Hierarchical TRIZ Algorithms

3rd Installment--July 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 second step of the 10 step algorithm (shown on the cover):

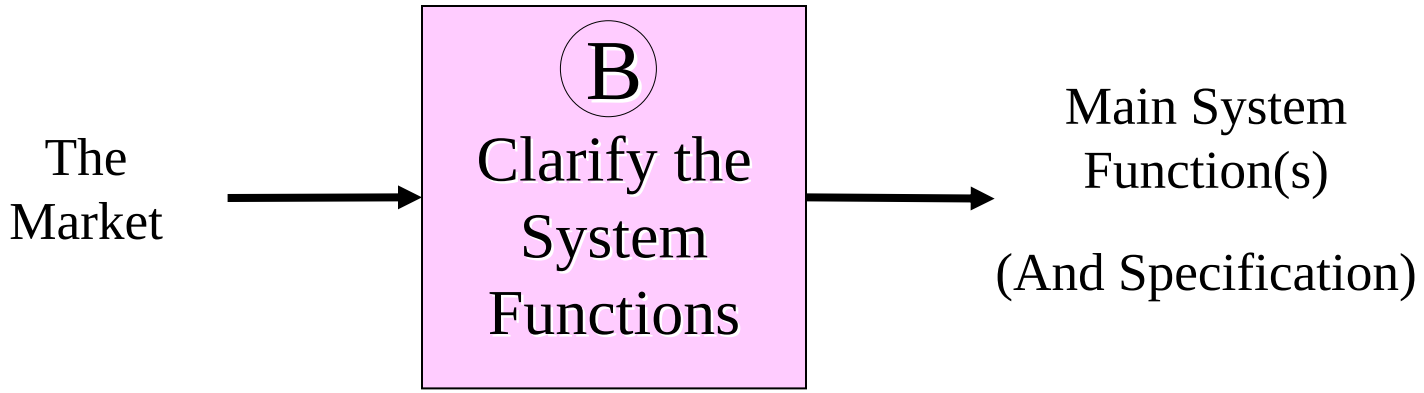
B. Clarify the System Functions

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

C. Identify the Physical Phenomena

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

By this point, we have identified a select group of people that are trying to get a job done. This is our market, which is the input to this step of the innovation process. The output of this step is to identify the essential functions that our system will perform to help our market get their job done.

The market may be a **recognized** market, in which case, we may feel that we know the main functions that our system is to perform. On the other hand, we should reconsider what we are taking for granted and ask ourselves these questions:

1. What other functions our system can take over from other objects involved in the job ? By looking around a little, we may notice other objects involved with the job. They perform a function too. We can consider pressing our system to perform more functions and thus take over the functions which these objects would normally do.

2. What can our system do to reduce other harmful situations in the super-system? In other words, can our system perform preventative or corrective functions functions that make the super-system work better.

3. What can our system do to measure what is going on in the super-system? There may be elements in the super-system (job) which are meant to inform the user of the system or another element. Our system can take over this job of informing.

4. What do we *ideally* want our system to do? (In light of the answers to the first 3 questions). What is the ideal object that our system should serve? And what is the ideal service that our system provides? Answers to these questions can change the nature of everything which is to follow. During this time of reasoning, we allow ourselves to question the very items that we thought our system was going to serve and how it would serve them.

Next, we will write a simple specification of how well the system is required to perform these functions. Once again, we take nothing for granted. Systems are often over specified in certain areas that the market would be willing to part with for the right cost. If the market is **recognized**, we may take for granted functional requirements that we think the customer cannot live without. An example of this is budget airlines that do not serve meals on their flights.

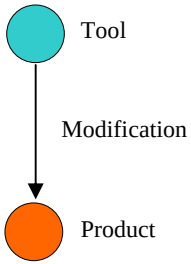
Also, there are usually certain requirements that could be greatly boosted in order to delight this market. If the market is **unrecognized**, these requirements may involve simplicity and convenience of operation.

One unintended result of this step is the discovery of unexpected markets. Alternatives to performing the function almost always introduce possibilities for performing a new job. This discovery may send us back a step.

Functional Nomenclature Functional language is first introduced in this chapter. It is recognized that the proliferation of TRIZ terms is objectionable and makes it difficult for the new student to translate between different authors. Sometimes different terms are used to mean the same thing. In order for the reader to "translate" while reading this text, a consistent nomenclature will be established. It is hoped that this nomenclature will already be familiar to most readers.

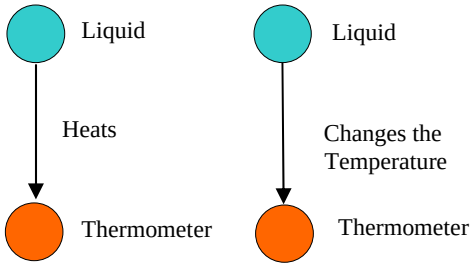
A **System** is a collection of physical objects that deliver a function. Examples of a system might be a toaster or a car. Many different objects make up a system, and they all work together to deliver a function to the user which helps to perform a job or task.

Objects in the system act upon each other. In function analysis, interactions between two objects are taken one at a time. Below is a generic function diagram showing its parts



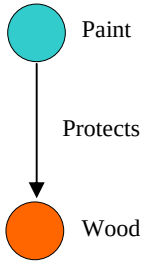
The physical element that is acted on will be referred to as the **Product**. (In other texts, it may be referred to as the object or artifact). The object that acts on the Product is referred to as the **Tool**. What the tool does to the product will be referred to as the **Modification**. (In some texts, this is referred to as the Action). It is usually a verb. The use of the term "Modification" will be new to many readers, however it is used to stress the requirement that the action verb must describe a change or control of the attribute of the product. This is sometimes difficult for beginners to grasp.

Beginners are encouraged, to use a longhand form of the modification. The longhand form begins with "Changes" or "Controls". For example, we can describe the action that occurs between a tool "liquid" and a product "thermometer" which is immersed in the liquid. The short form of the modification is "heats" or "cools." The longhand form of the modification would be "Changes the Temperature".

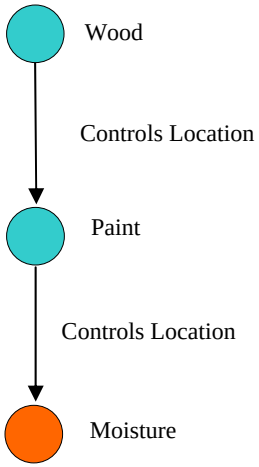


Short Form Longhand Form

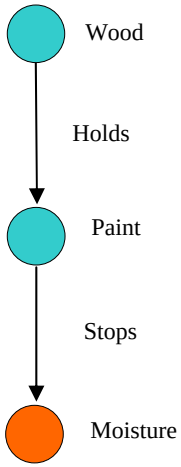
The use of the term "modification" helps the beginner to understand that the tool and product must be physical elements. It also helps to correctly describe "confusing functions," such as how paint protects wood. Beginners often write:



While the word "Protects" is a verb, it is not a modification, as it does not describe a *change* or *controlling* of the wood. Insistence on using the word "Protects" will hamper the problem solver in later steps. The longhand form encourages the student to correctly break the forgoing function into a small system of functions:



Once the longhand form is firmly entrenched, the student can usually revert back to the short form of the modification for brevity.



The modification to the product is *delivered* by an **Effect** (Physical Phenomenon). The term "Effect" is an artificial convention, introduced by TRIZ practitioners that allows us to group physical phenomenon into recognizable groupings. An example of an Effect would be "capillary action." The Effect of capillary action actually arises from complex physical interactions involving several different fields at the atomic level. However, most people readily recall the phenomenon of capillary action from demonstrations of liquids rising in tubes. TRIZ literature contains tables of these Effects that are very useful.

A **Field** is another artificial grouping convention, which allows us to talk about different manifestations of *fundamental fields* as recognizable groups such as vibration, electromagnetic radiation, gravity, mechanical stress and pressure. Some of these "fields" such as Odor & Taste may seem a little offbeat. One or several objects and their associated fields deliver effects.

In summary, the **Tool** delivers the **Effect**, which delivers the **Modification** to the **Product**.

The Following page outlines the tests for a correctly written function

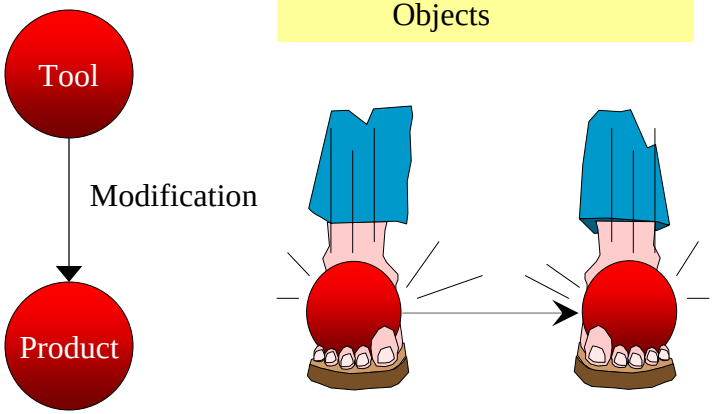
Tests for Correctly Written Functions

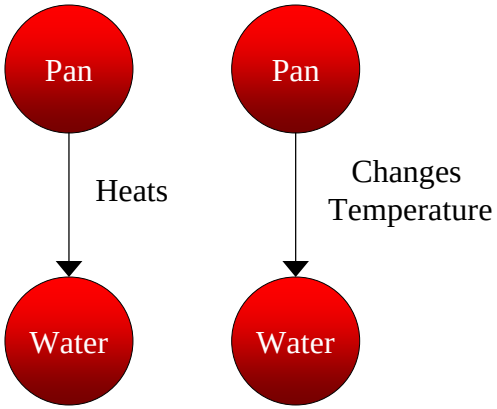
1. Are all of the Parts Present?

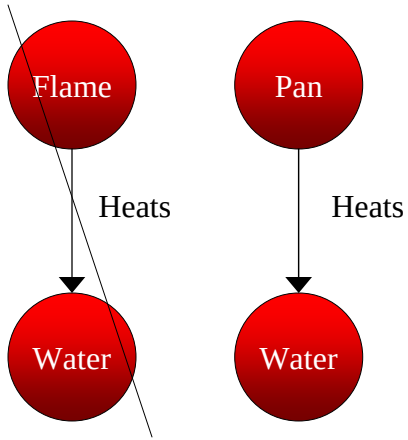
2. Are the tool and product something you could drop on your foot?
   - •Physical or virtual Objects

3. Does the modification describe a physical change or control of the product?
   - •Use longhand (Changes Or Controls) if confused.

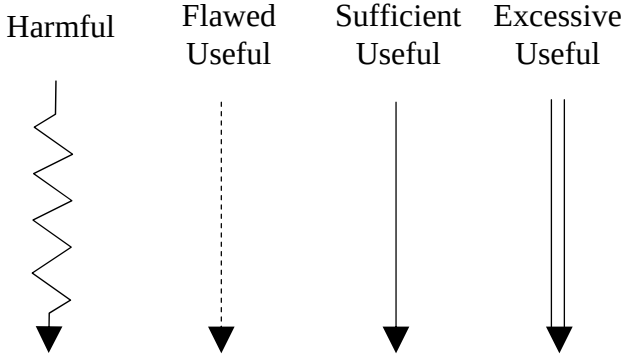
4. Does the tool directly modify the product?



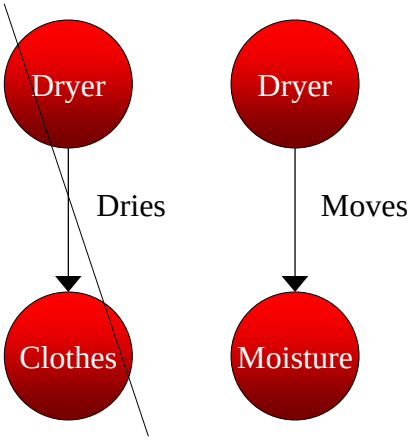


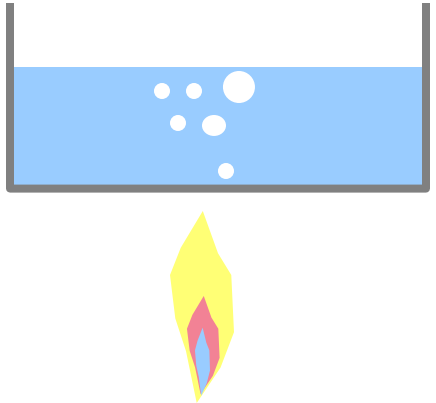


5. Is the correct function symbol used?



6. Does it describe what is really happening?
   - • Be Careful with Confusing Functions

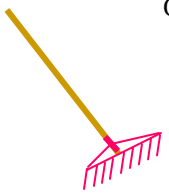




Simplified

What is the Main Function ?

Baseline the Main Function



Collects Loose Debris

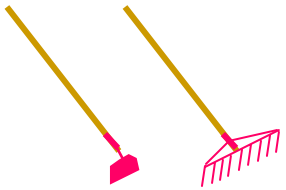
1. Decide what the system will do to perform the job for the target market.
2. Eliminate functions that have low value to the chosen market.

Main Function Not Required

Scales become a delicacy--scaling not required

1. All useful functions can be thought of in a remedial or preventative context. Ask:
   - What does it prevent?
   - What does it fix?
   - What does it make up for?
   - Does it counter something?
2. What change makes our system unnecessary? (There is no need to fix or prevent).

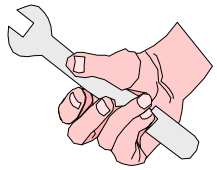
6 Universality Take on Other Functions?



Hoe and Rake?

1. Consider other objects nearby that are related to the job that the target market is interested in
2. Consider other objects that are almost always be found in the situation of the job.
2. Can your system take on the function of these objects?

Perform Human Functions



- Are humans required to monitor, maintain or service our system?
- Can the product perform some of these functions ?

Create a Specification

Stated Requirements

Specs

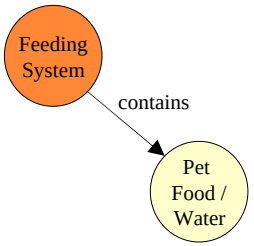
- How well must you meet the needs of the market segment that you are serving? Create a specification of the main attributes.

Detailed

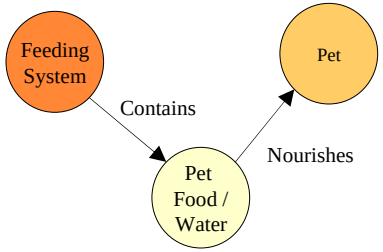
Identify Main System Functions

Model the Super-System (Job)

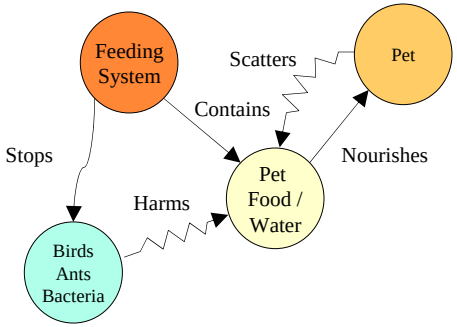
1. In functional terms, define how the **system** modifies the **system product** (look at how a pet bowl relates to the food that it holds)
   - **In the context of the job** (The owner just wants to feed the pet and keep it healthy)
   - Make this function as exact and carefully thought out as possible.
   - Follow all function rules shown on Page J26



2. In functional terms, describe how the **System Product** relates to the **Super-System Product.**
   - Describe this in the context of the job that the super-system is hired to do
     (The pet is nourished by the food contained in the bowl)

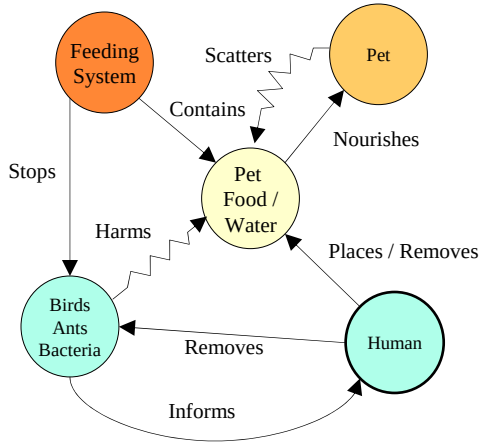


3. Include elements in the **immediate super-system** (the job environment) (here we notice that one of the main functions of the feeding system is to stop or constrain pests)



Include Human Interactions

1. Take special note of **human interactions** and functions.
2. Human elements are good candidates for removal. Perhaps our system can perform additional functions or solve a problem that removes the human from the system.



3. What humans are required to perform functions? (Someone has to clean the water and food bowls, especially in hot weather. A person also has to remove unused food and water to keep the population of bacteria down)
4. Are humans required to monitor, maintain or service our system? (Someone monitors the condition of the food for pests and contamination)

Add New Useful Functions

In order to:

Simplify the super-system

Take over the functions of other super-system objects

Prevent or reduce the harm to objects in the super-system

Monitor objects in the super-system

Delight the market with unexpected functions and capabilities

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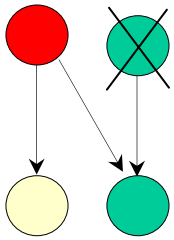
Discover unrecognized or new markets (sending us back a step)

Note, considerations in this step may move us ahead in the process by suggesting new system objects which would normally be done in a latter step

Take on Additional Functions (TRIZ Universality) (also ASIT Unification Tool)

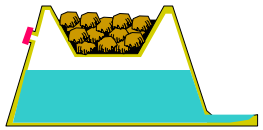


1. List objects in the environment associated with the job at hand. Take especial note of objects with similar functions.

A water bowl is also a part of the job of nourishing the dog

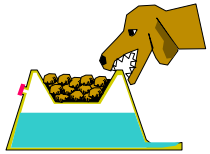
2. The Tool takes over all or part of another objects functions. This is not simply a combining of objects. When you are done, one of the two original objects should be "invisible". There should be no compromise in the original functions

The water bowl and food bowl are combined



3. Completely new and unexpected benefits must emerge. Try different orientations and combinations.

The pet can no longer drag the food bowl around, scattering the food



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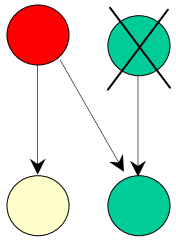
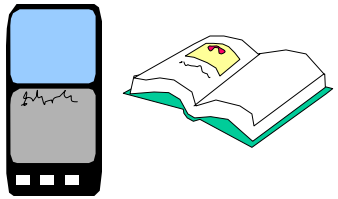
- Does this change the market that would find instant benefit from this virtual product?

Competing Objects



1. Identify other objects or processes that seek to provide the same functions. These objects may not be obvious. These are the competing systems. (The true competition)



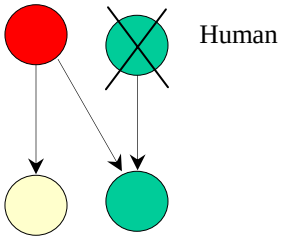
The Photo-album competes with the organizer for organizing information on contacts

2. Consider taking over all or part of these objects functions. New and exciting capabilities should emerge. New synergies between the objects that could not exist before.

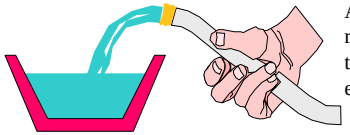
PDA also organized Pictures of Business Contacts (Takes Pictures as Well)

3. Does this change the market segment that you are trying to serve?

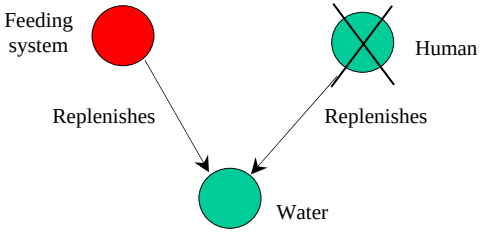
Usurp Human Interactions



1. Look at from the viewpoint of humans that interact with the system.
   - Are humans required to operate the system?
   - Are humans required to maintain the system?



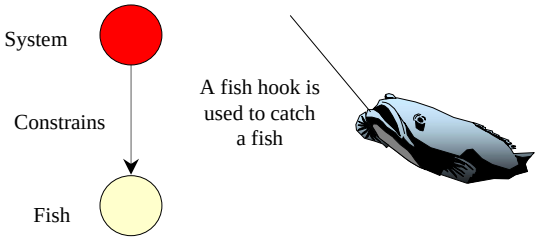
2. What changes to the system would allow the human to be removed from the system?



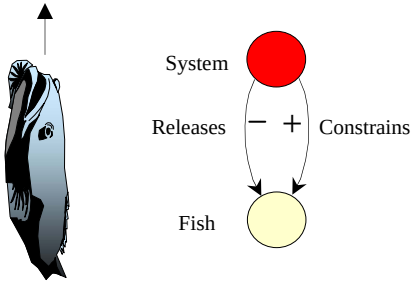
3. Would eliminating human interactions change or expand the target market?

Absorb the Anti-Function

1. Identify the useful function.

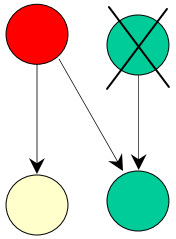


2. Identify the Anti-function. This is function which undoes the function or is a useful variant of the opposite of the useful function.

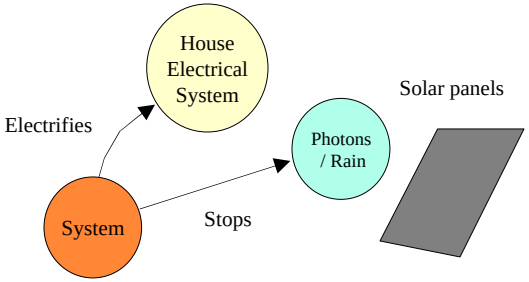


3. Does adding the anti-function expand or change the target market?

Boost Incidental Functions

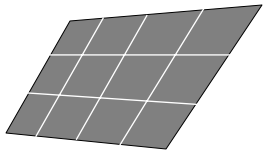


- Identify incidental functions that the system already performs



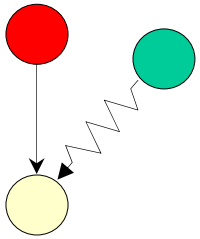
- What elements in the super-system normally deliver this function?

- Boost these incidental functions to take over for the other super-system elements.
- **Look for unexpected capabilities to emerge**

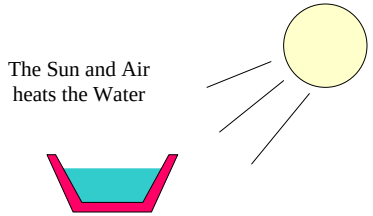


- Does boosting incidental functions expand or change the target market?

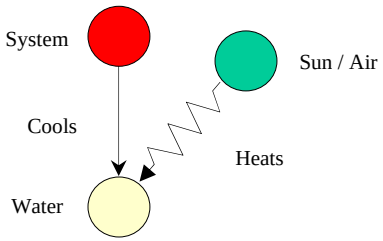
Cancel or Absorb Harmful Functions



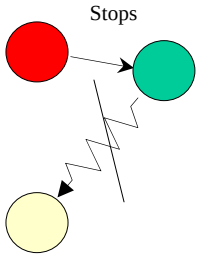
1. Identify harmful objects in the super-system which perform harmful functions on the system product or another element of the super-system.



2. Identify functions which counter the harmful function or absorb its influence



Exclude Harmful Objects



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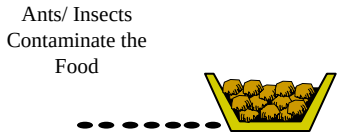
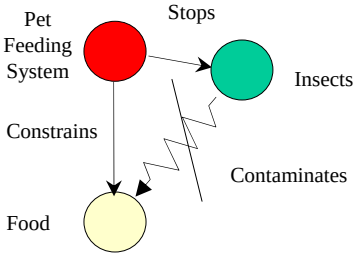
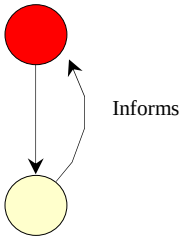


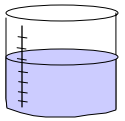
2. Are the objects which create the harmful function necessary? If not then the new function is to exclude the offending objects



Provide Measurement or Detection

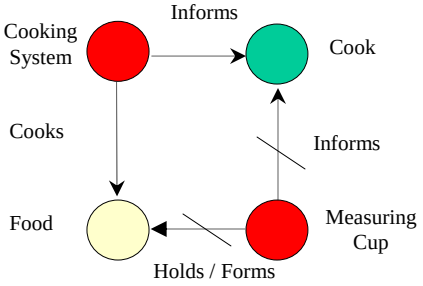


1. Identify objects in the super-system that perform measurement functions.



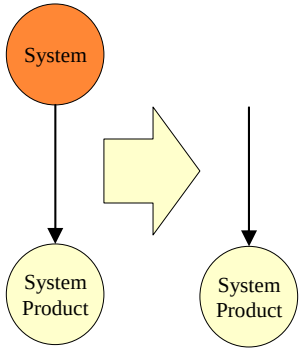
Measuring Cup
Measures Food

2. Take over these functions.

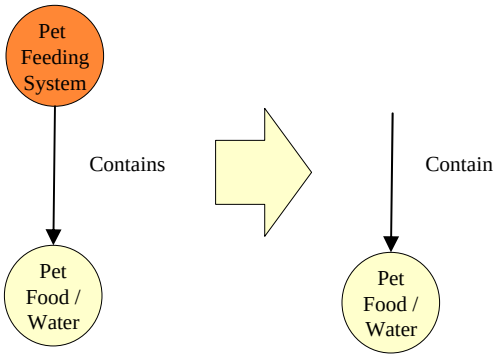


Idealize the Main System Functions

Isolate the Modification on the System Product

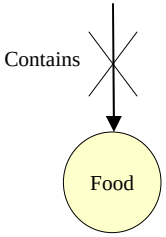


- Focus on the function that the system performs on the main system product. (In this case we focus on the pet feeding system which contains the pet food and water)
- Ignore the system that performs the function and focus only on the main system product and the modification to it.

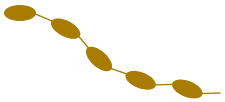


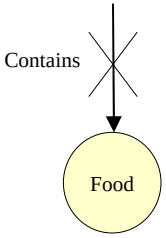
What is the Ideal System Product?

- Make certain that the System Product is what you want to Modify. Go to the Appendix-- Idealizing Functions for suggestions on identifying the ideal product.



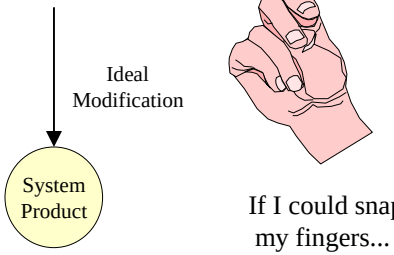
The dog food requires no container because it does not come in independent pieces. For instance, the food is linked together or comes as one piece. Perhaps it just hangs on a roll





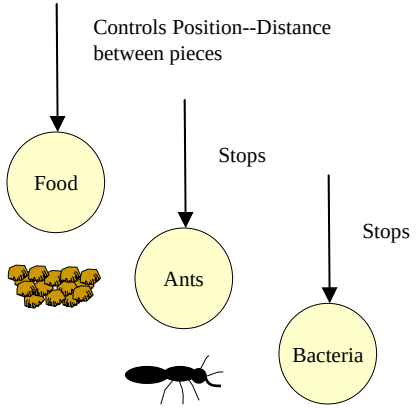
The food comes already contained. It matters not if the food is poured directly upon the ground. Neither the dog nor the food will sustain any injury.

What is the Ideal Modification?



If I could snap my fingers...

- Make certain that the Modification is as ideal as possible. Go to the Appendix-- Idealizing Functions for suggestions on identifying the ideal modification.



Using the Inverse: The food is positioned relative to the surrounding environment. Do we adjust the surroundings to accept scattered food?

Least Resources: Zero energy is required to maintain the distance.

How Well Must the Product Perform to Meet the Needs of the Market Segment?

The Competition

Competition

1. What constitutes the real competition? (Products which the consumer uses if he does not use yours).

The system is a PDA which organizes information. Other types of competition are picture albums, business card indexes

2. What are the strengths and weaknesses of the competitive products.

Competition Strengths:
1. Ability to browse
2. No need to power up
3. Low volatility of information

Competition Weaknesses:
1. Large size
2. Difficulty accessing certain pictures
3. Difficult to carry with you

3. If this is a recognized market, what properties would make the competition **irrelevant**?

The ability to carry wherever you go

Stated Requirements

Specification

Develop the specification for a PDA

1. Which of the functions that the industry takes for granted should be **eliminated**?
2. What requirements could be **reduced well below** the industry standards?
   - What could be gotten used to if the costs were low enough?

1M ➡ 100 K

Low picture quality could be gotten used to

3. What requirements should be **raised well above the industry standards**, especially if the cost was low enough?

1. Ability to point and shoot without attracting attention
2. Ability to show picture with other information
3. Ability to hold lots of pictures
4. Ability to pass pictures to next generation.

4. **Create a specification** for the product, process or service which gives more of what the market needs and less of what they can do without. **Include target manufacturing costs.**

1. Holds 200 pictures
2. Taking pictures does not attract attention
3. Can Zoom
4. Pictures come with information
5. Target production cost $ $80