary for turning knobs to the extreme. Extreme knob turning often leads to valuable insights.

Consider all Knobs in the Cause Effect Chain

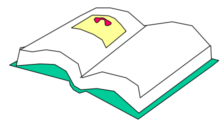


If the Cause-Effect Chain is properly formed, many contradictions will be evident from the side-by-side boxes. It is often the other knobs, which do not reside in the side-by-side boxes that we are reluctant to turn. Turning these knobs and resolving these contradictions often lead to the most satisfying solutions.

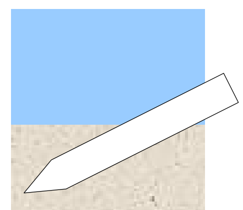
1. Consider ALL the knobs on the cause effect diagram in turn.
2. Consider the extreme condition in which the main problems go away.
3. Determine which knobs (or combination of knobs) can fix the main problem.
4. Focus on these knobs.

Example given on following page

Consult Table of Knobs (Appendix L) For Different Ways to Turn the Knobs

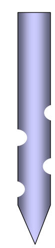


Our knob turning skills may not be as good as we think. There are often more than one way to turn a knob. We might have missed some knob turning possibilities. Consult the Table of Knobs for different ways to turn the knobs.

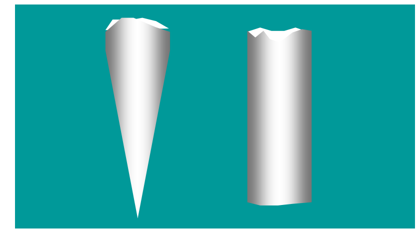


Drive at shallow angle--Low depth but good radial load carrying

Put voids in the pile--little effect on driving but after the ground settles the support is better



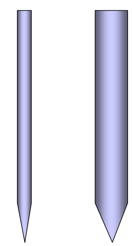
Form Contradictions



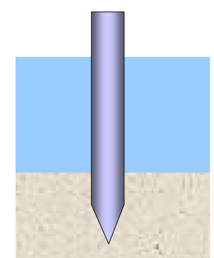
Very Sharp

Very Blunt

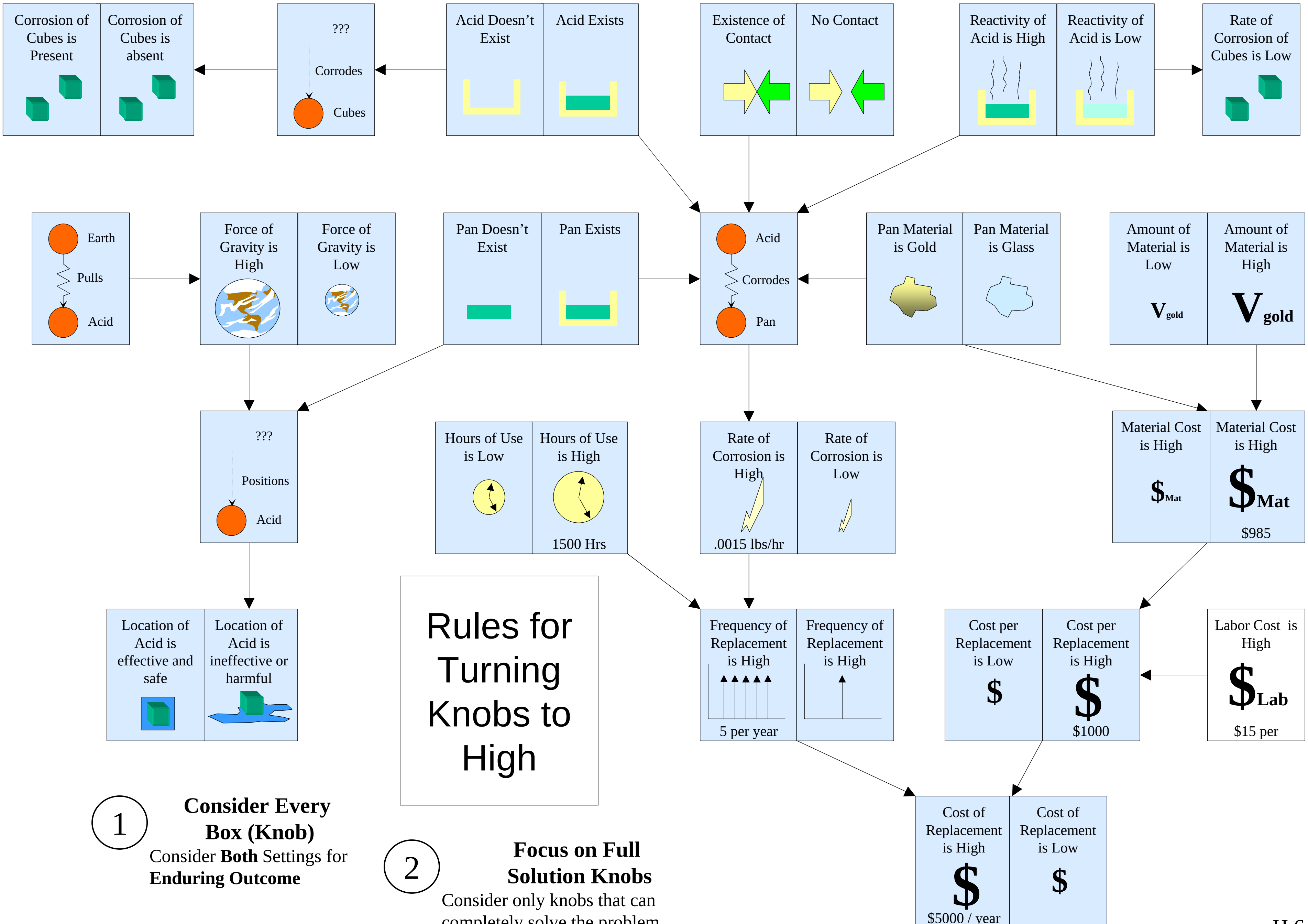
1. **Draw the interaction zone both ways**. Draw it in the most **ideal or extreme** conditions.
2. Form the short-hand version of the **contradiction**.



Thin and Thick



The Ground is Hard and Soft



Rules for Turning Knobs to High

1 **Consider Every Box (Knob)**
Consider **Both** Settings for **Enduring Outcome**

2 **Focus on Full Solution Knobs**
Consider only knobs that can completely solve the problem