Succeed in University

by Jim Davis

Introduction to the Theory of Constraints

Theory of Constraints, TOC for short, is a body of work by Eliyahu Goldratt and others. Goldratt was a Israeli phycisist who noticed that his graduate students would often come and ask him to review their calculations. For a short time he did this, but discovered that usually the calculations were just fine. The problem was the assumption(s) students made in deciding which calculations to perform. After checking around he discovered the problem of erroneous assumptions was very common, not just with students, and not just in physics.

In particular he noticed that there was little help for people who had to deal with complex problems. A complex problem is one which is characterized by a network of interacting causes and effects such that **it is difficult to determine the core problem**. As a result of this, people often attempted to solve their problems without first determining what the core problem is. Naturally these efforts almost always fail. This is the kind of problem commonly encountered by academics when they try to understand complex systems in their field.

Note: While I am referring to the exact sciences these skills also work when used in the social sciences and business too.

Goldratt developed a set of thinking skills which can be employed to deal with complex problems. He drew on his understanding of how the exact sciences work to understand complexity in nature. A brief summary of the process is:

First: understand complex situations by constructing a diagram called a Current Reality Tree (CRT) which shows all relevant interacting causes and effects of the situation.

Second: identify the core problem from the Current Reality Tree. There is usually only one core problem, sometimes there are two, but never more in any given system, because if there were more, the system itself would fall apart!

Third: define the problem clearly as a choice between two necessary but mutually exclusive alternatives.

Fourth: understand how to determine exactly which of the two apparent necessary conditions is actually necessary by examining the assumptions underlying each linkage.

Fifth: how to change the Current Reality Tree to solve the problem without causing new undesireable or unanticipated effects. To do this you employ the Future Reality Tree, the Negative Branch Reservations, the Prerequisites Tree and the Transition Tree.

If you are interested in the original literature on the subject here is a list some of the main books written by Goldratt.

The Goal 1986

A business novel describing the process of applying the results of the Thinking Skills in a manufacturing plant.

It's Not Luck 1996

A business novel which illustrates the Thinking Skills and how to use them.

Critical Chain 1997

An novel set in a university which illustrates the issues of project management and how TOC methods can help resolve those problems.

Necessary but not Sufficient 2000

A novel set in the Information industry. It demonstrates that while IT is necessary in business, it is not all by itself sufficient. The authors go on to show that by using TOC in conjuction with IT, the company can grow its sales to unprecendented levels.

Isn't it Obvious 2009

A novel set in a retail chain which demonstrates how through controlling inventory, a manager can increase both revenue and profits of the chain.

Understanding Theory of Constraints Tools

Theory of constraints is a set of tools created to conceptualize the thinking skills from the Accurate Sciences. (e.g. Physics, Chemistry and Biology) It is available to anyone who seeks to understand or communicate complex problems. So what is the process?

Problem solving consists of the following steps:

1. **Identify the problem** - determine what the problem is.

2. **Understand the problem** - at this point we need to determine whether the problem is a simple problem or a complex problem. If it is a simple problem anyone with the requisite knowledge and or background can solve it. If it is a complex problem then we need to create a Current Reality Tree in order to identify the core cause of the problem.

3. **Solve the problem** - for complex problems we use the core problem to frame the problem as a conflict between two necessary but conflicting issues. We then examine the unstated assumption(s) under each connection in the cloud to determine which one is not correct. This allows us to more clearly understand a complex problem, and why it was so difficult in the first place. Then we can devise a solution.

4. **Implement the Solution** - for problems which involve many people we need to secure their agreement. We use the Current Reality Tree to show the core cause of the problem, then use the Evaporating Cloud to communicate the problem, and the assumption(s) which has prevented us from understanding and finally solving the problem.

Consider for a moment, there are some problems in the world which can be understood by almost anybody, but there are other problems which nobody seems to be able to understand. What is different about these two types of problems? Why can almost anybody understand some problems, but almost no one can understand other problems. I suggest that the difference is their complexity. If a problem is not complex, then almost anyone can understand it and then proceed to solve it. However, if it is complex almost no one can solve it because they do not understand the problem. If they do not understand it, they also cannot communicate it to others. So I am going to label those problems which seem to be understandable by anyone **Simple Problems**, and those problems which nobody seems to understand as **Complex Problems**. So what makes a problem simple or complex?

Before anyone can solve any problem we must know its core cause. Without knowledge of the core cause we are acting blindly, finding its solution becomes either a matter of inspiration or pure luck. However, once we know the core cause of a problem, then we can begin to construct a solution that will work no matter how complex the problem is.

So the first step in solving a problem, as stated above, is to frame or identify what we believe the problem to be. Then we determine if the problem is simple or complex. If it is simple anyone with the requisite background can solve it. If it is complex then we need to employ the Theory of Constraints thinking tool called a Current Reality Tree. A problem is seen to be complex because its web of interacting causes and effects **obscures the core cause**. A Current Reality Tree maps out all the of causes and effects so that the core cause can be identified.

Once this is done, then the core cause is expressed using the Evaporating Cloud. An evaporating cloud frames the problem as a conflict between two necessary but conflicting prerequisites. In the accurate sciences, it is believed that until you can express a problem as a conflict between two necessary but conflicting requirements, you do not sufficiently understand the problem!

The second part of the evaporating cloud is to surface the assumptions beneath each arrow (why they are necessary) and to examine them in order to evaluate their accuracy. Usually one of the assumptions will be found to be false. At that point, we know which of the two apparently necessary conditions is actually necessary. Then we can proceed to solve the problem. The most powerful solutions to problems tend to be found when the assumption under the conflict arrow is invalidated, but the assumption under any arrow can be flawed.

Reading Current Reality Trees

This diagram is an attempt to map out the main causes and effects that make this a Complex problem. The rectangular boxes represent causes and effects. Boxes with arrows going out the top are causes. Boxes with arrows coming in the bottom are effects. Boxes with arrow entering from both top and bottom are both causes and effects. Trees are read from the bottom progressing upward. They should be read as follows.

One Connector

If there is only one connector then the box below causes the box above. It is read:

If (read contents of box below) then (read contents of box above).

Two (or more) Connectors with Oval Below

If there are two or more connections from below look for an oval just below the box. If present, it means that both causes must be present for the effect above to occur. So it is read:

If (read contents of first box below) **and** (read contents of second box below) then (read contents of box above).

If there are more than two connectors put an **and** between each box.

Two (or more) Connectors with No Oval Below

If there are two or more connections from below and no oval then the conjuction is OR. Either cause by itself can produce the effect. It would be read:

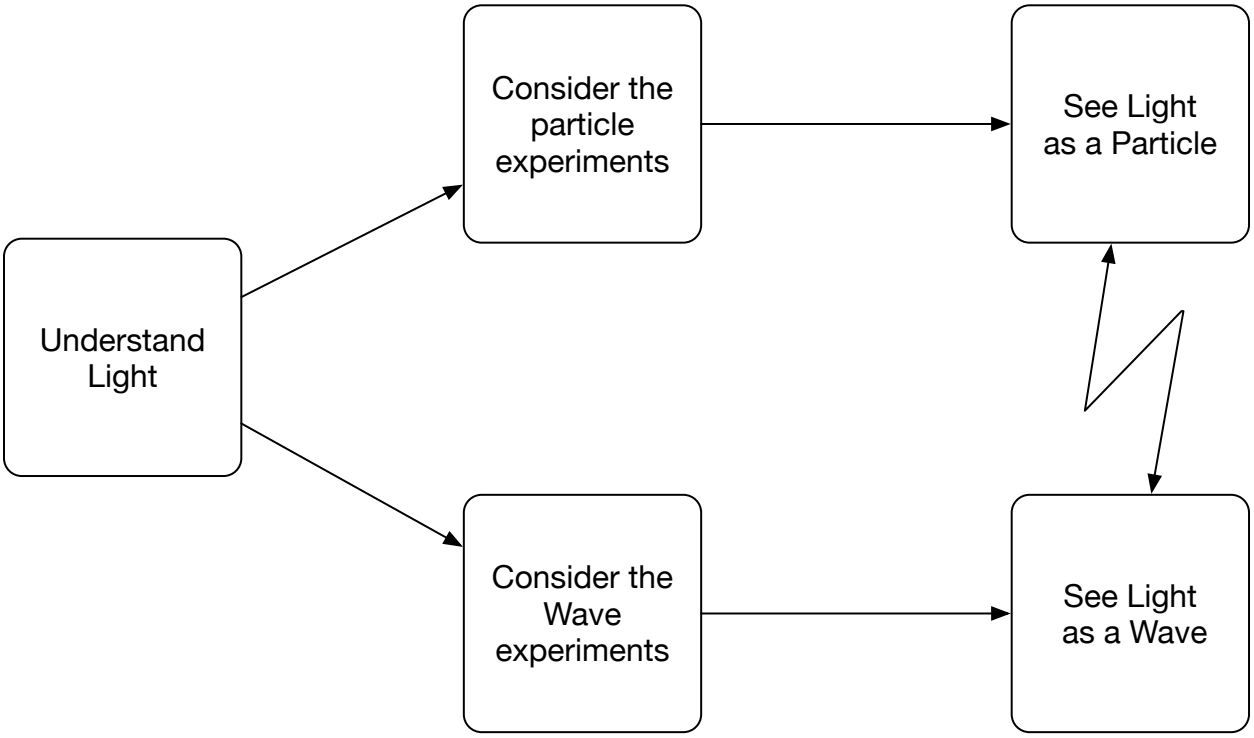
If (read contents of box below) or (read contents of other box below) then (read contents of box above).

If there are more than two connectors put an **or** between each box.

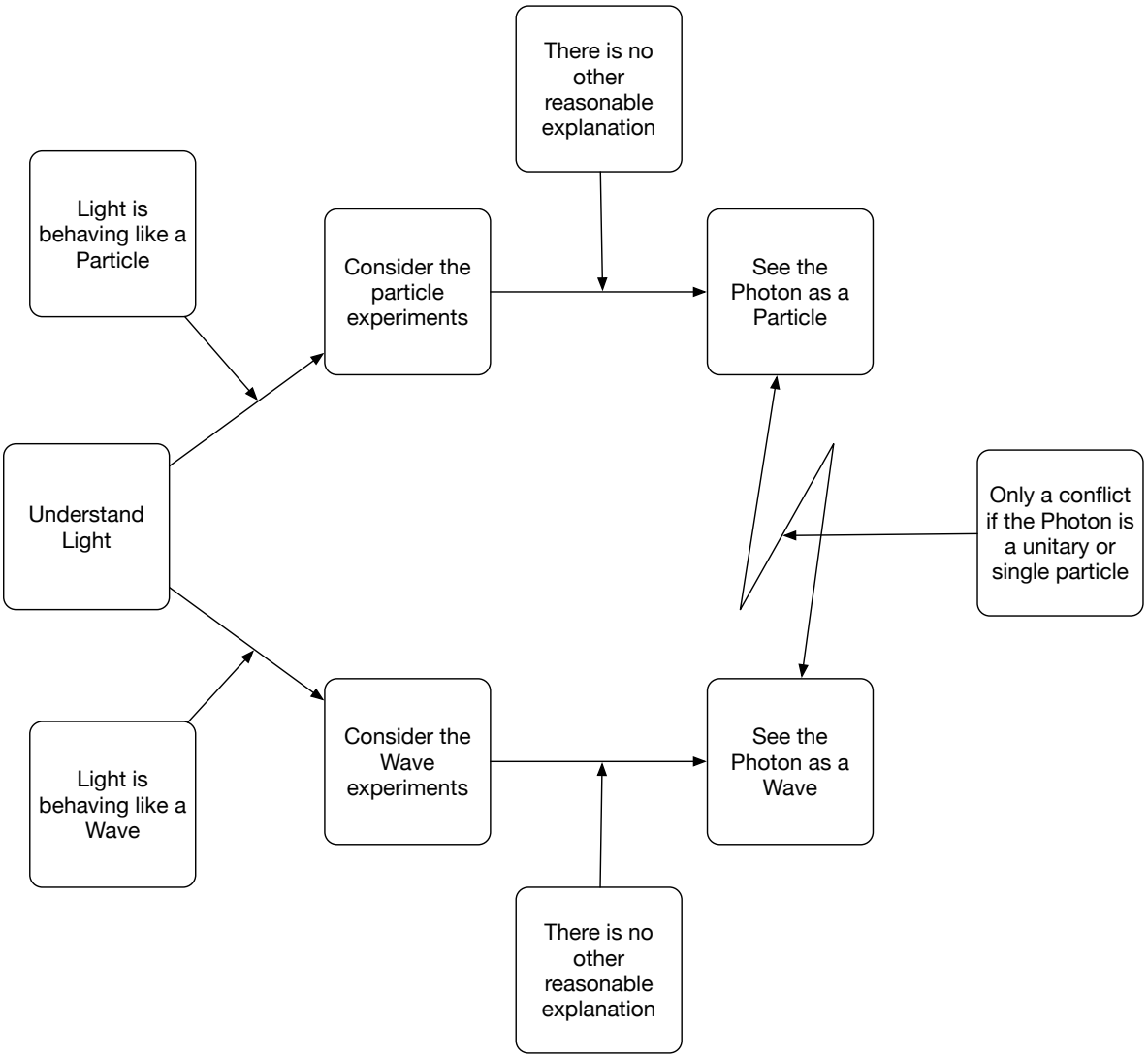
Reading Evaporating Clouds

The box on the left is the Unifying objective. Each arm is one of the necessary conditions. It is conceivable that there may be more than two but it is not common so we will confine ourselves to considering only two conditions. On the right we draw boxes to represent each of the two causes which appear to be in conflict. Between the conflicting cause, and the unifying objective we diagram the intermediate condition. For example, if we apply this to understanding the nature of Light, the evaporating cloud would appear as follows.

The unifying objective is to Understand Light. In the late 1800s many experiments were conducted by physicists trying to understand light. The experiments fell into two camps, they asserted either that light is a wave, or that light is a particle. This then, is the definitive statement of the problem. The diagram is read from left to right. Each pair of boxes would be expressed as follows: “In order to” (read contents of box to the left) “we must” (read contents of box to the right).



So which is it? To answer this we must look at the assumptions underlying the arrows. To the above reading we add another phrase as follows: “In order to” (read contents of box to the left) “we must” (read contents of box to the right) “**because**” (put the reason into the box perpendicular to the connector). This yields the diagram shown below.



Now we consider each of the assumptions to see if they are valid. In this case both assumptions for the Particle path and both assumptions for the Wave path appear to be valid. This is why today if you ask a physicist which one it is, they will answer: both! However, they have failed to resolve the problem mostly because they have neglected the conflict arrow. While they accept the experimental results, nobody understands how light can be both a wave and a particle at the same time.

However let us consider the conflict assumption: The Photon is assumed to be a unitary particle. What if it is actually a composite particle? One aspect of the Photon manifests as a Particle, and the other aspect manifests as a Wave. Interestingly, no physicist I am aware of has considered this, but it is the only way to break the cloud. Breaking the conflict assumption is also the most powerful way to break an evaporating cloud.

Applying the Ideas to University Education

Now take a look at the diagrams provided in the folder. Read the current reality tree. Does it capture the esssence of the environment which students face when attending university. Note, it is not exhastive, for example it does not consider the matter of affording a university education. This tree focuses only on the problems which can create trouble for students.

Now look at each of the clouds. Examine the competing arms. Do you agree with the assumptions identified as being faulty? What does this imply for how you can survive and prosper in university?

You may think this doesn't apply to you but it does—it applies to everyone on the planet regardless of age—in spades. Don't take my word for it. Check it out for yourself. A student does not have all these problems at the same time. Usually they occur one at a time, but if you look carefully you will find all five problems present in university life. You should also be able to discern how to solve each of them once the faulty assumption is exposed.