Hierarchical TRIZ Algorithms

8th Installment- Dec 2005

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 installation will cover the appendix which is required to perform steps 7 and 8:

L. Appendix--Table of Knobs (Object Properties)

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

G. What Causes the Problem

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/

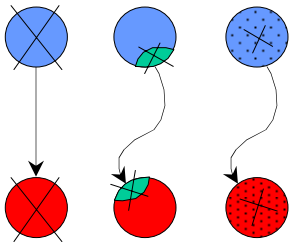
L Appendix
Table of Knobs

The Table of Knobs is a restructuring and reinterpretation of the parts of the "Standard Solutions" which deal with object knobs (knob resources).
In its original form the "Standard Solutions" presented solution models with the conflict already removed. In the Table of Controlling Variables, the removal of the contradiction is delayed until the "Remove Contradiction" step, thus allowing for a greater number of ways to resolve the contradiction than those included in the "Standard Solutions".
Using the Table of Controlling Variables will help the problem solver uncover several unanticipated ways to control the function.

Table of Knobs

Existence

Existence



Knob

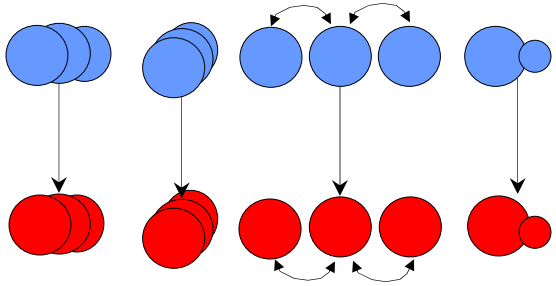
- Consider existence of the **tool**, its **source** or its **path**
- Consider existence of the **product**, its **source** or its **path**
- Consider existence of the interaction site on the tool or product.
- Consider the **micro-constituents** that interact

Extreme Setting

- Eliminate the **tool**, its **source** or its **path**
- Eliminate the **product**, its **source** or its **path**
- Identify and eliminate only the interaction site on the tool or product.
- Remove only the **micro-constituents** that interact.
- Contradiction often solved by transparency

Number of Objects

Number of Like Elements



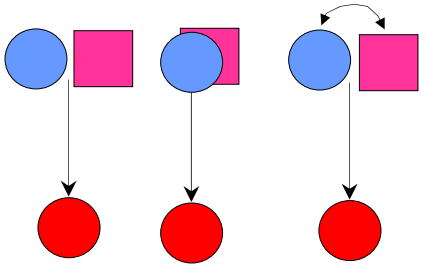
Knob

- Do any of the following changes affect the outcome? (With each of these, new capabilities should emerge)
- number of **tool elements**
- number of **product elements**
- **orientation** of multiplied elements.
- **combining or interacting** of multiplied elements
- Variety of size or features of multiplied elements?

Extreme Setting

- Multiply the product
- Multiply the tool
- Combine multiple elements in different orientations. New capabilities should emerge.
- Make the multiplied elements modify each other. New capabilities should emerge.
- **Nest or stack** the elements
- **Bias** some of the elements to handle different operating conditions

Hybrid Combination Of Tools



Knob

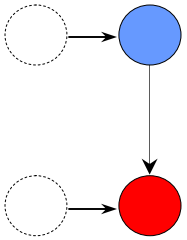
- Identify another effect/tool which performs the same function.
- What is the feature of the new tool which would extend the capability of the first tool?
- Identify the cheap tool which should deliver most of the function.

Extreme Setting

- Transfer the whole new tool or just the desirable feature of the new tool.
- Merge the tools. A new capability should emerge.
- Make the tools modify each other. **A new capability should emerge.**

Location or Movement

Location



Knob

- Define the entire location Envelope for the tool and product (What space can the tool and product be located in?)
- Move the tool about in higher dimensions. Are the fields affected?
- Move the product about in higher dimensions. Are the fields Affected?

Extreme Setting

- Move the product and tool to environments that are conducive to their operation or where the environment is much better

Interaction Zone Location

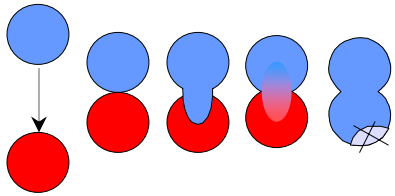
Knob

- Locate the **exact zone** of the modification on the tool and product.
- Does changing the location affect the fields of the function?

Extreme Setting

- Make the interaction zone a completely benign region on the tool and product.
- If the action degrades either the product or the tool, make sure that the location is not important

Distance
Contact or Combining



Knob

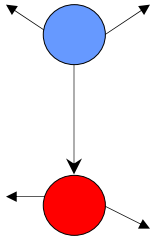
Consider the following changes:

- **Distance**
- **Contact or separation**
- **Location of contact**
- **Mixing** of tool and product
- **Absorption** of tool into product
- **Combining** the tool and product

Extreme Setting

- Move the parts **far away** from each other
- Try **different distances** from each other
- **Nestle** one into the other
- **Mix** the tool and product
- **Combine** the tool and product. Consolidate. Look for new capabilities
- **Combine with super-system**. Look for much consolidation, new capabilities and room for growth.

Velocity
Acceleration
Or Jerk



Knob

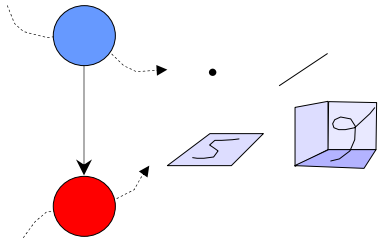
Consider the following changes:

- •**Velocity** or relative velocity
- •**Stopping** the tool or product
- •**Acceleration**
- •Rate of change of the acceleration (jerk)

Extreme Setting

- **Stop** the tool or product
- Try **extremely high or low** rates of acceleration

Path



Knob

Consider the following changes:

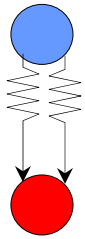
- Path or relative path
- Moving paths to different dimensions. (Useful functions **increase** path dimensions. Harmful functions **decrease** path dimensions).

Extreme Setting

- Use paths in **different dimensions**
- Useful functions **increase** path dimensions. Harmful functions **decrease** path dimensions.

Scale

Intensity or Scope



Knob

- If you were an **artist**, how would you work the defect into the picture?
- How would you artistically extend the defect?
- Imagine the **defect multiplied**, what pattern would you multiply it to yield a useful function?

Extreme Setting

- Grossly increase the intensity of the interaction, whether it is harmful or useful
- **Excessively perform** the function and then remove the excess.
- Artistically work the defect in.
- Increase the number of defects and arrange artistically

Size of Interaction Zone

Knob

- Identify the location of the interaction zone.
- How big is it?
- **Volume or surface area** of the interaction site
- **Size** of the interaction zone.
- **Dimension** of the zone.

Extreme Setting

- Greatly increase or decrease the size of the interaction zone
- Increase **dimension** of the zone.
- Purposely cross or avoid **critical boundaries**

Number of Interaction Sites

Knob

- How many interaction sites are there now on the tool and product?
- Consider the **number** and locations of the sites.

Extreme Setting

- Greatly increase or decrease the number of interaction sites

Use of Micro-Sites

Knob

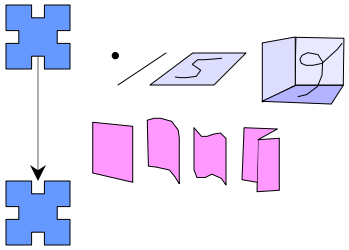
- Imagine interaction at smaller and smaller scales at multiple small interaction sites.
- Are the sites on the surface or in the volume?
- Does the function **already exist, to any degree,** at the bulk material level?

Extreme Setting

- Greatly increase or decrease the number of Micro-sites

Object Structure

Shape or Size



Knob

- Identify **poorly used space** around the tool and product
- Identify the dimensional construction of the interaction zone.
- If you were looking at a dimensioned drawing of the tool and product, what would be the **critical dimensions** for the function?
- Consider **shape**, **size** and **aspect ratio**.

Extreme Setting

- Play like the tool and product are made from expandable clay. Form the tool and product into the ideal **shape**, **size** and **aspect ratio**.
- Change surfaces to higher order dimensions.

Symmetry

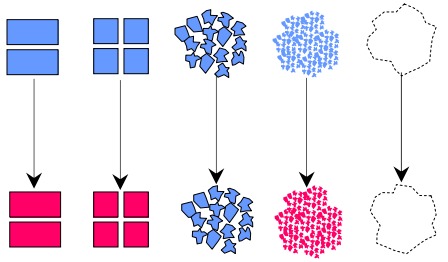
Knob

- Consider parameters or knobs which have already been identified. Are they symmetrically located?
- Consider **symmetry** or **asymmetry** of the tool and product

Extreme Setting

- Change symmetry to **another axis**
- Make the tool or product **unsymmetrical**
- Make **symmetrical**

Segmentation



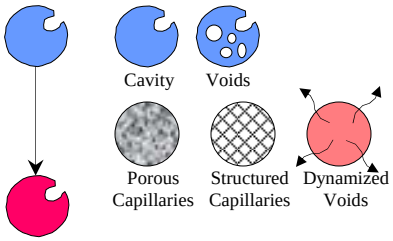
Knob

- Would increasing the number of **interaction sites** improve the function? Can the sites be **independent?**
- Consider the affect that the following would have on the segmented pieces:
  - Dividing into **multiple copies** of the original elements.
  - **Size**
  - **Shape**
  - **Aspect Ratio**

Extreme Setting

- Make the sites **independent**
- Break the original piece into **sections** that can be easily dismantled and assembled.
- Make **multiple copies** of the original elements. Reduce in size. Combine or make interact
- Change the shape of the segmented pieces
- Change to a **powder or aerosol**
- **Decompose:** Grains--Dust--Molecules--Atoms--Ions--Sub Atomic Particles
- **Combine:** Sub Atomic Particles--Ions--Atoms--Molecules--Dust--Grains
- **Solidify a liquid** or its constituents into particles

Voids and Capillary Structures



Knob

- Consider the affect of the following changes to the tool or product
- Voids
- **Porosity**
- **Structured capillaries**
- **Fluids** in voids or capillary structures

Extreme Setting

- Place a specially shaped cavity in the tool or product.
- Place **specially shaped** voids in the tool or product (honeycomb, spherical, random)
- Use open or closed celled **porous** materials
    - Sintered powders
    - Dried or fired clays
    - porcelain
    - Sand
    - Loose Powders
    - Pumice
- Make the tool or product from **structured capillary** materials such as:
    - Fabrics
    - Fiber batting
    - Fiber bundles (thread, string, rope…)
    - Screen or layers of screens
    - Capillary tubes or tube bundles
- Fill the porous material with special **fluids** or allow fluids to move through the porous material

Thickness

Knob

- Does the thickness of the tool or the product affect the function

Extreme Setting

- Replace solid constructions with flexible membranes
- Isolate objects with thin films

Curvature

Knob

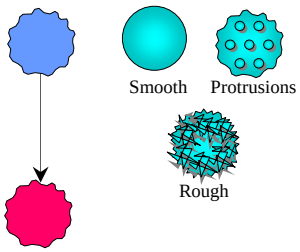
- Does the curvature of the tool or product affect the outcome

Extreme Setting

- Change from linear shapes to curved shapes
- Use rollers or balls
- Change from linear to rotary motion

Surface Properties

Surface Shape



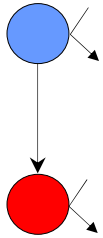
Knob

- How does the surface shape affect the fields of interaction?

Extreme Setting

- Make the surface **smooth** if it is not already
- Make ridges **protrusions** in the surface of the tool or product (Random or structured)
- Make the surface of the tool or product **rough** (random or structured)
- Use a finer and finer surface roughness

Surface Properties



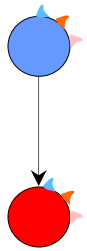
Knob

- Identify the fields which deliver the modification.
- Consult the **Table of Surface Properties** to see which ones modify the fields of the function

Extreme Setting

- Greatly increase the surface properties.
- Change to new materials or coatings if necessary.

Surface Cleanliness

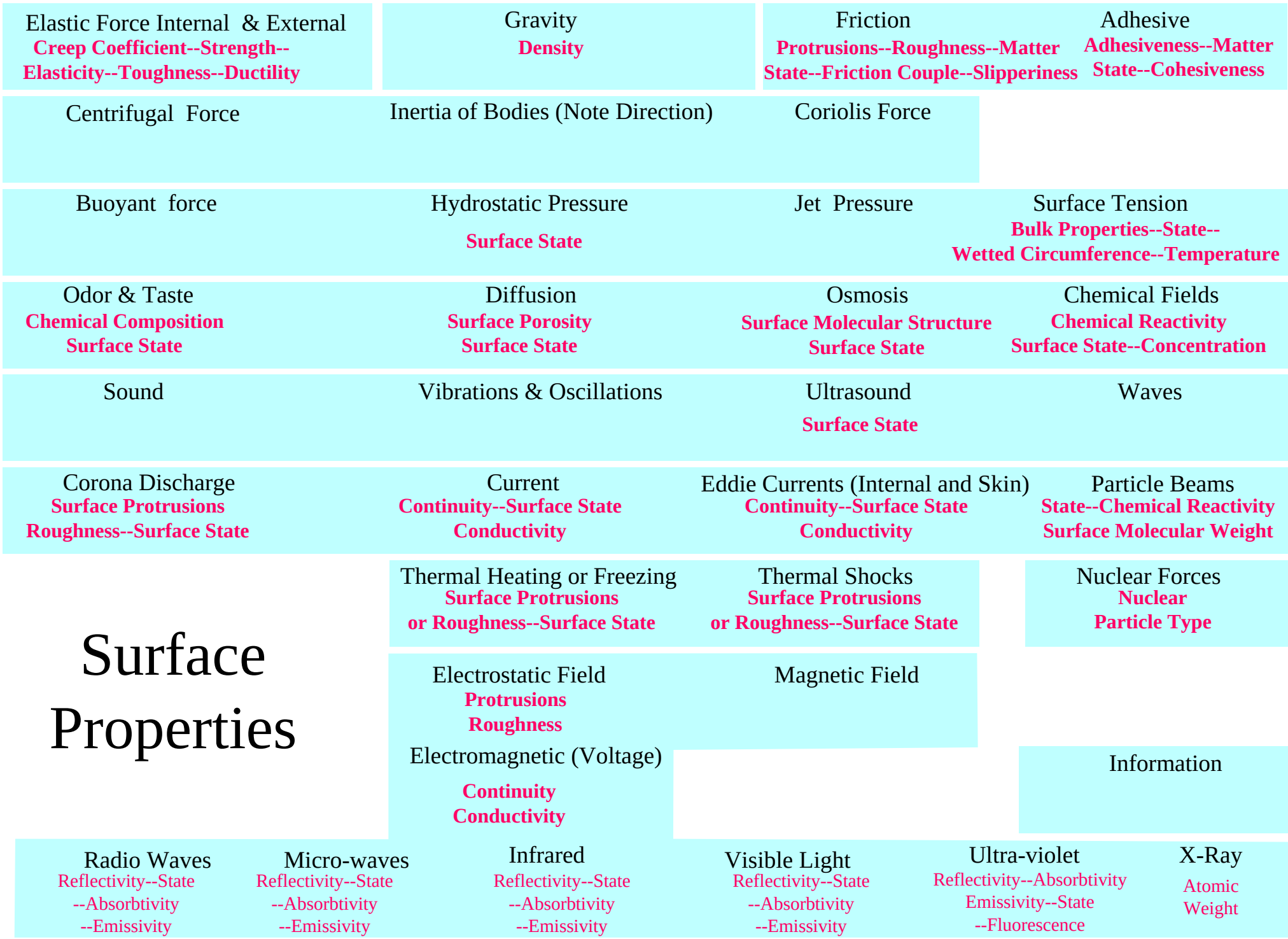


Knob

- Can contaminants find their way to the surface?
  - •Solids
  - •Liquids
  - •Gasses

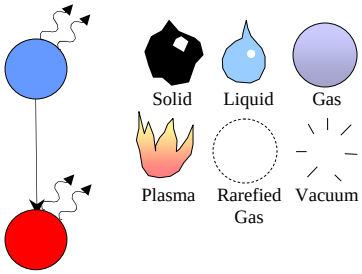
Extreme Setting

- Greatly decrease the surface contaminants until the surface is ultra-clean
- Greatly increase the contaminants
- Add a lubricant to the surface
- Condense a liquid onto the surface


Elastic Force Internal & External
Creep Coefficient--Strength--
Elasticity--Toughness--Ductility
Gravity
Density
Friction
Protrusions--Roughness--Matter
State--Friction Couple--Slipperiness
Adhesive
Adhesiveness--Matter
State--Cohesiveness
Centrifugal Force
Inertia of Bodies (Note Direction)
Coriolis Force
Buoyant force
Hydrostatic Pressure
Surface State
Jet Pressure
Surface Tension
Bulk Properties--State--
Wetted Circumference--Temperature
Odor & Taste
Chemical Composition
Surface State
Diffusion
Surface Porosity
Surface State
Osmosis
Surface Molecular Structure
Surface State
Chemical Fields
Chemical Reactivity
Surface State--Concentration
Sound
Vibrations & Oscillations
Ultrasound
Surface State
Waves
Corona Discharge
Surface Protrusions
Roughness--Surface State
Current
Continuity--Surface State
Conductivity
Eddie Currents (Internal and Skin)
Continuity--Surface State
Conductivity
Particle Beams
State--Chemical Reactivity
Surface Molecular Weight
Thermal Heating or Freezing
Surface Protrusions
or Roughness--Surface State
Thermal Shocks
Surface Protrusions
or Roughness--Surface State
Nuclear Forces
Nuclear
Particle Type
Surface Properties
Electrostatic Field
Protrusions
Roughness
Magnetic Field
Electromagnetic (Voltage)
Continuity
Conductivity
Information
Radio Waves
Reflectivity--State
--Absorbtivity
--Emissivity
Micro-waves
Reflectivity--State
--Absorbtivity
--Emissivity
Infrared
Reflectivity--State
--Absorbtivity
--Emissivity
Visible Light
Reflectivity--State
--Absorbtivity
--Emissivity
Ultra-violet
Reflectivity--Absorbtivity
Emissivity--State
--Fluorescence
X-Ray
Atomic
Weight

Bulk Properties

State of Matter



Knob

Consider how the following affect the interaction or fields:

- State of the tool
- State of the Product
- State of the Environment
- Note that **state of matter controls most fields**

Extreme Setting

- Change the State of the tool
- Change the State of the Product
- Change the State of the Environment
- (Note that **state of matter controls most fields)**

Bulk Properties of Substance

Cheap Substances

- Grocery store products
- Powders
- Foam
- Void
- Loose Bodies
- Waste or transformed waste
- Garbage
- Water, Steam or Hydrates
- Air and its components

Knob

- Identify the current fields throughout the tool or product
- What materials are affected by these these fields. What are their bulk properties (Properties spread throughout the volume)

Extreme Setting

- Change the product or tool to create the ideal bulk properties
  - Density
  - Conductivity
  - Magnetic Properties
  - Elasticity
  - Dielectric Strength
- Change the bulk properties by chemically transforming, decomposing, combining existing materials or by heat treatment.
- further enhance by adding a field

Example of Bulk Properties

- Creep Coefficient
- Strength
- Elasticity
- Toughness
- Ductility
- Physical State
- Density
- Temperature
- Viscosity
- Coefficient of restitution
- Gas Constant
- Gamma
- Cohesiveness
- Chemical Composition
- Molecular Weight
- Ionization Potential
- Molecular size
- Ease of Ionization
- Rarefaction
- Conductivity
- Trans Conductance
- Thermal Conductivity
- Coefficient of Thermal Expansion
- Thermal Capacity
- Dielectric Constant
- Magnetic Permeability
- Magnetic Hysteresis
- Curie Point
- Permeability
- Transparency
- Image Splitting Properties
- Refractive Index

Use of Foam

Extreme Setting

- Change the product or tool to a foam structure

Bulk Properties

Elastic Force Internal & External
Creep Coeff...--Strength--Elasticity--Toughness--Ductility--Physical State

Gravity
Density--State

Friction
Temperature--Viscosity --State

Adhesive
Temperature State of Mater

Centrifugal Force
Density

Inertia of Bodies (Note Direction)
Density--State--Elasticity Coeff. of Restitution

Coriolis Force
Density

Buoyant force
Density--State

Hydrostatic Pressure
Gas Constant--State-- Gamma--Temperature

Jet Pressure
Density--State

Surface Tension
Cohesiveness --State

Odor & Taste
Chemical Composition --State

Diffusion
Molecular Weight--State

Osmosis
Molecular Size Ionization Potential--State

Chemical Fields
Chemical Composition Concentration--State

Sound
Coeff. of Restitution Viscosity--Density--State

Vibrations & Oscillations
Coeff. of Restitution Viscosity--Density--State

Ultrasound
Coeff. of Restitution Viscosity--Density--State

Waves
Coeff. of Restitution Viscosity--Density--State

Corona Discharge
Ease of Ionization Rarefaction--State

Current
Conductivity--State Trans-conductance

Eddie Currents (internal and skin)
Conductivity--State Trans-conductance

Particle Beams
Molecular Weight

Thermal Heating or Freezing
Thermal Conductivity Coeff. Thermal Expansion Thermal Capacity--State

Thermal Shocks
Thermal Conductivity Coeff. Thermal Expansion Thermal Capacity--State

Nuclear Forces
Atomic Weight--Density Temperature

Electrostatic Field
Dielectric Constant

Magnetic Field
Magnetic Permeability Magnetic Hysteresis--Curie Point

Electromagnetic (Voltage)
Permeability--Conductivity Dielectric Constant

Information

Radio Waves
Transparency--State --Image Splitting Refractive index

Micro-waves
Transparency--State --Image Splitting Refractive index

Infrared
Transparency--State --Image Splitting Refractive index

Light (Coherent & light Pressure)
Transparency--State --Image Splitting Refractive index

Ultra-violet
Transparency--State --Image Splitting Refractive index

X-Ray
Molecular Weight

Match or Mis-Match of Properties

Knob

- Are the tool and product alike? Do the bulk properties match each other?
- Consider the following and how well matched the tool and product are
  - Thermal expansion
  - Thermal Conductivity
  - Electrical Conductivity
  - Modulus of Elasticity

Extreme Setting

- **Match or mismatch** tool and product properties, especially if they are in contact or must move or expand together
- Make the product and tool **from the same materials**

Gradients of Components

Knob

- Consider the bulk constituents. Can they be made non-uniform?
- How would a material gradient affect the internal fields?

Extreme Setting

- Allow a gradation or mixture gradient of material constituents
- Allow a sharp gradation of material constituents
- Add a new material and allow the gradient to vary

Chemical Activity

Knob

- Consider how chemically reactive the Product is to the Tool

Extreme Setting

Increase Chemical Activity

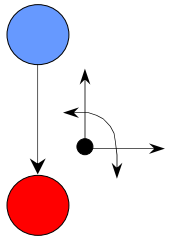
- Change to very active chemical substances
- Use progressively activated oxygen.
  - Ambient Air
  - Oxygenated Air
  - Pure Oxygen
  - Ionized Oxygen
  - Ozone
  - Singlet Oxygen

Change the tool or product to an inert substance

- Introduce inert gasses
- Introduce or mix in inert substances
- Use a vacuum

Direction

Direction of Action or Fields



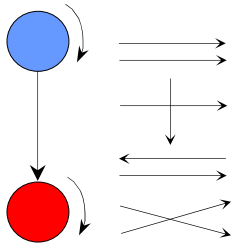
Knob

- Identify the Field Gradients
- Identify current direction of Action or fields
- How does the direction of the fields affect the interaction?

Extreme Setting

- **Reverse** the direction of action or fields.
- Change from linear to rotary motion.
- Change from rotary to linear motion.
- Go 90 degrees to the current direction

Relative Orientation



Knob

- Try different rotational orientations, relative to each other.
- Consider differences between linear and rotary motion.

Extreme Setting

- Change the orientation of the tool to the product

Direction of Action

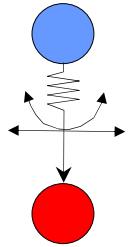
Knob

- What constitutes the reverse of the current action?
- What is the action performed relative to?

Extreme Setting

- Change the relative action
- Perform the reverse action
- Place parts upside down or backward
- Make moving parts stationary

Movement Relative to Gradients



Knob

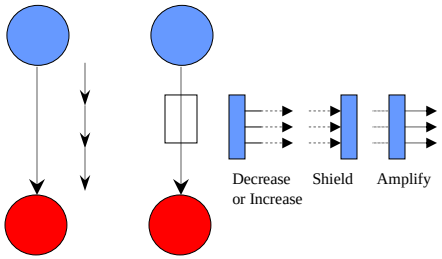
- **Draw the field lines** and the equipotential lines
- Does either element move or rotate through a field gradient?
- What direction do they move relative to the gradient?

Extreme Setting

- Make elements move **along** equipotential lines
- If either element already moves along equipotential lines, **changing the field slightly** can make the function adjustable. How can the fields be changed?
- Avoid lifting at all

Field Structure

Field Intensity or Conductance



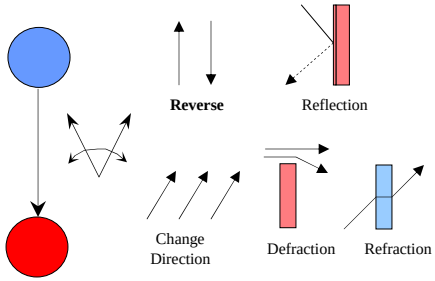
Knob

- Draw Field Potential Lines and Gradients
- How does the conductivity of the medium affect the interaction?

Extreme Setting

- Increase or Decrease the field intensity from the Tool
- Use an intermediate substance to shield, amplify or decrease the field
- Change the Conductivity of the Mediator

Field Direction



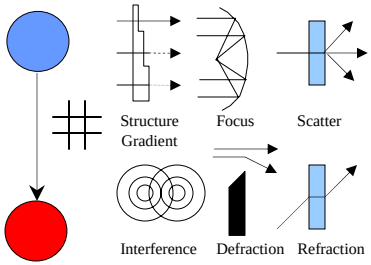
Knob

- Identify the field gradients and potential lines
- Is the field **direction** important?
- What would happen if the fields were **reversed**?

Extreme Setting

- Change to the ideal field direction.
- **Reverse** the fields?

Field Gradient or Concentration



Knob

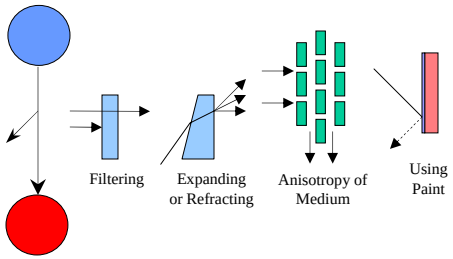
Draw the field gradients and field potential lines as they currently exist. Consider the following:

- Concentration of the field
- Rate of change of field gradient
- Coherence of field
- Interference of field
- Field Scatter

Extreme Setting

- Change the **gradient** to the ideal
- Move to higher dimensions
- Change the dimension of the affected area of the product
- Use heat to change the refractive index
- Sharply change the field gradient to eliminate harmful functions
- Make the Field **Coherent**

Variety or Separation of Field Components



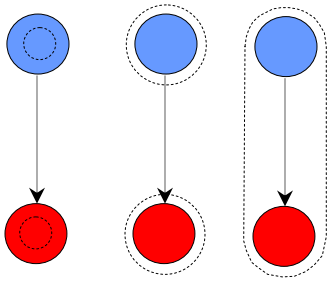
Knob

- Can the field be broken into various components by direction, Frequency or Variety of Fundamental Fields?
- Identify the **truly useful components**
- What properties of the product or tool affect the variety of field components?
  - Transmission of frequency
  - Absorption of frequency
  - Reflection of frequency
  - Anisotropy of Medium
  - Resonance properties of medium

Extreme Setting

- Break the field into various component
  - Direction
  - Frequency
  - Variety of Fundamental Fields
- Separate out the **useful components**
- Use a different Color: Filter field or reflect only certain frequencies
- Change the receptivity of the product to certain field components
- Search the **Table of Effects** for ways to separate field components
- Move to a higher dimension to enhance the filter.

Adding or Superimposing Fields



Knob

- Identify substances and constructions which react strongly to the existing fields or fields which would react strongly to the existing substances
- Identify other fields in the environment
- Consider **assisting fields** or **counter fields**, that could be superimposed **into**, **onto** or **in the environment** of the elements?
- Consult the table of Storage of Fields for consideration of **residual fields**

Extreme Setting

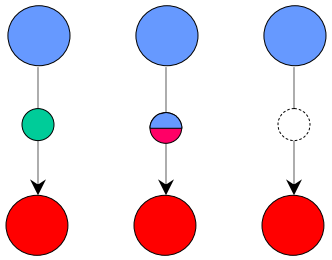
- Superimpose a **counter field**
- Superimpose an **assisting field**
- Superimpose a **new field type**
- **Pre-stress** the parts

Possible Modifications to Substances

- State of Matter
- Chemically altered
- Heat treatment
- Electrification
- Heated
- Foam
- Decomposed
- Mobilized
- Internal additives
- Ionized
- Recombined
- Dilution of constituents
- Concentration of constituents
- Change of Bulk Properties
- Form structures at micro level

Mediators

Type of Mediator



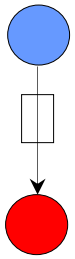
Knob

- Is direct contact required?
- What is currently between the tool and product?
- Can a substance be introduced ?
- If no contact is required, what is the medium or mediator which transmits the field?
- Consider the Refractive index of medium
- Consider the Gradient of the medium
- Break the function down into two separate functions. Consider each separately

Extreme Setting

- Add an **alien mediator**
- Use a **modification** of the tool substance
- Use a **modification** of the product substance
- Use a **mixture** of the tool and product
- Use **multiplied versions** of the tool or product
- Place a **void** or rarified gas between the tool and product
- **Enclose** both the tool and the product in the mediator

Conductivity of the Medium



Knob

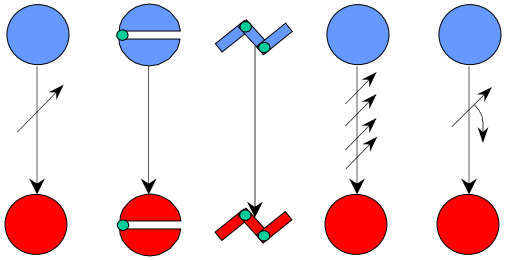
- What medium is between the tool and product?
- Is the conductivity of the medium adjustable?
- Should a different medium be used?

Extreme Setting

- Change the conductivity of the medium by using concentrated additives
- Change the gradient of conductivity
- Change to a different medium with higher or lower conductance

Making Adjustable

Adjustability



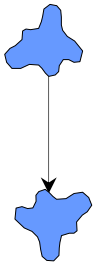
Knob

- Which of the features of the tool, product or field can be made adjustable? Consider the following:
  - Number of **Joints** in the tool or product
  - **Degrees of freedom**
  - **Variety** of adjustable features
  - **Continuity** of Adjustment

Extreme Setting

- Make adjustable to adapt to each stage of operation.
- Make self adjusting according to operating conditions. Immobile objects become mobile.
- Place **Joints** in the tool or product
- Increase the **number of joints**
- If a parameter is already adjustable, **increase** the degrees of freedom.
- Make **several** controlling parameters adjustable
- Make an existing or new parameter **continuously adjustable.**

Flexibility



Knob

Everything is flexible. Look at the system as a collection of springs, masses and dampers.

- Consider the flexibility of the **tool**.
- Consider the flexibility of the **product**.
- Consider the **direction** of flexibility
- Consider the **State of Matter**

Extreme Setting

•Change the flexibility of the **tool**.
•Change the flexibility of the **product**.
•Change the **direction** of flexibility.
•Make very flexible by transforming to a **liquid or gas**.

Nearness to Critical Point

Knob

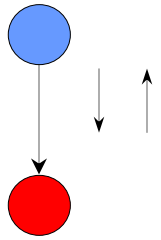
- Does the feature have a **natural critical condition** or threshold, such as boiling point or curie temperature?
- Can a critical condition or threshold **be created** for a feature which does not normally have one, such as a bi-stable condition?
- If the function is useful, **operation near the critical condition** can trigger large results.
- If the function is harmful, operating **far away** from the critical point reduces the effect.

Extreme Setting

- **Operate near the critical condition**
- Operate **far away** from the critical point.

Timing

Continuity of Operation



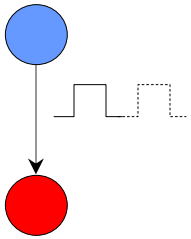
Knob

- Does the Tool Follow a Path?
- Can the Tool perform the function on the entire path, both coming and going?
- Is the function at full load (always operating)?
- Have dummy runs and downtimes been eliminated?

Extreme Setting

- Make the Tool perform the function on the entire path

Different Time



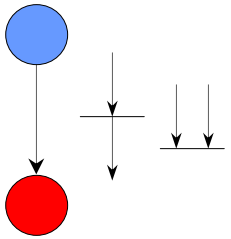
Knob

- Process Map the changing conditions over time.
- Does the requirement for the function vary over time?
- Could other tools help out at another time?
- If the modification is performed as a step in a process, can the sequence be varied?

Extreme Setting

- Change the Sequence
- Change the time
- Perform during transportation or while queued or waiting

Partial Modification



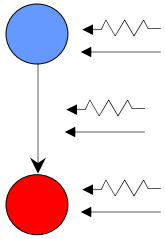
Knob

- Can the modification be broken into two (or more) **stages**?
- Can the operation be broken into **parallel** processes?

Extreme Setting

- Separate the modification into two or more serial **stages**
- Separate the operation into **parallel** stages
- Perform setup at the same time as the operation.
- Implies use of a **previously placed tool**.

Addition or Subtraction of Other Functions



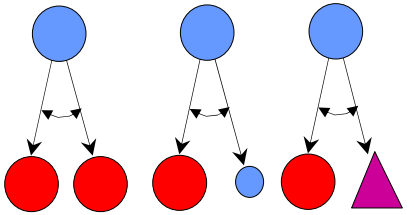
Knob

- Identify other functions performed on the tool, product and field.
- Does uncoupling these other functions affect the interaction
- Would coupling other functions such as vibration affect the outcome?

Extreme Setting

- Couple or uncouple other functions such as vibration

Uninterrupted Operation



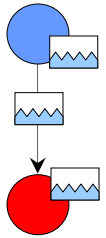
Knob

- Are all parts of the system at full load?
- Have dummy runs and downtimes been eliminated?
- What else in the system requires the same modification?

Extreme Setting

- Move to uninterrupted operation
- Make the tool operate on other similar products
- Modify the tool to operate on diverse products

Storage of Action or Field



Knob

- Identify the main fields of the function.
- Consult the next page for ways to store this field
- Is this field stored, even for an instant in the tool, product or in space? (is there a lag between field generation and application?)
- Is there energy storage in oscillations?
- Does storage improve the function?
- Can storage be a mediator between the tool and product?

Extreme Setting

- Store the field in the lag between field generation and application
- Store Energy in oscillations
- Make storage a mediator between the tool and product

Elastic Force Internal & External
Springs
Elastic Media

Gravity
Height of Objects
Weight or Density

Friction

Adhesive

Centrifugal Force
Momentum

Inertia of Bodies (Note Direction)
Momentum

Coriolis Force
Momentum

Buoyant force
Average Density of Buoyant Object

Hydrostatic Pressure
Pressure Vessel

Jet Pressure
Fluid Momentum

Surface Tension
Surface Tension
Area

Odor & Taste
Container

Diffusion
Pressure
Vessel

Osmosis
Container

Chemical Fields
Explosives
Chemical Potential

Sound
Oscillation Chamber--Distance of Travel--Resonance of Objects

Vibrations & Oscillations
Oscillation Chamber--Distance of Travel--Resonance of Objects

Ultrasound
Oscillation Chamber--Distance of Travel--Resonance of Objects

Waves
Oscillation Chamber--Distance of Travel--Resonance of Objects

Corona Discharge
Low Field
Vacuum

Current
Inductance
Super-conducting media

Eddie Currents (internal and skin)
Inductance
Super-conducting media

Particle Beams
Low Field
Vacuum

Storage of Fields

Thermal Heating or Freezing
Thermal Mass

Thermal Shocks
Thermal Mass of Two Objects

Nuclear Forces
Radio-active Materials

Electrostatic Field
Capacitance--Piezo Electric Materials

Magnetic Field
Permanent Magnet

Electromagnetic (Voltage)
Separation Space

Information
Data Fields

Radio Waves
Separation Space
Oscillating Circuits

Micro-waves
Separation Space
Oscillating Circuits

Infrared
Separation Space
Hot Objects

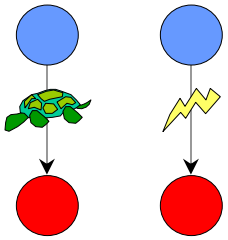
Visible Light
Separation Space
Hot Objects
Fluorescence

Ultra-violet
Separation Space
Hot Objects
Fluorescence

X-Ray
Separation Space
Radio-active Materials

Time Variation

Speed



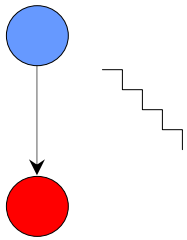
Knob

- How are the fields changed by performing the modification at different speeds?
- If the modification were performed more rapidly, would other harmful functions be precluded?

Extreme Setting

- Slow the function way down (hours, days, weeks, months, years)
- Perform the modification very rapidly to preclude harmful or hazardous functions.

Discrete or Continuous



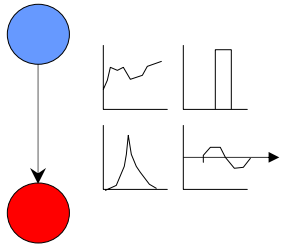
Knob

- If the action is continuous, is there any advantage to make it **discrete?**
  - Can the Tool be **Multiplied or segmented** into separate pieces.
  - Can each piece moves into action in discrete steps or into fixed positions or amplitudes.
- If the action is discrete, can it be made **continuous**

Extreme Setting

- Continuous actions move to discrete actions
  - **Multiply or segment** the tool into separate pieces.
  - Each piece moves into action in discrete steps or into fixed positions or amplitudes.
- Discrete actions move to continuous actions

Time Variance or Pulse



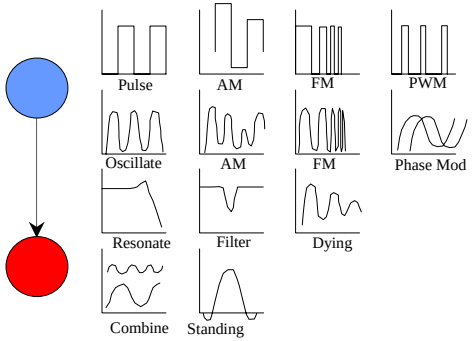
Knob

- How is the interaction affected if you could continuously vary the action in time?

Extreme Setting

- Shape the curve
- Square pulse the action.
- Shape the pulse.
- Make the pulse travel.

Pulsation or Oscillation



Knob

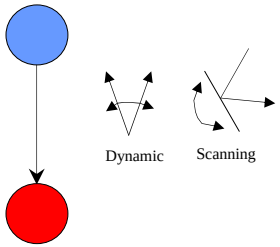
Is the interaction affected by pulsing or oscillating the **tool, product or field**?

- Can a feature or knob of the tool, product or field be oscillated
- How do the natural frequencies of the tool and product affect the interaction?

Extreme Setting

•Pulsate or oscillate the tool
•Pulsate or oscillate the product
•Pulsate or oscillate the field
•Pulsate or oscillate the product receptivity
•Resonate the tool, product or field
•Create standing waves
•Cancel oscillations in the tool, product or field
•Mismatch the product natural frequency with the tool driving frequency
•Increase or decrease the frequency

Vary Field Direction



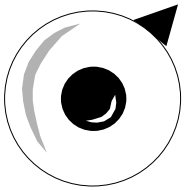
Knob

- Identify the field gradient and potential
- Does varying the field direction affect the function?

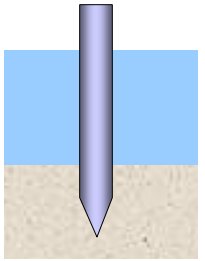
Extreme Setting

- Vary the field direction

5 Types of Knobs

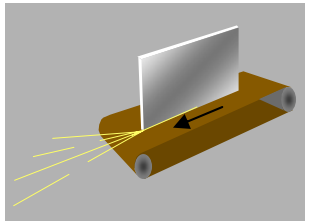


- Easily Turned (Full control and nothing else gets worse)
- Little Effect (Turning the knob through the full range has little effect)
- Something Else Gets Worse
  (Turning the knob makes something else worse)



Sharp for driving & Blunt for supporting

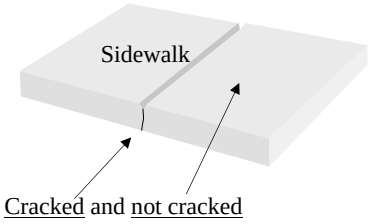
- One Flavor or Setting
  The knob cannot be turned, it only has one setting



The glass only came thin yet it needed to be thick for polishing

- Outcome

(The knob cannot be turned dependent on other knob settings)



The sidewalk must crack because we are not going to address what causes the crack but it must not crack