Hierarchical TRIZ Algorithms

5th Installment--Sept 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 installment includes the fourth step of the 10 step algorithm (shown on the cover):

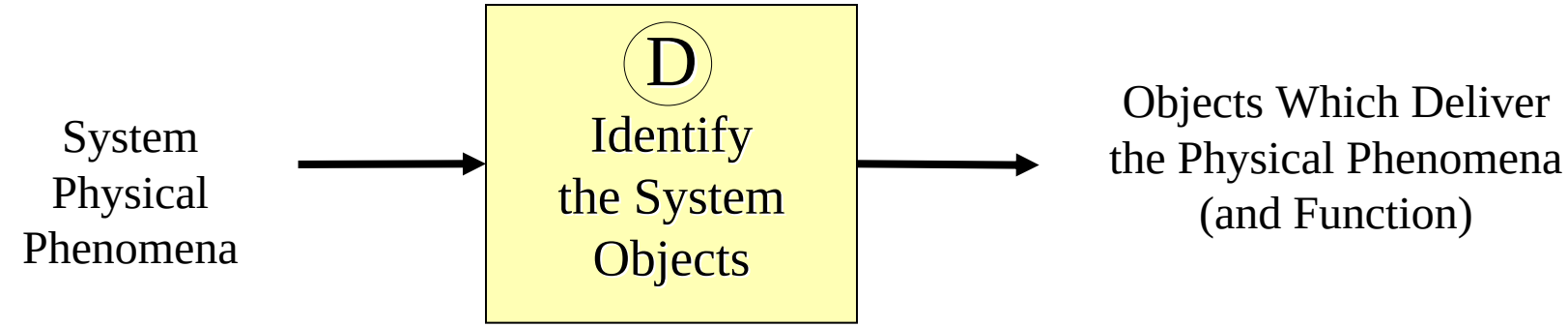
D. Identify the System Objects

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

E. Simplify the System

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

Now that we know the physical phenomena which will deliver the main system function, it is necessary to identify the physical objects which will, in turn, deliver the physical phenomena. As in all other steps, the choices that are made in this step need to be as ideal as possible. If the function is really required, we would like to deliver it without the use of any substance. If the addition of a substance is necessary, then we would like to do it without the addition of any new elements. This leaves us to deliver the function with either elements that exist in the super-system (job or environment) or to use elements that we have already chosen for our system. The environment is usually full of objects with attending fields that can be used. Also, each new element that is introduced into the system can be a resource tool for other required functions.

Simply making a list of field and object resources that builds as we add objects will help a great deal.

The first question that we need to make is: what objects in the super-system can deliver the main functions. Perhaps our system only needs to assist these other objects. If it is not possible to deliver the function with existing objects, we we need to consider creating a system to perform this main function.

In the previous section, we listed field and object resources in order to help us to determine what fields or physical phenomena were abundant and what could be used to perform our primary function. Now we can use some of these same objects to deliver the function that we require.

Additionally, each new object that is added gives us a new “abundant” field or resource.

The addition of each function and element should be treated in the same fashion as the system function was treated. We always ask: what is the ideal product, modification, effect and tool.

The system that we are creating must have four basic elements. An energy source, a transmission element, a working element and a control element. Without some form of each of these elements, the system cannot operate.

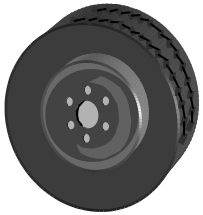
Suggestions are given for the addition of control elements. There is often a tendency to design complicated control systems. This is only necessary with more developed and differentiated systems in which we are running out of resources. For new systems, keep it simple. In general, the most ideal form of control is passive control. This is because the element which senses also actuates the working element, making the system simpler.

The output of this step are the physical objects and a baseline description of our system. It would not be unusual for this system to be highly flawed.

Simplified

Ideal Objects?

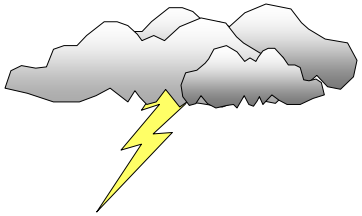
Identify a Baseline System



- If the system already exists, identify a baseline system that represents the situation. Be as specific as possible. (The system may already exist but in highly flawed form)

(OR)

Brainstorm Objects or Parts



- If the system does not exist, brainstorm physical phenomena and objects which will deliver the required function. Consider the four possibilities from the 40 principles shown below.

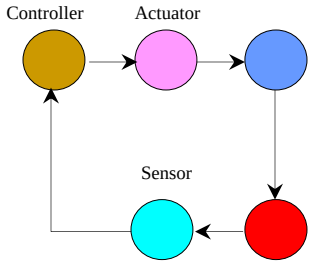
Ask How Several Times

How?
How?
How?
How ?
How ?

If you are creating a system for the first time, new elements must be considered to reach the desired outcome.

- Each new element that we add will need to be acted upon by other elements.

23 **Add Feedback**

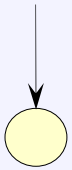


Detailed

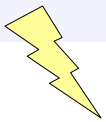
Determine Objects which will Deliver the Physical Phenomena

The market that I have chosen is people who are trying to dry their shoes after washing or after use in wet conditions.

The system function is move moisture

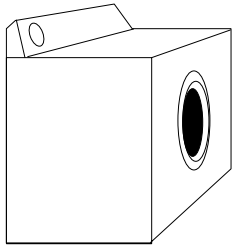


The Physical Phenomena that I have chosen is Evaporation.

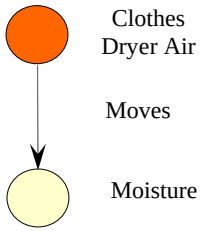


Identify the Main System Tool

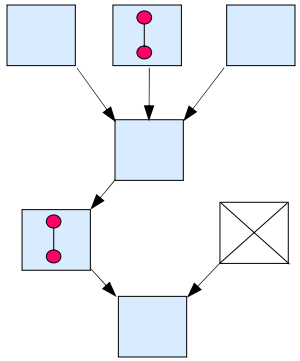
- Go to the Appendix for Idealizing Systems and use the section on defining the ideal tool to deliver the main system modification.



The Clothes dryer is handy. It performs an analogous function on clothes



Build the Rest of the System

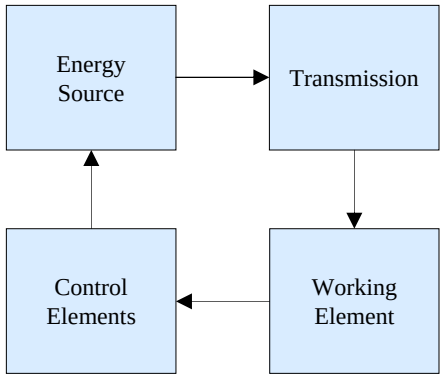


1. Follow the rules for the **Positive Cause-Effect Chain** to capture most of the objects and functions which will be required.

An example of this is given on the following pages for a shoe dryer.

2. Add all objects according to the rules in the appendix which covers idealizing functions.

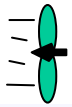
Verify Crucial System Elements



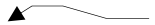
1. Review the function chain to verify that all crucial elements are present.

The heating coil is a second energy source

The motor is an energy source



The fan transmits the energy to the air



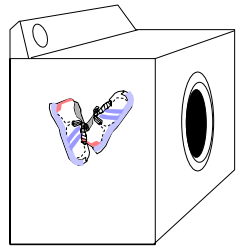
Air is Working Element

Dryer thermostat is the control element

2. Review the section on Control Elements for ideas on which type of control elements might be required.

Identify a Baseline System

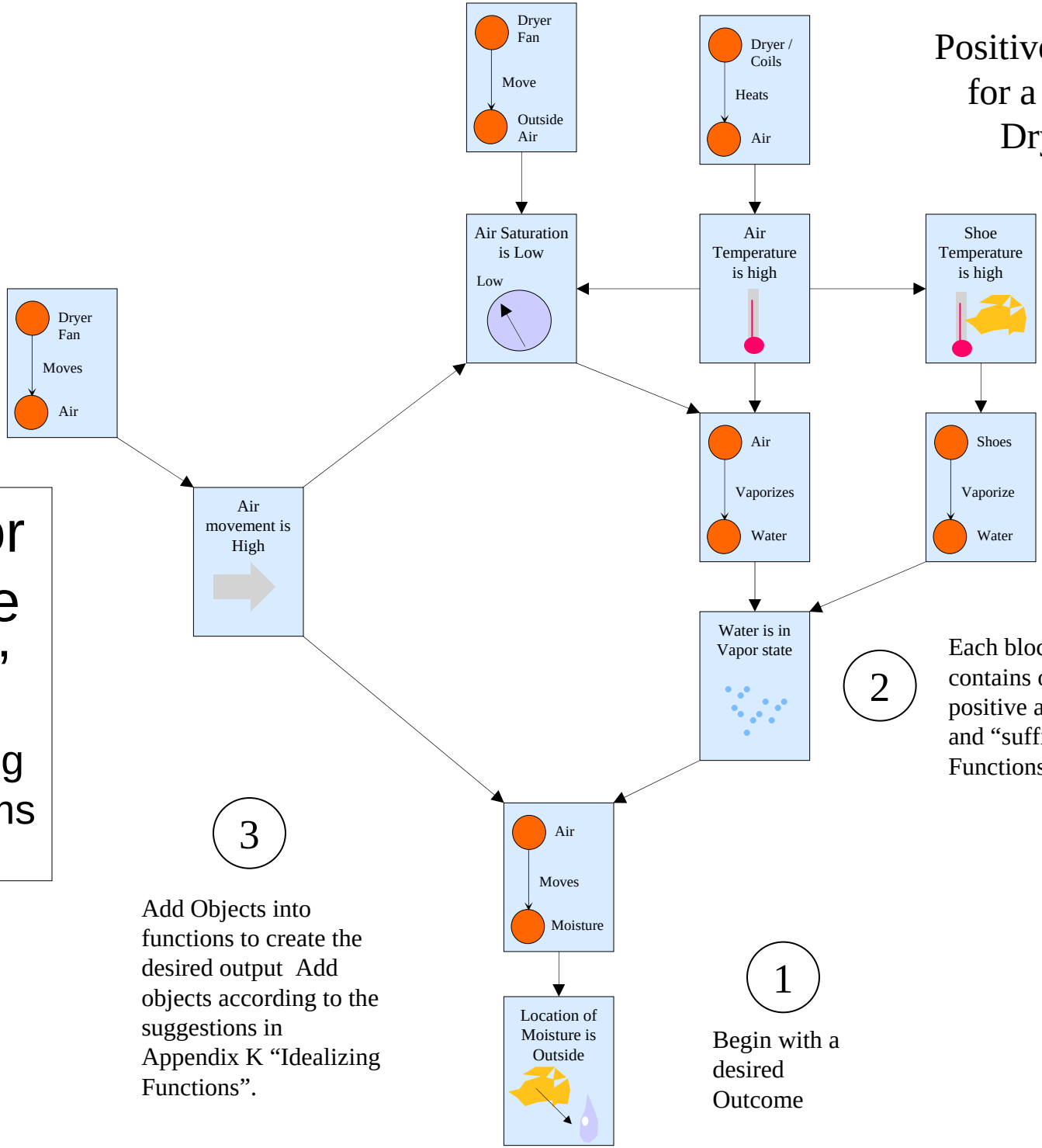
- Identify a **Baseline system** that represents the situation. Be as **specific** as possible. (The system may already exist but in highly flawed form)



The shoes are somehow dried in the clothes dryer

- If you are not changing the system, then the existing system will serve as the baseline system

Positive Chain for a Shoe Dryer



Rules for "Positive Chains"

For Creating New Systems

2

Each block contains only positive attributes and "sufficient" Functions

3

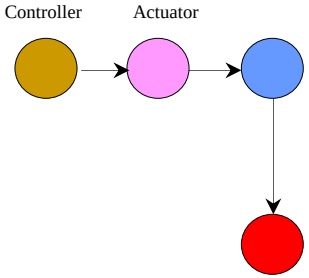
Add Objects into functions to create the desired output Add objects according to the suggestions in Appendix K "Idealizing Functions".

1

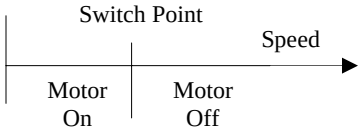
Begin with a desired Outcome

Different Control Philosophies

Open Loop Control

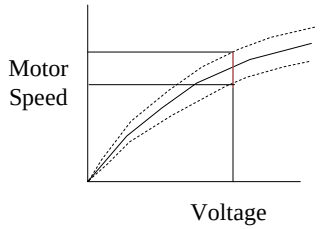


- Does the modification need to be more precise?
- Is the tool or product already adjustable?
  - Discrete positions=bang-bang



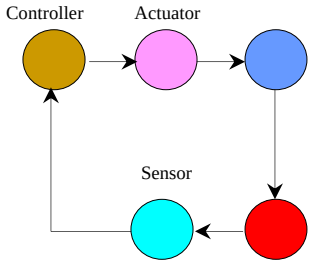
Bang-Bang Speed Controller

  - Continuously adjustable?

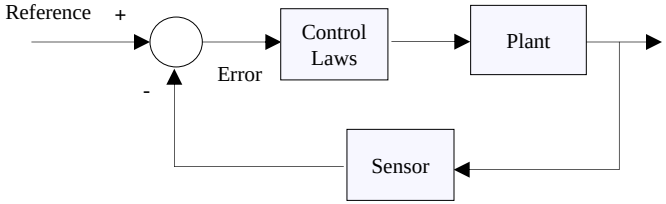


- Are means provided to sense changing conditions
- **Add Actuator** to tool or product
- **Add Controller**

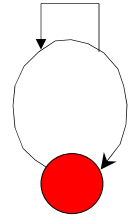
Use of Closed Loop Control



- Does the modification need to be yet more precise?
- Add a sensor to sense the modified feature
- Increase the number of parameters sensed
- Increase the order of the variable sensed (first derivative, second derivative…)



Use of Passive Control



- **The highest form of control is passive control**
- Does the system ideally use one field for operation and control?
- Provide for self-service operation (Ideal Tool / Effect)
- Identify the **critical point** at which small changes in input cause large changes in output
- Move the critical point to the desired control point.

Critical Points

- Sheer Strength
- Ultimate Strength
- Tip Angle
- Static Friction
- Adhesive Failure point
- Zero Buoyancy
- Triple point
- Surface Tension
- Resonant Frequency
- Spark point
- Freezing point
- Boiling point
- Curie Temperature