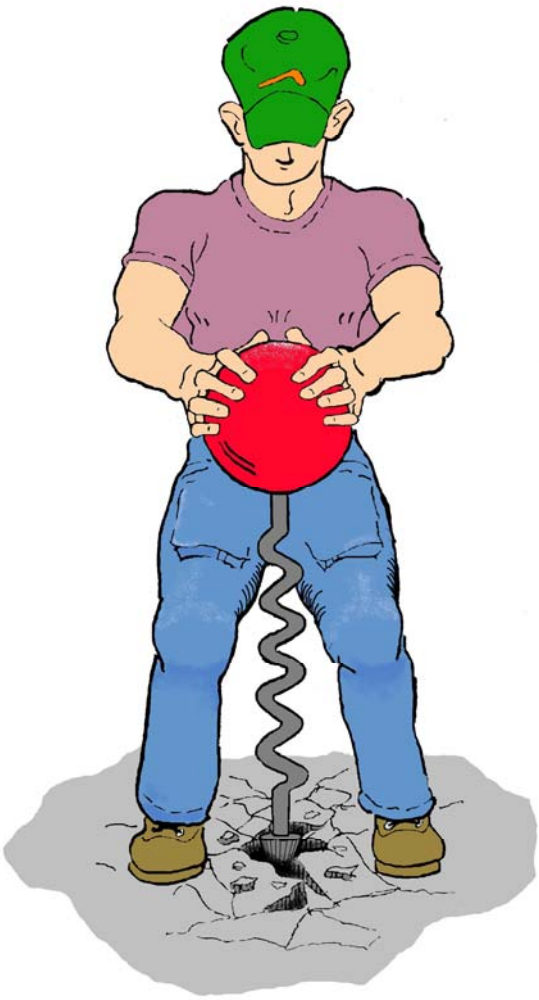
TRIZ POWER TOOLS

Skill #2 Working with Functions

April 2012 Edition



Learning a New and Useful Language

TRIZ Power Tools

Working with Functions

March 2012 Edition

TRIZ Power Tools by Collaborative Coauthors

22 Pages

Copyright 2012 by Collaborative Authors, All rights reserved

Acknowledgements

This book is the work of a collaborative group of coauthors.

Coauthors

Larry Ball

David Troness

Kartik Ariyur

Jason Huang

Don Rossi

Petr Krupansky

Steve Hickman

Editors

Erika Hernandez

Larry Ball

David Troness

Paul Dwyer

S. Robert Lang

Illustrators

Larry Ball

David Troness

Other Authors, Theoreticians, Practitioners Whose Writings or Teachings have Impacted This Work

Genrich Altshuller

Ellen Domb

Roni Horowitz

John Terninko

Alla Zusman

Boris Zlotin

Lev Shulyak

Yuri Salamatov

Victor Fey

Eugene Rivin

Darrell Mann

Sergei Ikovenko

Simon Litvin

Peter Ulan

Lane Desborough

Clayton Christensen

Renee Mauborgne

Kim Chan

Greg Yezersky

Table of Contents

(Table of Contents)

Introduction

(If you are reading the PDF format—navigate the algorithms with the "Bookmarks" to the left.)

Since the ability to work with functions permeates all of the TRIZ Power Tools books, a stand-alone book was created to help people become familiar with the topic and to give exercises to grow the skill.

It is remarkable that a language for function exists. It was originally created by Lawrence Miles of general electric in the 1950. The story goes that Lawrence was trying to advance ways of creating and manufacturing products that would use less materials which had become scarce due to the massive construction projects of WWII. At the same time, Genrich Altshuller was developing TRIZ in the former Soviet Union. Ultimately, Altshuller would develop a similar approach to function modeling which is described as substance-field analysis. This was also useful for describing what objects performed in a system. Contemporary practitioners of TRIZ use both function analysis and substance-field analysis.

The language of functions describes what objects do. It is more than a description of interactions between objects. With regards to useful functions, it describes purposeful actions between objects. Useful functions modify or control some parameter of an object.

Measurement and detection functions take on the more general name of informing functions. Informing functions are a subclass of useful functions that require a slightly different treatment. These differences come out more in the TRIZ Power tool books on Useful and Informing functions. They are built in a different sequence because informing functions always operate on the measurement tool which is not the focus of the function. The item being measured is the focus of the function.

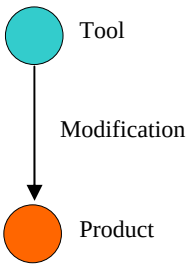
When we build a good machine, we also build a bad machine. The bad machine is working in the background, performing harm. We may not notice the output of the harmful machine until a lot of damage is done. Harmful functions are also included in functional modeling. Harmful functions are not purposeful in the same way that useful or informing functions are.

Productive functions are not yet covered in this material. Productive functions include joining, combining or disassociating objects. Such functions can be shown as useful functions on two objects at once. One object is shown behind or joined to the other. This is a clumsy approach, but a better approach is not known by the author.

Function Nomenclature

Functional Nomenclature

A system is not what it looks like. A system is what it does. Functional language is a convenient and compact way to describe what a system does.

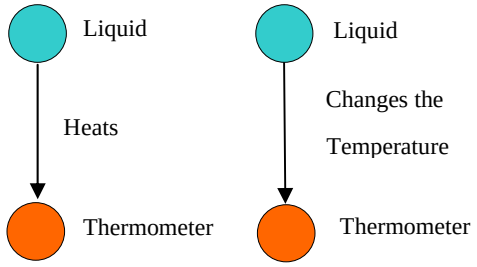


It is recognized that the proliferation of TRIZ terms is objectionable and makes it difficult for the new student to translate between different authors. Sometimes different terms are used to mean the same thing. In order for the reader to "translate" while reading this text, a consistent nomenclature 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."



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: "paint protects wood".

Systems of Functions

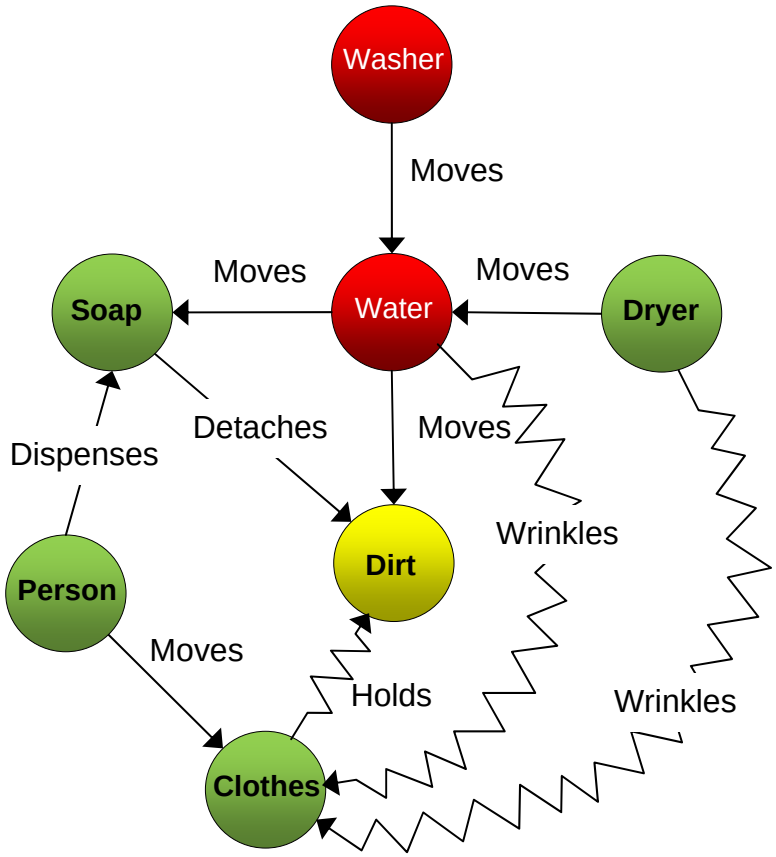
By linking together functions, we can create systems of functions that describe a situation. We might want to describe the super-system or job that our system is helping to do. We might want to describe the system of functions between subsystem elements. In any case, when we start linking together functions, we will refer to this as a "function diagram".

Let's first depict the super-system with a function diagram. The super-system is composed of the functions related to a job that someone is trying to do. It also contains a few elements usually found in the environment where the job takes place. Our system is usually one functional element of the super-system. A functional element performs a

discrete useful function in the function diagram. Because our system is part of the super-system it performs select functions within the job. In rare cases, it may perform all of the functions of the job. The part of the job that our system would perform was a historical decision.

A special element of the super-system is called the system product. Our system acts directly on this system product to modify it.

Below is a function diagram for the job of cleaning clothes. We are looking at this job from the perspective of the super-system. All of the elements shown are elements of the super-system. The system elements are shown in red. The rest of the elements are other super-system elements. The dirt is the system product which is another super-system element. We color it yellow to keep it as the focus of the system.



Let's pretend that we make clothes washers, but not dryers so our system is the washer. We have design authority over the washer and its parts. Because we control the water, and have full authority over it (we can even replace it if we would like) we also consider the water part of our system. While we can recommend the soap that is to be used, the amount and type that is used is not under our control so we consider this to be a super-system element. The dryer is also a super-system element that is not under our control. Notice that it's function is to move water which our system demands.

The system product is the stuff that needs to be removed from the clothes (stains, dirt, perspiration, etc which we will refer to as dirt for brevity). It may be a little confusing that our system is not actually designed to operate on clothes, but rather on the dirt. Again, think of the job as what we hire a clothes washer to do. We don't hire the washer to modify the clothes. Our washer should be called a "dirt mover" rather than a "clothes washer". The dirt is also a part of the super-system. We don't have control over it. While our job is to eliminate the dirt, we do not have authority over how much is present.

In addition to the useful function of moving dirt, the water of our system also wrinkles the clothing which is showed as a harmful function. In addition to the useful function of moving water, the dryer also wrinkles the clothes, which is a harmful function. The person who is involved in washing the clothes is involved in moving them and dispensing the soap.

Even though we call our system a clothes washer, the clothes are not the system product. The clothes have a harmful function of holding or supporting the dirt. If the clothes were doing their job properly, they would not hold

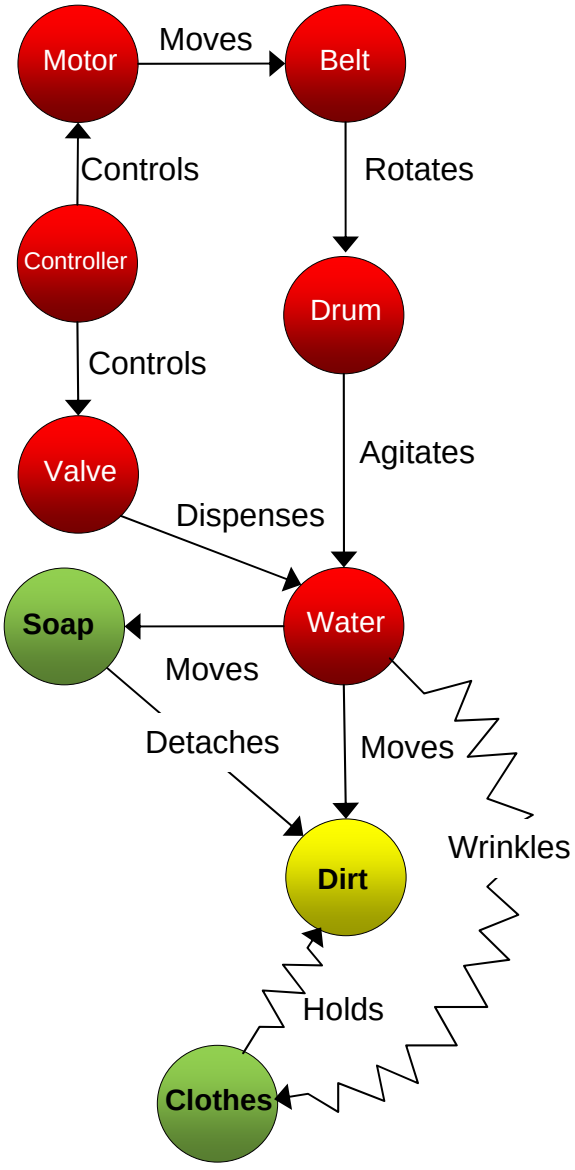
the dirt! Because we have no control over the clothes, and they are not directly part of the washer, they are an element in the super-system.

The process of creating this diagram teaches us a lot about the job of cleaning clothes. Each element in the system carries it's burdens. For instance, the clothes have the burden of holding the dirt. The water and dryer wrinkle the clothes. The person has the job of moving clothing and detergent about. So much could be done to simplify this system from the viewpoint of the person who needs to take care of the clothes. Unfortunately, this is covered in another book, "TRIZ Power Tools—Job #5 Simplifying.

Each of the above super-system elements can be broken down further into sub-system components. Our system, the clothes washer, is also composed of sub-system elements. Some, but not all, of these components operate on the system product. Let's break down our system into functional sub-system components.

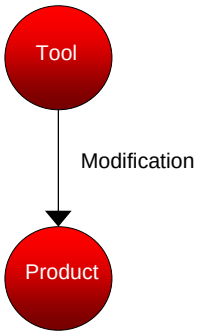
We will continue to show the system product "dirt" but will not show all of the super-system elements for brevity.

Each of the sub-system elements is shown in red. The elements of the washer are common components of washers. Each of them can be broken down yet further. Which brings us to a point. All systems are elements of higher super-systems. All elements can be broken down into sub-systems to the point of sub-atomic particles. The modifications, themselves, are actually shorthand for processes that occur in time. Each modification verb can be broken down into process steps. What is important is that we are able to understand the system at the level that gives us sufficient insight into what we are considering. In this case, we are talking about solving problems, so certain functional elements will be more important than others. This takes experience to know how far to break the system down.



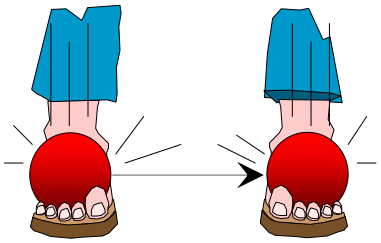
Tests for Correctly Written Functions

This test can be used when you are beginning to write functions. Knowing how to correctly write a function will help the problem solver at later stages when the function is being "fixed" or idealized. It is difficult to idealize or fix a function if it is not stated correctly.



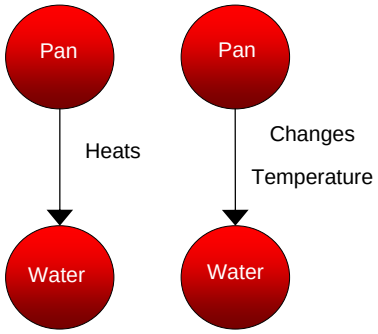
Test 1: Are all of the Parts Present? One quality of a correctly stated function is that the tool, modification and product are all clearly shown. The product is the object being modified. The modification can be stated in long or short hand. The tool is the object that will modify the tool. The direction of modification or the causality should be correctly stated.

Test 2: Are the tool and product something you could drop on your foot? The tool and product are always physical objects when it comes to physical phenomena. However, when software and business problems are worked, there may be the need to consider virtual objects such as used in object oriented software.

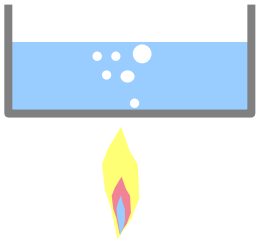


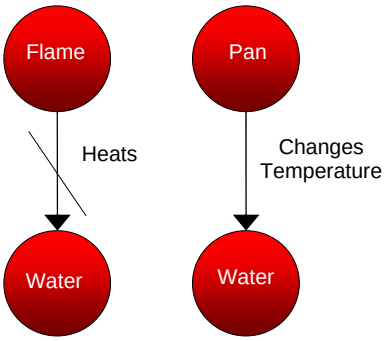
Test 3: Does the modification describe a physical change or control of the product? If necessary, use the longhand form of the modification (Changes Or Controls) to avoid confusion. In this example, we have replaced the word "heats" with the words" changes temperature". We are signifying that the temperature of the water is changing over time because functions denote what happens over time.

If the system were being used to correct the temperature of the water over the course of time, we would have chosen the word "controls" instead of "changes".

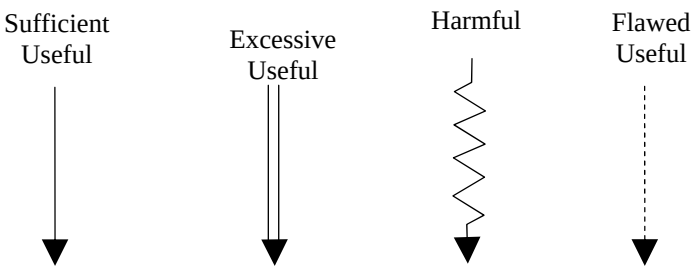


Test 4: Does the tool directly modify the product? This is not a hard and fast rule because sometimes brevity is required. However, it is important to understand the chain of physics that is involved, and if you do choose to be brief, it should be understood that this is a simplification and not a description of the actual physics. In this case, the pan is an intermediary for the heat to warm up the water. The flame does not directly affect the heating of the water.

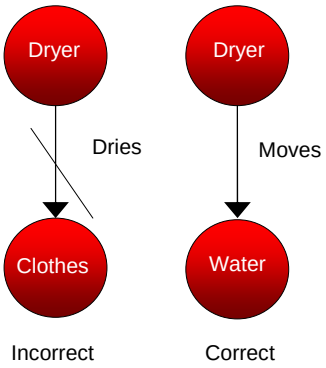




Test5: Is the correct function symbol used? It is possible to use other symbols or colors to denote the type of function, as long as you are consistent. Using such notation makes it easier to locate problem areas when a function diagram is built. A function can be useful, harmful, useful but insufficient or excessive. Useful functions can be distinguished by a solid line between the tool and the product. Harmful functions use a wavy line. Insufficient functions use a dashed line and excessive functions use two lines.



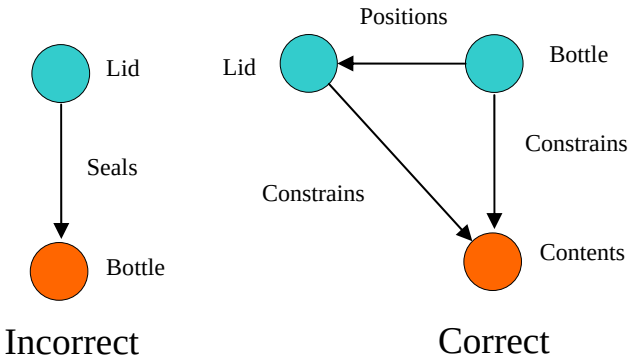
Test 6: Does it describe what is really happening? Be Careful with Confusing Functions. Look at what you are trying to describe and think in terms of the actual physics rather than describing what is happening in sentences. In the case of a clothes dryer, the function of the clothes dryer is not to act on the clothes, but rather the moisture that is in the clothes. Hangers and irons operate on clothing. Dryers operate on moisture.



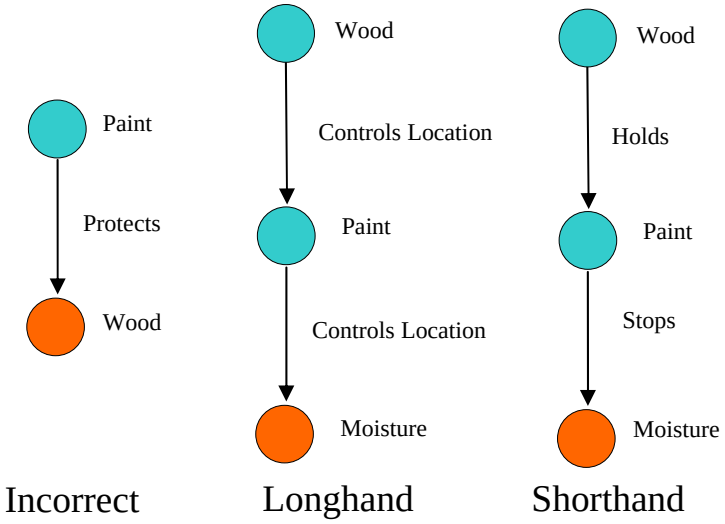
Confusing Functions

As a matter of practicality, it is important that the modification be properly described to ensure clear thinking. The modification must directly change some attribute of the product. For instance, the modification could be the density, position, color or smell of the product. In the shorthand form, the modification is a verb. This cannot be just any verb, but only verbs that describe a change or control of the product.

The selection of the verb can often be confusing. This is particularly true when it comes to creating modifications from common English descriptions of functions. For instance, we may say that "a bottle lid seals the bottle". This is an example of a confusing function. We might be tempted to think that the lid is actually doing something to the bottle. If we are applying the above tests, we see that test #3 is failed. The verb "seals" does not actually modify or change the bottle whatsoever. If we write out all of the elements which are involved, we notice that we have a bottle, a lid and the contents. If we ask how each modifies the other we get a better picture of what is happening. What is really happening has more to do with keeping the contents of the bottle inside or what is outside from coming into the bottle. We could state this in English is a less confusing fashion. "The lid constrains the content of the bottle" and/or "the lid constrains the outside gases". Less related is the function that the bottle performs on the lid by positioning it.



If there is confusion, one should consider using the longhand form of the modification. This starts with the words "Change" "Control" or "Create", thus making it clear that some physical parameter of the product must be physically influenced. We may say that paint protects the wood. 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.



Note that in both cases, the English phrase would tempt us to form a function with only two objects. In reality, more objects were required to describe what was really going on.

Function Diagrams

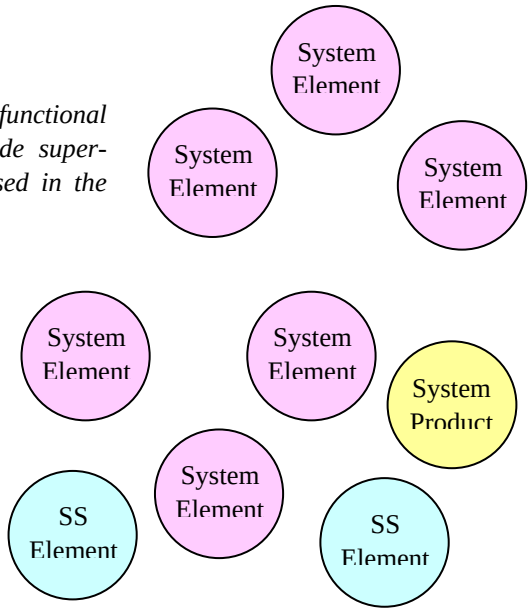
Following is a description of the method for describing a problem using functional language. Several examples are given. Following that are exercises to strengthen the skill of writing functions when the situation is confusing. Answers are given following the exercises. Please note that your answers may be correct and still not match the answers given due to the fact that the functional elements can be broken down into sub-systems and displayed differently, similar to what was shown in the clothes washer explanation above.

By the end of the exercises for confusing functions, it is hoped that the reader will have a new appreciation for how much the perception and understanding of the problem solver can be changed by simply forming a function diagram.

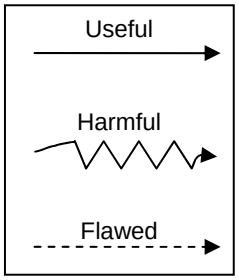
L2-Method

Step 1: Break the system down into functional elements. At this point, do not include super-system elements. (This will be discussed in the next step).

Step 2: Add Super-System elements and identify the system product. The system product is the element that the system modifies. Super-system elements are a part of the job and reside in the environment. The system product is a special type of super-system element that the system serves. The system modifies the system product.



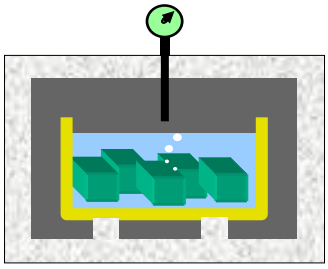
Step 3: Introduce Modification Links including useful, flawed and harmful links. Verify that all rules for forming functions have been followed (look in the appendix for this). It is possible to discover system problems during this process because we consider the possibility of interactions between every element. Harmful and useful but flawed modification links should be included.



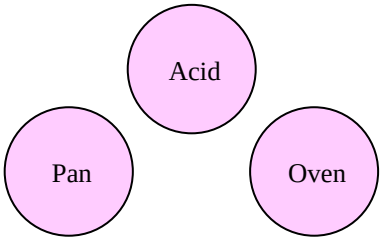
Step 4: Identify the primary useful function and the auxiliary elements in the system and then target auxiliary elements which are involved in the problem for elimination.

Example—Acid Container

Metallic Test cubes are immersed in hot acid for long periods of time to test the corrosive resistance of the metals. The cubes are placed in a corrosion resistant container which is then placed in an oven. The action of the acid is sufficient to corrode the cubes, but there is a problem. The container that contains the cubes and acid is eventually corroded and has to be replaced. Replacing the container is very expensive since it is made from a very expensive material.

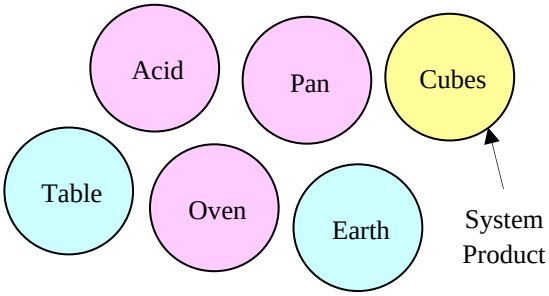


Step 1: Break the system down into functional elements. At this point, do not include super-system elements. The functional elements of the cube corrosion system include the acid, oven and pan.



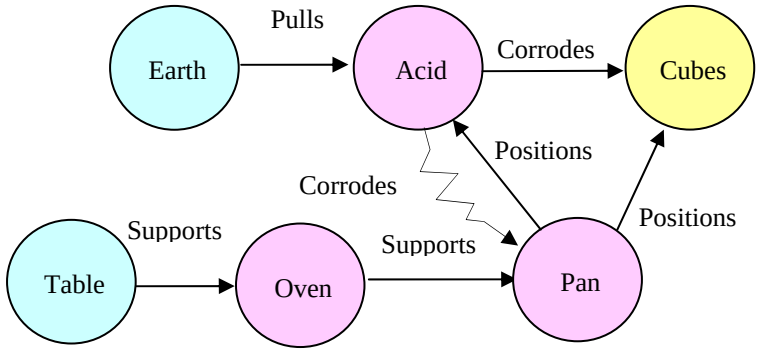
Step 2: Add Super-System elements and identify the system product.

The Super-System elements in this case are the table, earth and cubes. The cube is the system product. The cubes are what the system modifies by corroding them.



Step 3: Introduce Modification Links including useful, flawed and harmful links.

Note that this time we have included the harmful function of pan corrosion.

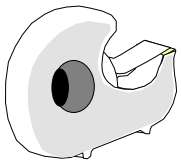


Step 4: Identify the primary useful function and the auxiliary elements in the system and then target auxiliary elements which are involved in the problem for elimination.

The primary useful function is to corrode the cubes. The acid is directly involved. All other elements are auxiliary objects which support this function and can therefore be eliminated. In particular, the pan should be targeted for elimination since it is involved in the problem at hand.

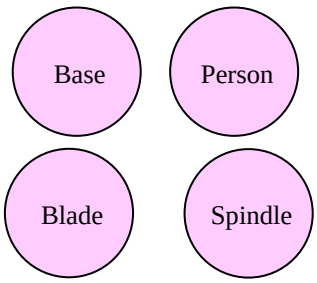
Example – Dispensing Tape

The cost to manufacture a common tape dispenser is too high to be competitive. What can be done to reduce the cost of manufacture?



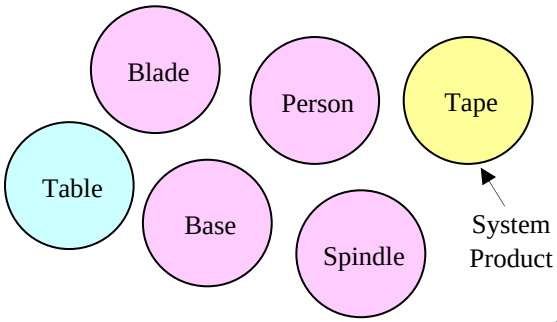
Step 1: Break the system into functional elements.

The functional elements of "tape dispensing" include the spindle, base, blade and person.



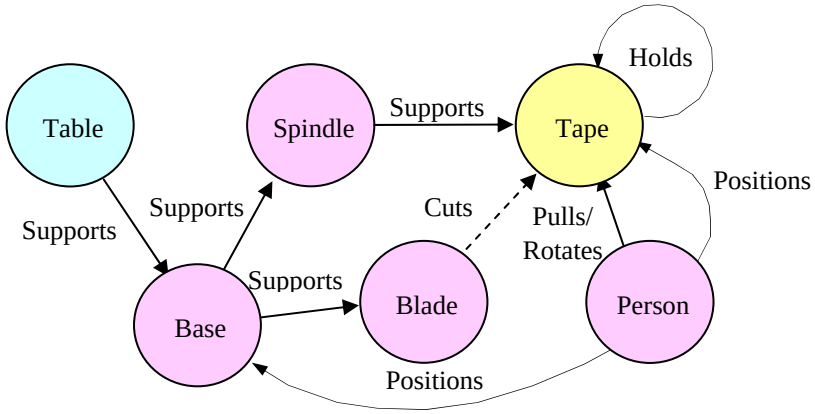
Step 2: Add Super-System elements and identify the system product.

The tape is the system "product", which is a type of super-system element.



Step 3: Introduce Modification Links. Include useful, flawed and harmful links.

You can see the modification links in the figure below, e.g. the table supports the base, the spindle supports the tape and the person cuts the tape, though inconsistently.



One curious function is that the tape holds itself. Recall that the tape adheres to itself as it comes off of the roll. While this might not seem clever, actually, it may have resolved a very difficult conflict at one time. Consider that an adhesive is fixed to one side of the tape. How do we move the tape about without it becoming stuck to everything in sight? How do we keep it from becoming contaminated with dust and dirt? A mediator is required to keep the tape safe. This mediator could have been supplied by some "foreign" material, but the idea of allowing the tape to protect itself satisfied the requirements, so long as the adhesive did not stick well to the opposite side of the tape. Additionally, this provides a convenient means of positioning the tape for the purpose of tearing.

Step 4: Identify the primary useful function and the auxiliary elements in the system and then target auxiliary elements which are involved in the problem for elimination.

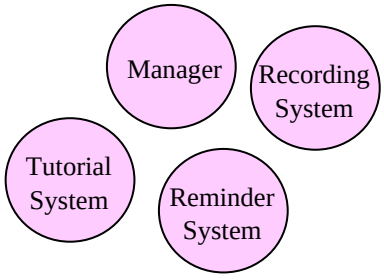
The primary useful functions are the supporting, positioning and cutting of the tape. The only element not directly involved in this is the base. Since the reduction of cost is the main purpose of this problem solving activity, the base is targeted for elimination.

Business Example—Year End Review

The yearly performance review process is very time-consuming, especially when you have a large number of direct reports. How can the time be reduced?

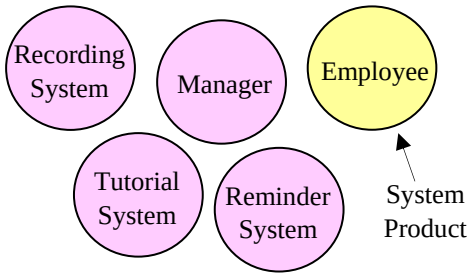
Step 1: Break the system down into functional elements.

The functional elements of the year-end review system include the manager, approval system reminder system and recording system.



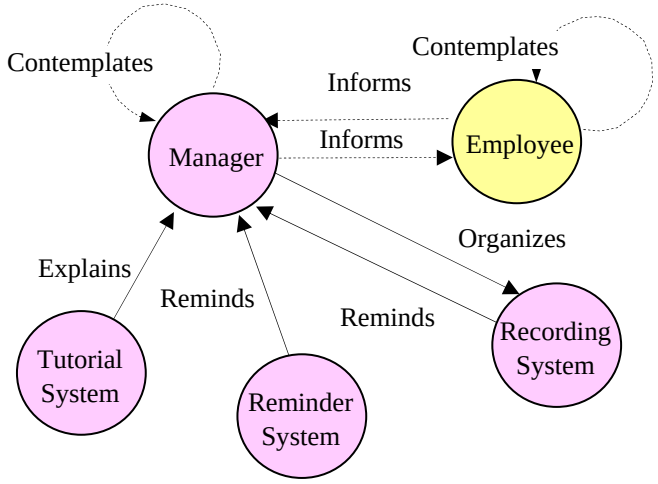
Step 2: Add super-system elements and identify the system product.

No super-system elements will be mentioned. The system product is the employee.



Step 3: Introduce Modification Links. Include useful, flawed and harmful links.

The modification links are shown below.



Note that the employee and manager perform functions on themselves. Human systems often have a number of interesting and surprising functions. Transaction systems, such as a checkout at a grocery store, are particularly interesting because they involve functions that we take for granted. When we ask what gets modified, it is often related to changed concepts in the mind such as who owns what. At a checkout line, for instance, the question of who owns the item changes from the store owning the item to the buyer owning the item. We say that we bought the item, but in reality the item never changes; only our concept of who owns it changes, both in the mind of the buyer and seller. In the case of the year end review, information is exchanged between the manager and the employee. We say that they inform each other. Both must contemplate, both before and after the review. This contemplation changes their perception of what has happened during the year and what is expected to happen the next year. In effect, both the manager and the employee change themselves. We could say that the manager motivates or de motivates the employee, but this would be misleading. The manager does not have direct power to do this. Information flows, and the employee then changes the "motivated" or "de-motivated" register in his or her mind. Creating this diagram reminds us that motivating the employee is the primary function of the system. We show these functions as flawed, harmful, useful or excessive depending on the specific situation at hand. In this case, we are showing an interview where the employee is poorly motivated. This could have been shown as a harmful or flawed function. Here it is shown as a flawed "contemplation" function. Following is the system function diagram.

Step 4: Identify the primary useful function and the auxiliary elements in the system and then target auxiliary elements which are involved in the problem for elimination.

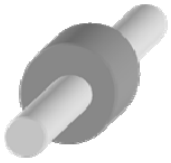
The primary useful functions of the system are the functions of the employee and manager informing each other. The tutorial, reminder and recording system are all auxiliary systems and can be targeted for elimination.

Exercises

Exercise—"The Ball Breaks the Glass"

To the right is shown a window being broken with a baseball. This is not generally a good situation so we will consider this harmful in our case. Create a functional description of the English phrase. There are several ways to describe the modification. Hint: First draw all of the substance elements (that you could drop on your foot) and then make the functional links. The answer is given further on.

Exercise—"The Bearing Holds the Rod"



To the right is a picture of a bearing and a rod. The bearing positions the rod so that it can freely rotate. The positioning is vertical and horizontal, yet it allows free rotation. Create a functional description of the English phrase. There are several ways to describe the modification. Hint: First draw all of the substance elements (that you could drop on your foot) and then make the functional links. The answer is given further on.

Exercise—"The Pipe Conducts the Liquid"

To the right is a picture of a cut-away of a pipe with a liquid flowing inside. Create a functional description of the English phrase. We are progressing to functions that may be more difficult. Hint: In this case, the English phrase is not too bad. Try writing out the long-hand form if you are not sure what to write. The answer is given further on.

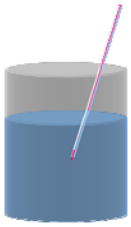
Exercise—"The Wire Conducts Electricity"

To the right is shown a copper electrical wire with insulation. This wire conducts electricity. Create a functional description of the English phrase. Hint: This is very similar to the problem of conducting liquids in a pipe. The thing that may make this more fuzzy has to do with the term electricity. Try and convert this to an object that you could drop on your foot, even if it is very tiny.

Exercise—"The Lightning Rod Protects the House"

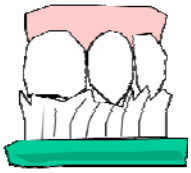
In the picture to the right, a lightning rod is used to keep lightning from directly striking a house. The rod is usually higher than the house and has a sharp point. The sharp point creates a high field gradient at the tip which ionizes the air and makes a great attractor for lightning. Create a functional description of the English phrase. Hint: This is a confusing function because the English phrase does not properly describe what is going on.

Exercise—"The Thermometer Measures the Temperature"



The picture to the right, shows a cylinder filled with liquid. A mercury thermometer is used to measure the temperature of the liquid. Create a functional description of the English phrase. Hint: This is a confusing function because the English phrase does not properly describe what is going on.

Exercise—"The Toothbrush Brushes the Teeth"



In the picture to the right, is a toothbrush in the act of brushing teeth. Create a functional description of the English phrase. Hint: This is a confusing function because the English phrase does not properly describe what is going on.

Exercise—"The Oil Lubricates the System"

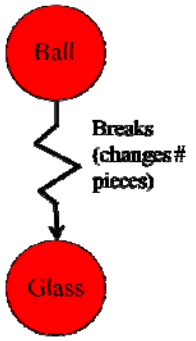
Shown to the right is a piston for an internal combustion engine or a compressor. The piston moves up and down in the bore. Oil is used to lubricate the piston and keep the bore and piston from wearing. Create a functional description of the English phrase. Hint: This is a confusing function because the English phrase does not properly describe what is going on.

Exercise—"The Gold Improves the Reliability"

Shown to the left is an electrical pin connector. The connector is the combination of a male pin that slips into a female "socket" and makes electrical contact. There is usually some mechanism to cause a load between the surfaces. Putting gold on the surface keeps the pin from corroding and thus makes it more reliable. Create a functional description of the English phrase. Hint: This is a confusing function because the English phrase does not properly describe what is going on.

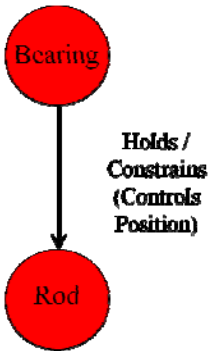
Exercise Answers

The exercise answers are not meant to be all inclusive as there are several ways that any given function might be described.



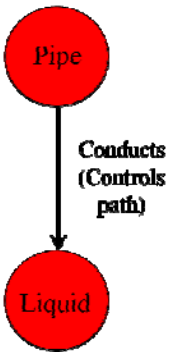
Answer—"The Ball Breaks the Glass"

In this case, the English phrase correctly describes the function. Notice that both the shorthand (break) and longhand (changes # pieces) is used. This could have been described several ways.



Answer—"The Bearing Holds the Rod"

In this case, the English phrase correctly describes the function. Notice that both the shorthand (holds) and longhand (controls position) is used. This could have been described several ways.

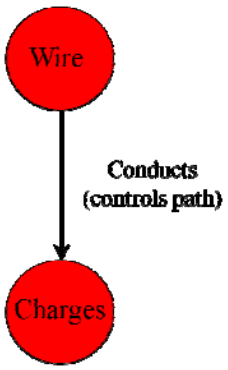


Answer—"The Pipe Conducts the Liquid"

Once again, the English phrase correctly describes the function. Notice that both the shorthand (conducts) and longhand (controls path) is used. This could have been described several ways.

Answer—"The Wire Conducts Electricity"

Once again, the English phrase correctly describes the function. However, we needed to change the term "electricity" to charges or electrons.

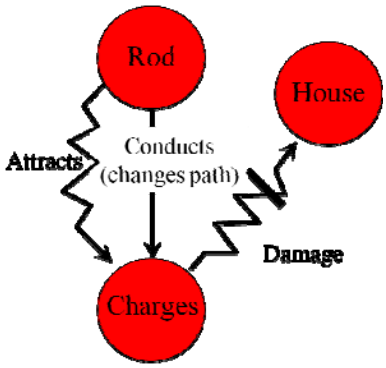


Answer—"The Lightning Rod Protects the House"

The temptation is to write

Lightning Rod→Protects→House

But notice that the verb "protect" does not modify anything having to do with the house. Once again, the lightning rod directly affects the charges or electrons. Without the rod, the electrons would more easily damage the house. With the rod, the damage from the electrons to the house is minimized. This is shown by a line through the harmful function of "Damage". Notice also that there is a harmful function that the rod may attract the charges. Setting up lightning rods is tricky business. A more effective approach is to repel the charges.

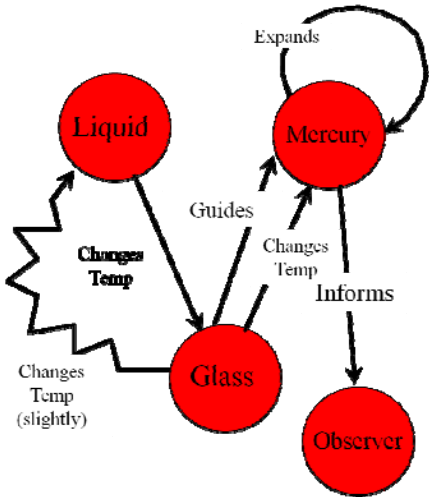


Answer—"The Thermometer Measures the Temperature"

The temptation is to write

Thermometer→Measures→Temperature

This is a very confusing function. The thermometer is truly involved in the system, but notice that the thermometer does not change the liquid. The liquid changes the thermometer. This is true in all measurement (informing) functions. The thing that is being observed (subject) always changes the thing that needs to measure it (observer). Also notice that "measures" does not change anything and "temperature" is not something that can be dropped on your foot. A lot of rules were violated. The safe way to write any



function is to first identify the material objects in the system. Notice that the liquid, glass, mercury and observer are all material objects. Then we determine the functional links between each, making sure that the direction of the arrows is correct.

An alternate system would be for the liquid to change the temperature of a whole thermometer which would then inform the observer. In this case, the thermometer was broken down to two sub-systems, the glass and the mercury.

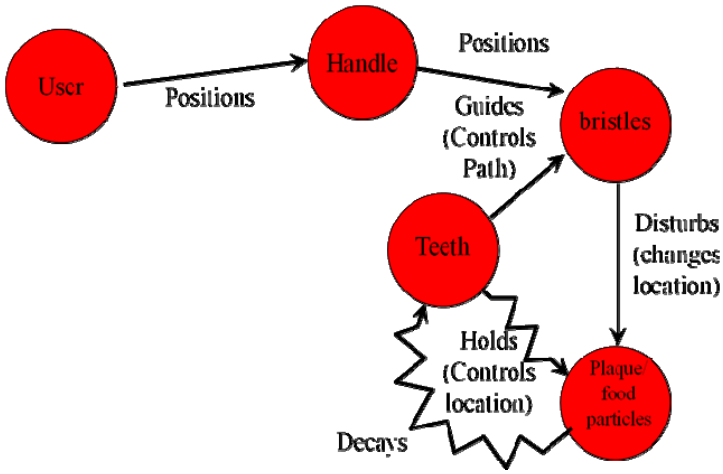
One other thing to notice is that most measurement systems disturb what they are trying to measure. The act of putting the thermometer into the liquid changes the temperature of the liquid. This is shown as a harmful function. The glass changes the temperature of the liquid.

Answer—"The Toothbrush Brushes the Teeth"

The temptation is to write

Brush→Brushes→Teeth

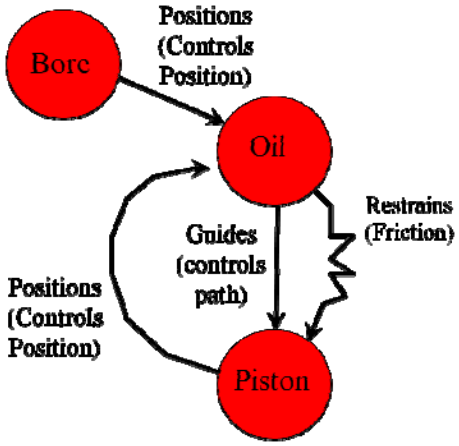
This would violate a couple of rules. First, the verb "brushes" does not describe a modification to anything. Secondly, it is not the teeth that need to be modified, but rather the plaque and the food particles. Creating such a functional diagram is actually very illuminating. Notice that the only useful function that the teeth perform is to guide the brush. Other than that, it has a harmful function of controlling the position of the plaque and food particles. Once again. The best approach is to write down all of the substance objects involved and then determine the functional links between each of them.



Answer—"The Oil Lubricates the System"

The temptation is to write

Oil→Lubricates→Piston



But notice that the verb "lubricates" does not actually indicate a change to the piston. Another temptation is to believe that the piston is guided by the wall and the oil reduces the wear. If the piston was actually touching the wall very much, the life would be quite short. In reality, the contact between the piston and the cylinder is quite rare and usually happens when the engine starts. Another way to say this is if the oil is doing its job, the piston and cylinder never touch. If this is the case, then the oil is the only thing left to guide the piston. The oil does create some drag on the piston which is shown as a harmful function. Also, notice that the piston smears the oil around and thus controls its position. One could also argue that the bore is involved in positioning the oil. This is not shown on the diagram.

Answer—"The Gold Improves the Reliability"

The temptation is to write

Oil→Improves→Reliability

"Improves" describes a modification, but it is a very imprecise description. Worse, "reliability" is not something that you can drop on your feet. It was given that the reason the reliability improved was because the corrosive effects of things coming from the atmosphere are reduced. The diagram indicated two substances: water and oxygen. That is the function of the gold, to deflect damaging objects in the atmosphere.