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**GOLDRATT'S THINKING PROCESS: IS THERE A PLACE FOR IT IN THE  
TOTAL ENTERPRISE SIMULATION**

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### **ABSTRACT**

*Designers of business simulations attempt to achieve representational validity through the use of algorithms that mimic the business world (Feinstein & Cannon, 2002). This paper introduces the Eliyahu Goldratt's Theory of Constraint and Thinking Process as a means of modeling the decision making process. Both the Theory of Constraints and the Thinking Process are described and explained through the application of a simulated small business start up. Possible application of this theory to the business simulation is explored.*

### **INTRODUCTION**

Business simulations have been in use in university classes in the United States for over 50 years (Watson, 1981). More than 200 business games are in use at more than 1700 universities and community colleges (Faria, 1998) and Faria and Wellington (2004) report that 47.7% of the respondents of a 14,497 subject survey currently or have used a business simulation game.

Designers of business simulations must translate concepts into student decisions, which are then tested in a simulated marketplace (Cannon & Schwaiger, 2005). This marketplace is simulated with actual algorithms that link decisions with outcomes mimicking those in the business world. It is in this formulation that representational validity should be achieved (Feinstein and Cannon, 2002). To accomplish this, the simulation structure and logic should

represent actual business phenomena. One of the challenges has been to replicate decision making with multiple options and influences.

### **GOLDRATT'S THINKING PROCESS**

Eliyahu M. Goldratt introduced "The Goal," to readers in 1984 bringing to life the thought processes involved in solving a problem with win-win solutions. In the book, a plant manager, Alex Rogo, is faced with the pending closure of his plant. His personal life is in chaos as well as his security in knowing that his job might not be there unless he can devise a solution save it. A chance encounter reunites him with an old professor who guides him to the Theory of Constraints and a Thinking Process. With the use of the Theory of Constraints, Alex is able to focus on improving the correct performance measures in the plant with methods that **had** never been seen in his industry. "It's Not Luck," was later written by Goldratt [1994] as a step by step instruction manual giving a more clear understanding of how to go through the necessary steps and devise a solution which creates a win-win situation for all involved.

The principles of the Theory of Constraints and the Thinking Process are not new and have been used for many years in the sciences and medicine. What is new is the fact that Goldratt has applied the process to manufacturing and other areas of the business environment. Dettmer [1998], Lepore and Cohen, [1999] and Roybal, Baxendale, and Gupta [1999], all allude to the Theory of Constraints as an

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emerging philosophy that offers some distinct advantages, both theoretical and practical.

The Theory of Constraints posits that a given group of processes will have a slowest process and the slowest process controls the rate of system production. In order to maximize the system production, the slowest process must be improved and all other processes regulated to the speed of the slowest process. The slowest process is referred to as the “constraint”. In order to find the core problem, all areas must be examined together to determine the constraint.

Since the constraint is not always obvious, Goldratt [1992-c] developed the Thinking Process. This concept consists of a series of steps to locate the constraint (What to Change?), determine the solution (What to change to?) and how to implement the solution (How to make the change?). While the Theory of Constraints was developed for manufacturing, the application of the three steps of the Thinking Process could be applicable for all processes and problems regardless of the context.

### THINKING PROCESS

#### What to Change?

The symptoms of a root cause are undesirable effects (UDEs). Since organizations strive to eliminate undesirable effects and the effects are brought on by the root cause itself, it follows that this root cause needs to be exposed and eliminated.

The methodology employed in the search for root causes is based on a cause and effect relationship. It begins by diagramming the interconnections of major UDEs through a Current Reality Tree (CRT). Goldratt [1994-c] states, the first step of developing this tool is to list several (10 – 12) UDEs that currently exist. These UDE’s are listed in arbitrary order since the process of building the Current Reality Tree does not focus on the severity, ranking, or order, but on the Effect-Cause-Effect relationships of the list of UDEs.

This concept is illustrated within the context of the small business environment. According to the U.S. Small Business Administration (2003), small businesses represent more than 99.7 percent of all employers, create 60 to 80 percent of the new jobs annually, and employ more than half of all private sector employees. The U.S. Small Business Administration (2003) estimates for small businesses with employees indicate that in 2002 there were more closures (584,500) than startups (550,100). These figures do not include the numerous new business start-ups that do not hire employees. Holland (1998) quotes a Dun & Bradstreet report which estimate, “businesses with fewer than 20 employees have only a 37% chance of surviving four years (in business) and only a 9% chance of surviving 10 years.”

Considering a new small business start up , the following UDEs can be identified.

1. Insufficient operating capital.
2. Lack of realistic planning.
3. Lack in business management skills.

4. Unaware of city/government ordinances and regulations.
5. Delay in collecting accounts receivables.
6. Insufficient money for start-up costs.
7. Negative cash flow.
8. Unpredictable extraordinary circumstance.
9. Misconception of work required to stay in business.
10. Corruption or unethical behavior.
11. Dishonest employees.
12. Lazy employees..

Using logical based common sense, the UDE’s are interconnected through cause and effect relationships. If one UDE is not sufficient to cause another UDE by itself, an “insufficiency” may be necessary. The insufficiency is noted beside the UDE, with their arrows connected with an oval that Goldratt calls a “banana”. Additionally, there may be more than one UDE leading to another UDE without a banana connecting their arrows. This means that either of the first two UDEs is sufficient alone to cause the resulting UDE. To simplify the logical format, one may add a statement Goldratt calls “clarity” between two UDEs or between an UDE and another clarity. The resulting CRT is the current state in a diagram format, with the core problem(s) clearly identified. Figure 1 shows the current reality tree for the high failure rate of new business start-ups.

The CRT is read from the bottom, using if...then statements to follow the cause and effect relationships. The CRT identifies UDE # 3 (lack in business management skills) as a core problem. In addition, this core problem is shown to be the consequence of two interjections, “inadequate business related work experience”, and “inadequate business education”. The CRT identifies a second possible core problem, UDE #8, an unpredictable extraordinary circumstance.

If there is inadequate business related work experience and if there is inadequate business education, then there will be a lack in business management skills. If there is a lack in business management skills, if dishonest and lazy employees exist, and if hiring honest, hardworking employees requires management skills, then dishonest employees may be hired. If dishonest employees are hired, then there may be corruption or unethical behavior. If there is corruption or unethical behavior, then one may go out of business.

If there is a lack in business management skill and if government ordinances and regulations are part of the business education or experience process, then one may be unaware of city/government ordinances and regulations. If one is unaware of city/government ordinances and regulations and if following city/government ordinances and regulations is necessary to stay in business, then one may go out of business.



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If there are inadequate business related work experience and if there is a lack in business management skills, then there may be a misconception of the work required to stay in business. If there is a misconception of the work required to stay in business and if there is a significant amount of work required to stay in business, then they may go out of business.

If there are inadequate of business management skills, then goals may be unrealistic or undetermined. If there are inadequate business management skills and if goals are unrealistic or undetermined, then there is a lack of realistic planning. If there is a lack of realistic planning and if when starting a business there is often a delay in building a customer base, then sales can be less than expected. (There are alternative causes of sales being less than expected presented later).

If there is a lack in business management skill, if dishonest and lazy employees exist, and if hiring honest, hardworking employees requires management skills, then lazy employees may be hired. If lazy employees are hired and if there is a lack of business management skills, then sales may be less than expected. Additionally, if there is an unpredictable extraordinary circumstance, then sales may be less than expected. If sales are less than expected, then sales may not cover expenses. Alternatively, if there is an unpredictable extraordinary circumstance, then there may be a deterioration of sales. If there is a deterioration of sales, then sales may not cover expenses. Still, if there is a lack of realistic planning, then expenses may be higher than expected. If expenses are higher than expected, then sales may not cover expenses. If sales do not cover expenses, then there is a negative cash flow. If there is a negative cash flow, then there may be insufficient operating capital. If there is insufficient operating capital, then they may go out of business.

If there is an unpredictable extraordinary circumstance, then there may be a delay in collecting accounts receivables. If there a delay in collecting accounts receivables, if cash

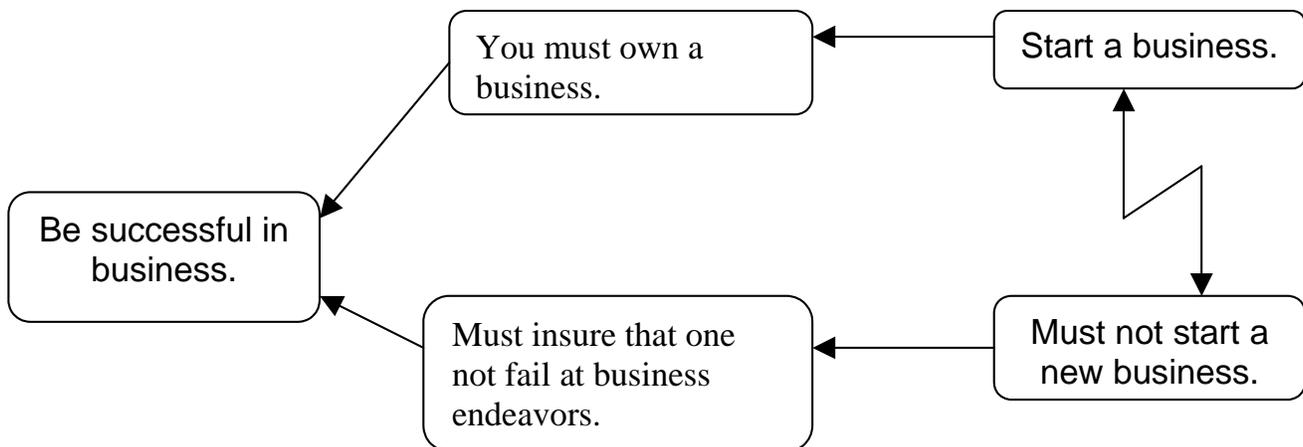
accounts are too low, and if sales do not cover expenses, then there may be insufficient operating capital. If there is insufficient operating capital and if some people lack morals, then there may be corruption or unethical behavior. If there is corruption or unethical behavior, then they may go out of business.

### What to Change to?

The second step in the Thinking process is to determine the solution (What to change to?). A conflict generally emerges in the CRT and usually pulls the situation in two different directions. The most common tendency in managing conflict has been to compromise in some fashion. If compromise were a true alternative, the conflict would have been eliminated a long time ago. Therefore the tendency to look for a compromise should be overcome and the true core problem should be eliminated.

Goldratt [1992-a] writes, since a vacuum does not exist, eliminating the core problem means creating a new reality, in which the opposite of the core problem exists. To eliminate the core problem, a tool called the Evaporating Cloud (EC) should be used. An EC, according to Goldratt [1993] is the thinking process that enables a person to precisely present the conflict perpetuating the core problem, and then direct the search for a solution through challenging the assumptions underlying the conflict. The EC starts with an objective, which is the opposite of the core problem. From the objective, the requirements (minimum of two) are listed. Each requirement will have at least one prerequisite. It is the prerequisites that depict the tug-of-war. All the requirements and prerequisite are based on assumptions that have been ingrained in our minds over time. It is these assumptions that keep us in this tug-of-war environment. What is needed is a set of injections that can be used to break the validity of any one of the assumptions. This is the first step in freeing our self from the binding controversy.

**FIGURE 2**  
**EVAPORATIVE CLOUD**



**Evaporative Cloud**

In constructing the EC, one injects the ideal answer, which would burst the cloud and thereby remove the problem. The EC is read from the left to right, starting with the top portion, using “In order for.... they must” syntax.

The EC begins with an objective. The objective has a minimum of two requirements listed. Each requirement has a prerequisite. The prerequisites reveal a tug-of-war. Once a cloud is constructed, one must concentrate on the arrow that bothers them the most and look for an additional assumption for that arrow. An injection at that arrow will provide for a win-win solution that is not just a compromise.

Figure 2 depicts the EC for the small business start up example.

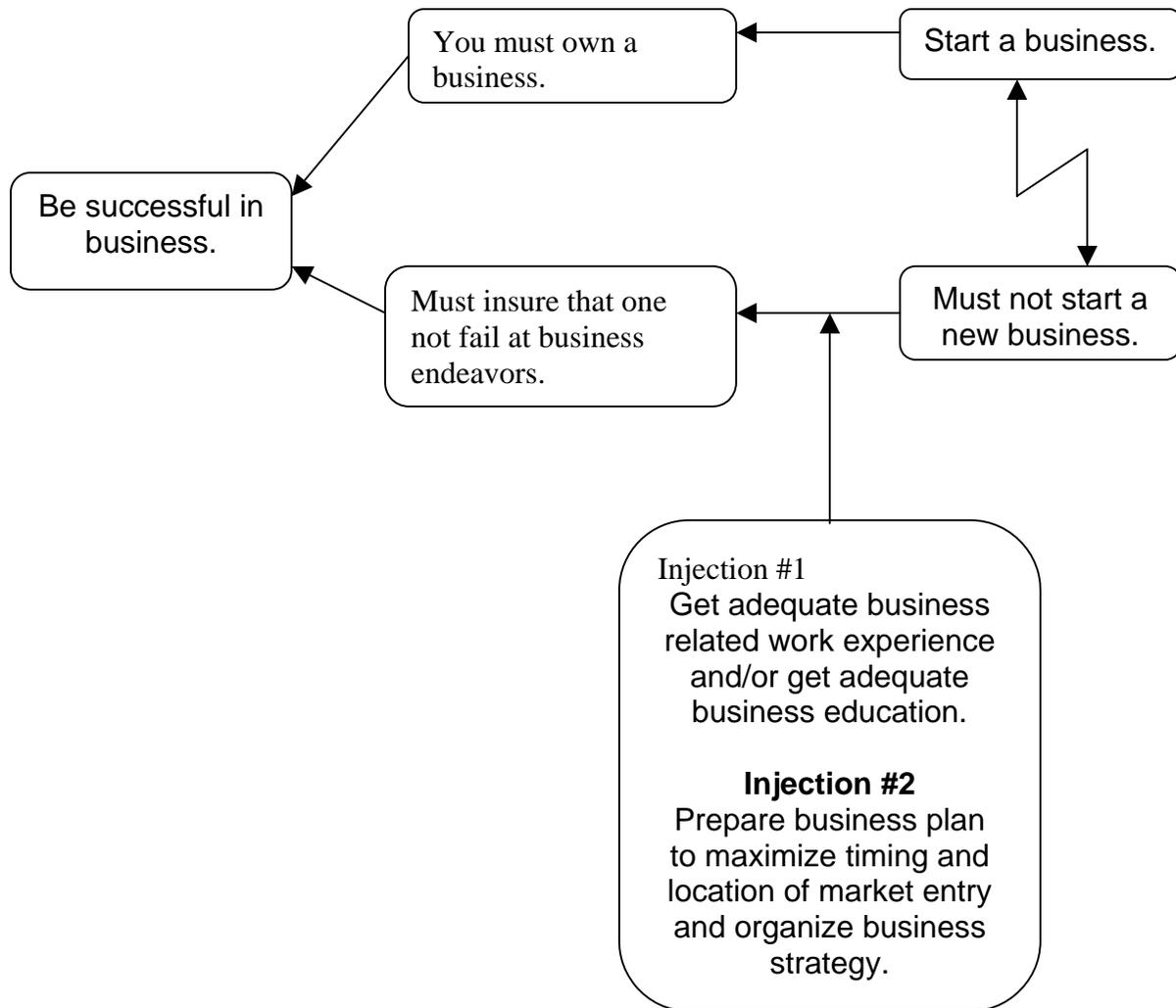
The objective is “to be successful in business”. In order to be successful in business one must own your own

business. In addition, in order to be successful in business, one must not fail at business endeavors. In order to own a business, one must start a new business. On the other hand, to insure that one not fail at business endeavors, one must not start a new business. The conflict lies in the prerequisites that one must start a new business and one must not start a new business.

The troublesome assumption is that to insure that one not fail at business endeavors, one must not start a new business. This assumption is made because new businesses have a high failure rate. Figure 3 illustrates how this assumption, and cloud, can be broken with the inclusion of the following injections:

1. Get business related work experience or get business education.
2. Prepare business plan to maximize timing of market entry and organize business strategy

**Figure 3**  
**Evaporative Cloud with Injections**



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### How to Cause the Change

The third step in the Thinking Process is how to implement the solution (How to make the change?). This step begins by considering whether the injections will direct desirable effects. With the injections and the logical based common sense cause and effect relationships, the desired effects can be connected and the future outcome developed. This technique is called building the Future Reality Tree (FRT).

The Future Reality Tree is the thinking process that enables a person to construct a solution that, when implemented, replaces the existing undesirable effects with desirable effects without creating devastating new ones (Goldratt, 1993). Step-by-step the solution is created, and each stem is scrutinized to logically show that once the injections are implemented, the desirable effects can be accomplished.

When the EC is broken, the Future Reality Tree is built starting with the injections from the EC. The injections are connected with the Effect-Cause-Effect logic and uses clarities and insufficiencies where additional information is required. This process tests the solution and is enhanced by criticism and negative comments. If criticisms, negative comments and undesirable effects can be overcome by the proposed solution then this provides proof of the solution and leads to the next step in the process. This process taps into the natural tendencies of criticism and negativity.

The FRT is read from the bottom up using if...then statements in a logical format just as the CRT and is used to establish that the injection, by itself, is sufficient to reach the objective. The FRT has traditionally been built from the injections used to break the conflicts in the Clouds. The injection(s) are placed near the constraints at the bottom of the page. Using cause-and-effect analysis, one should attempt to reach the objectives from the injections. As with the CRT, one adds clarities and insufficiencies to simplify the logical format. Figure 4 illustrates the future reality tree. For the small business start up example.

If one gets adequate business related work experience or gets adequate business education, then adequate business management skills will exist. If adequate business management skills exist, if dishonest and lazy employees exist, and if hiring honest, hardworking employees requires management skills, then dishonest employees would not be employed long term. If dishonest employees would not be employed long term, then corruption or unethical behavior would be less likely. If corruption or unethical behavior is less likely, then they may not go out of business.

If adequate business management skills exist and if government ordinances and regulations are part of the business education or experience process, then there is an awareness of government ordinances and regulations. If there is an awareness of government ordinances and regulations, and following city/government ordinances and regulations is necessary to stay in business, then one may not go out of business.

If adequate business management skills exist, then there would be an understanding of the work required to stay in business. If there is an understanding of the work required to stay in business and if there is a significant amount of work required to stay in business, then one may not go out of business.

If adequate business management skills exist, then goals may not be unrealistic or undetermined. If adequate business management skills exist and if goals are not unrealistic or undetermined, then planning is realistic. If planning is realistic and if when starting a business there is often a delay in building a customer base, then sales should be adequate. If sales are adequate, planning is realistic, and most accounts receivable will be collectable, then cash accounts may not be too low. If cash accounts are not too low and if planning is realistic, then there should be sufficient money for start-up costs. If there is sufficient money for start-up costs, then one may not go out of business.

If there are adequate business management skills, if dishonest and lazy employees exist, and if hiring honest, hardworking employees requires management skills, then lazy employees would not be employed long term. If lazy employees are not employed long term and if there are adequate business management skills, then sales should be adequate. Additionally, if one gets adequate business related work experience or gets adequate business education and if one prepares a business plan to maximize timing of market entry and organize business strategy, then most unpredictable extraordinary circumstances can be dealt with. If most unpredictable extraordinary circumstances can be dealt with, then sales should be adequate. If sales are adequate, then sales should cover expenses. Alternatively, if most unpredictable extraordinary circumstances can be dealt with, then deterioration of sales can be controlled. If deterioration of sales can be controlled, then sales should cover expenses. Still, if planning is realistic, then expenses should not be higher than expected. If expenses are not higher than expected, then sales should cover expenses. If sales cover expenses, then there is a positive cash flow. If there is a positive cash flow, then there should be sufficient operating capital. If there is sufficient operating capital, then one should not go out of business.

If most unpredictable extraordinary circumstances can be dealt with, then most accounts receivable will be collectable. If most accounts receivable will be collectable, if cash accounts are adequate, and if sales cover expenses, then there should be sufficient operating capital. If there is sufficient operating capital and if some people lack morals, then corruption or unethical behavior is less likely. If corruption or unethical behavior is less likely, then one may not go out of business.

## CONCLUSION

This method of analysis, although somewhat different from the normal methods of analysis provides us with a tool



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to understand the existing nature of the cause. It does this by discussing and scrutinizing our basic intuitive sense, which exists in our environment. Different the more traditional approach of correlation and classification, it practical, and can be applied to any problem in any context. According to Goldratt [1992-b], you start with an effect in reality. Then hypothesize a plausible cause for the existence of that effect. Since the aim is to reveal the underlying causes that govern the entire subject, try to validate the hypothesis by predicting what else this hypothesis must cause. Once such predictions are found, concentrate efforts to verify whether or not each prediction holds water by asking questions. If it turns out that one of the predictions doesn't hold up, find another hypothesis. If all of them hold up, continue until the entire subject is understood through the bonds of cause and effect.

Bob Fox [1989], President of the Goldratt Institute, states: "I do not believe any longer that the challenge is the technology of what to do. That has been well developed - maybe not disseminated very well yet, but developed....This method of problem solving requires ability that everyone has and stems from the systematic methods and thinking processes. It provides you with the framework necessary to direct these efforts and to verbalize your intuition to gain a better understanding of managements 'intestinal sensations.'

Cannon and Feinstein (2002) challenge business simulation developers to base games on theory to develop both representational and educational validity. Perhaps the inclusion of the Thinking Process within the simulation framework will allow students a chance to experience the "messiness" of the real world and develop a more systematic approach to problem solving. This scientific systematic cause and effect approach is used in many areas of science and math. To develop a demonstrated thinking process that allows students to "dig down" past symptoms to look at causes is a valuable addition to any simulated environment. Truly, here is nothing more important than the ability to answer: "What to change", "What to change to", and "How to cause the change."

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