The Core Structure of TOC Thinking Processes and their applications to improve systems (The "U" shape)

The use of the "U-Shape" for the analysis of the problems in a single project environment and the development of the solution - CCPM – Critical Chain Project Management.

Oded Cohen

Introduction

For many years – the systematic approach to improve systems dealt with three major issues: the problem, the solution and implementation of the solution. In other words – it is about the part of the system that is of a need to change, the change itself and making this change happen. Theory of constraints (TOC) has taken this approach further with the constant view of ensuring the high impact for the minimal level of effort and hence providing significant return for the investment put in making it happen. The move to system improvement was lead by special departments within large organizations in the 1960's and was acknowledged by the academic world. This was manifested by the development of Industrial Engineering, Management faculties and the MBA programs. In the 1980's with the realization of the significant competitive edge of the Japanese manufacturer it became apparent that the improvement is not only the responsibility of just one department within an enterprise but, it should be a part of the role of every manager in the organization. In addition – the significant movement of the TQM has taught us that we need to consider the continuous improvement as the systems cannot rest on their victories for long before they have to embark on new improvements.

The pressure to improve is driven by two forces: 1. from the top – by the shareholders through the board of directors and the executives of the company, and 2. from inside – by the managers themselves who want to improve in order to progress on their career as bosses and companies tend to reward good managers for their outstanding performance for the company.

Many managers find themselves in a position that they do not know how to answer the three process improvement questions. Sometimes they do not know what to change, sometimes they know what the problem is but they do not know the solution and in many cases they know the problem and the solution but find it difficult to persuade their people to implement the solution.

TOC – the Theory of Constraints – can help the managers that want to lead the change but are not happy with the progress that they have achieved so far. TOC developed thinking processes that can be used in order to answer the three system improvement questions: What to change? What to change to? How to cause the change? On top of these questions TOC also provides the tool for answering the forth question - What is

next? - What creates the POOGI – the process of ongoing improvement? With TOC a manager can handle the demand for continuous improvement of the area under their responsibility.

Not every change is an improvement. To qualify for improvement an idea must cause a better performance of the system as per agreed performance measurement. The practical solution has to address an existing problem of the system and create a new reality that produces benefits for the system. TOC claims that such statements and commitments can be verbalized as systems tend to have their own logical connections that explain the way that they operate. Because of that managers that want to improve the performance of their systems must know the logic that dominates their current system and should understand the logic of the solution. To capture the relevant logic that connects the problem with the solution to the desired positive outcomes of the solution – once implemented, TOC uses the comprehensive logical tool that is called “The U-Shape”.

Part 1

The U-Shape

The U-shape connects all relevant TOC Thinking Processes dealing with each of the four continuous improvement questions in a rigid logical flow, allowing a problem analyst to become a proficient solution developer and providing a person assessing the solution with the ability to check: ‘if that is the solution, what problem does it solve?’

In a simple schematic way the U-Shape records the logic of the relevant components that participate in the analysis of an existing current reality of a system understudy, the direction of the solution, the necessary elements of the detailed solution and the expected benefits and impact on the performance of the system. It covers the majority of what is necessary in order to develop a full conceptual improvement solution that is viable and contains very little risk to the existing system.

The U-Shape provides evidence of what is claimed to be the "inherent simplicity" of every system. Through the logic of cause and effect relationships it allows the individual to better comprehend the large amount of new knowledge elements, to store the logical structure and to be able to retrieve and use it when needed.

The U-Shape covers most of the TOC thinking tools necessary to perform the "engineering work" of designing a system solution. It contains the TOC specially defined data elements such as: system performance measurements, system problems – the undesirable effects, the core problem, the direction of the solution, the elements of the solution – the injections, the potential risks (negative outcomes) and the expected benefits from the solution. This set of logical tools allows the designer, the implementer, the sponsors and the people supporting the initiative to go through a proper decision making process that is based on a true consensus. As such it allows the team to agree on the problem, the direction of the solution, the elements of the solution and their corresponding benefits.

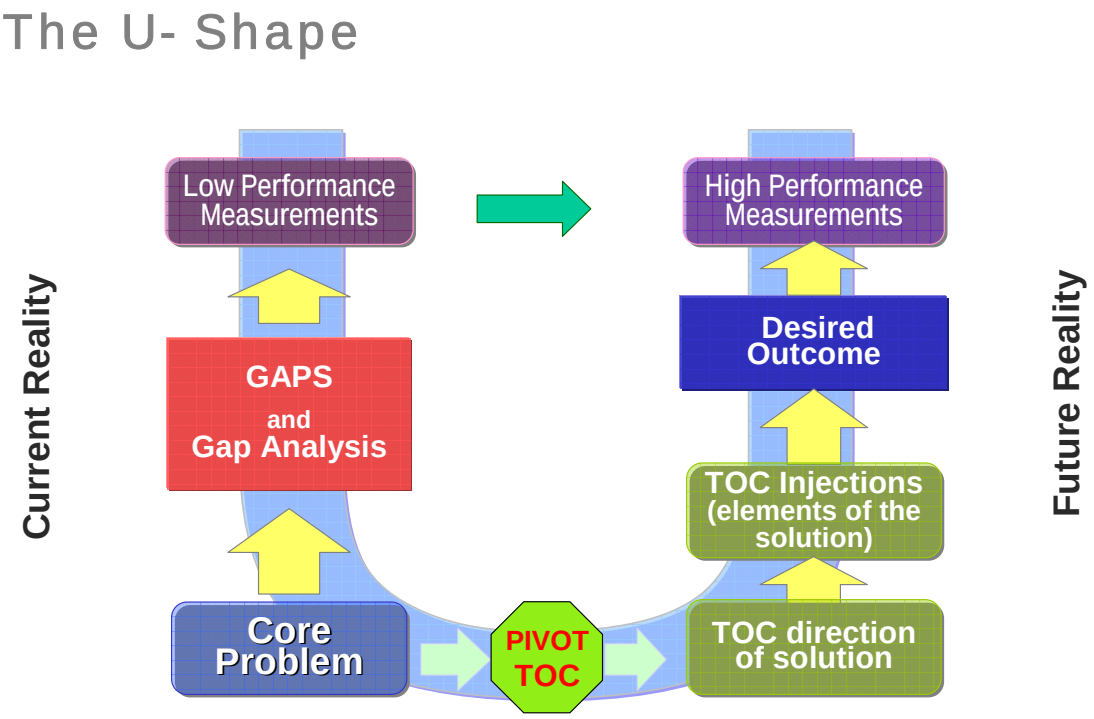


Figure 1: The general structure of the U-shape

What really makes a U-shape a U-shape, what provides the true link between the Current Reality reflected in the U-shape left side and the Future Reality in its right side – is the Pivot. The pivot is the central point – it describes the core of the change, it is like changing the course of a huge ship. It explains what **is** the different paradigm that is about to be employed to the extent that it will drive the new desired reality.

The bottom part of the U-shape contains the core problem, the Pivot and the new core driver. It provides the answer to the question – "why is it going to work this time?" Many managers come to TOC because they are looking for something new. As long as managers have the ability to improve the performance of their systems to their satisfaction and/or to the satisfaction of their bosses with conventional approaches – they are not searching for any new managerial approach. When the pressure to improve (internal or external) is growing managers are shopping around for new ideas.

We strongly believe that the structure of the U-shape can be used also to explain other managerial approaches that provide answers to the continuous improvement questions. What will be unique to every managerial approach is the recognition of the core problem, the pivot of the approach and the direction of the solution.

The TOC pivot provides the suggested TOC Change. It comes under the heading of "Management the TOC Way".

What is unique about Managing the TOC Way?

The TOC Way is based on the realization that the performance of every system is governed by very few of its constraints. The constraint blocks the system from achieving higher performance versus its goal and at the same time provides the manager with the direction to grow ("lift") the system and to improve its performance. Due to that the term constraint is so significant in TOC to the extent that it gives the name to the entire approach.

What prevents us from achieving the goal?

CONSTRAINTS –
factors or elements that determine
how much the system can accomplish

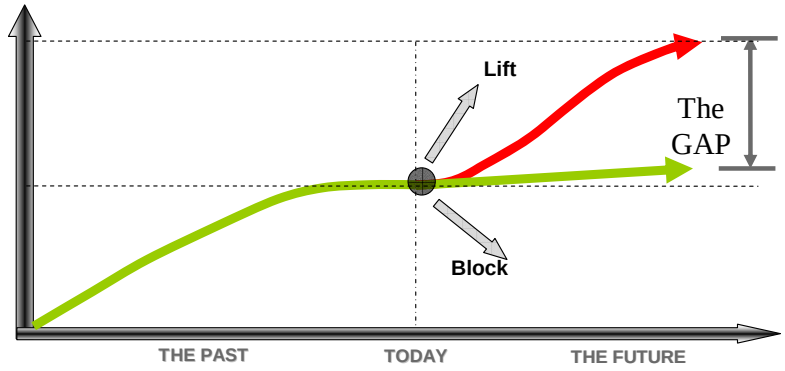


Figure 2: The constraints

Once managers identify the constraints they can manage their systems through the constraints. There are few types of constraints: Capacity, Lead-time, Market (customer orders) and Behavior (support and collaboration). These constraints are 'things' that are in shortage in the current reality.

- **Capacity** constraint states that there is not enough capacity of the specific resource in order to fulfill all the demand that is imposed on it.
- **Lead-time** constraint means that the time to complete a full project is too long versus the competitors or versus the real needs of the market.
- **Market** constraint means not enough customers orders.
- **Behavior** constraint means that the current attitude, motivation and enthusiasm of the workforce are below the necessary expected level the organization needs. These stem from the organization's policies and measurements, which are not constraints on their own, but rather severe obstacles on the way of achieving the desired goal by conditioning people to certain undesirable behaviors.

When managers realize the critical impact of the constraint on the performance of their system it has a profound impact on their mode of management. After identifying what the constraint is managers should make conscious effort to squeeze the most of the constraints while not wasting them and thereafter to bring more to elevate the constraint.

This is the point to highlight the difference between step 2 of focusing – decide how to exploit the system's constraint and step 4 – elevate the system's constraint. When facing a constraint manager tends to react instinctively to relieve the pain associated with the constraint by elevating it. If it is a capacity constraint they buy more capacity, if it is customer orders – they push sales by offering lower prices or special promotions. If it is the project lead-time they use all their authority to push the project managers to commit to shorter delivery times to guarantee the receipt of the contract.

TOC focusing steps call for exploiting the constraints before elevating them for two major reasons. First – exploiting means salvaging wasted units of the constraints. This can be done immediately, hardly needs heavy investment and the return is quick. The second reason is that we must know what in the current reality causes the waste of the constraint and without this knowledge there is a high risk that we will continue to waste even the elevated constraint.

While constraints are very few in a system, all of other entities of the system are non-constraints and demand a different type of management – less attention while ensuring they do not cause difficulty to the systems.

There are different characteristics to the above types of constraints that have to be kept in mind.

Capacity constraint is when the demand imposed on a resource or machine is more than its available capacity. In the environment that is not constraint-conscious it is likely that the constraint is not getting any specific managerial attention. When managers take actions to stop wasting the available capacity they **release more** capacity and relieve the stress caused by lack of capacity. To elevate the constraint managers need to **get more** capacity.

Lead-time constraint is experienced when the quoted lead time (QLT) is larger than the customer can tolerate. To secure the customer order project managers are pushed to commit to shorter lead-tines than they would like to have. In other cases top management decide to introduce more projects with the same level of resources. The end result is that projects struggle to finish on time. This damage the financial performance of the company and the reputation of the company. Therefore – management has to first ensure the **on time delivery** –to ensure the market perceive the system as reliable. This is a decision of exploiting the constraint. Only when reputation is regained we can move to the elevation step by taking actions to **reduce** the quoted lead time to a competitive level.

Market Constraint is always the primary constraint. Manufacturing and service companies can generate throughput only by selling their products or services. In a free competitive market when customers have a choice of suppliers – market has to be acknowledged as the constraint that determines success and failure of the company.

Managers have to ensure that current customers are happy with the level of service for the existing business they do with the company. This will help to **retain** the customers the company has. Later on, managers have to consider how they can get **more** orders from **more** customers.

Behavior constraint is not quantitative. It is apparent when you compare cultures of different companies and different nations. Addressing the behavior constraint means **stop** doing the "wrong" things which calls for less undesirable behavior and thereafter **promote** doing the "right" things and more of the desired behavior.

Choosing your constraint

Besides the market constraint an organization may experience some of the other types of constraints listed above. It is recommended to choose the market as the strategic constraint of the company as it can provide the company with endless growth. The more orders the higher the performance of the systems.

In certain cases you may choose capacity or lead-time as secondary constraints for the transition period. Everyone in the system knows that customer orders are the most important in the system and capacity or lead-time are subservient to them and need special managerial attention.

Behavior constraint usually coincides with poor system performance. However, based on our experience as TOC practitioners I suggest that we should not address directly the behavior constraint. TOC strength is in the system solutions that improve performance. When the system performs better – everybody is happy and there is a better chance to remove many causes for frustrations that impact the human behavior. We do not give up on addressing human behavior. We have Buffer Management (BM) – which is a part of every TOC solution and can highlight areas of specific behaviors that are a source for concern and needs management attention.

I would like to mention here that TOC is not the answer to everything that is needed for the system to improve. TOC deals with the managerial part of the system. There are certain areas that are mandatory for the system and they should be drawn for experts in these areas. For example, technological superiority and higher quality of the products or services give the organization competitive edge. TOC does not deal directly with these areas but provides management with tools and approach to better manage in a competitive environment. Through the use of Buffer Management managers can recognize the areas that need special attention due to quality problems and TOC can help managers to get early to the market with new products and services ahead of their competitors.

In this article I deal with the U-shape in general and its use for managing projects. In other articles I am dealing with the use of the U-shape for logistical systems of supply chain management – operations and distribution as well as the financial and measurement systems supporting managerial decisions making. For these systems TOC provides sets of solutions aimed at performance improvements.

The TOC Solution

As stated above - the Pivot describes the essence of the change – moving to managing systems the TOC way. As managers of a system we are interested to know the details of the solution suggested by TOC and the logic explaining the reasons why they are going to work and provide significant results.

The solution starts with the **direction of the solution** for the system understudy. We can look on every U-shape as a system on its own. If the pivot is – managing the TOC way then the direction of the solution is "Managing the (specific) system the TOC Way". As such operations management the TOC way, distribution management the TOC Way etc.

In the direction of the solution we choose the dominant constraint for the system and we supply a new method, approach or paradigm how to manage this constraint.

For project management the direction is – project management the TOC way CCPM – Critical Chain Project Management. The chosen constraint is the project lead-time. The traditional way of managing projects is called CPM – critical path method. TOC suggests that the lead-time of a project is dominated by a combination of dependent activities and availability of resource – by the Critical Chain (CC). The Critical Chain determines the lead time of the project as it is the longest series of activities (tasks) that have to be performed sequentially, one after the other. As long as the time for performing every task is fixed and the capacity and availability of resources needed to perform the tasks are given the time to complete the project cannot be reduced!

The complete solution has several elements. In the TOC terminology they are called **Injections**. The injections are the real breakthrough that the TOC solutions inject into the reality. They are new elements that are brought into the system. They are considered as breakthrough because they have never been a part of the system. Once implemented in reality the injections provide permanent and continuous "new blood" to the system and directly contribute to the improved performance.

Even though many systems implementations provide the experience and the confidence that the TOC Solution works, it is important to provide the logic of the solution explaining why it works. Through cause and effect relationships that are proven to exist in reality the logical connection is built between the elements of the solution and the desired outcome. This is a part of the TOC body of knowledge (TOC BOK) that is so crucial for the design of the solution. Yet again, this knowledge is based on the thorough understanding of systems and the way they operate.

The desired outcomes of the TOC Injections are connected by cause & effect relationships to the improved performance supporting the claim that the injections, once correctly implemented, will lead to better performance of the system.

With that we have covered the backbone of the right hand side of the U-shape that deals with the question – What to Change to? What is the solution?

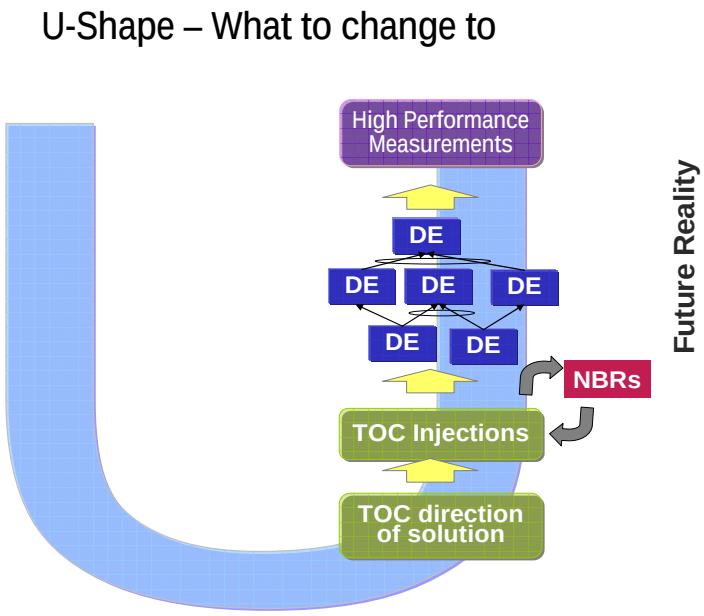


Figure 3: The right side of the U-shape – What to change to?

Based on this logic every TOC practitioner – a TOC scholar that is committed to improve systems - has to know and demonstrate the link between every injection and its corresponding DE – Desired Effect – the positive outcome that stems from this injection.

At the same time, we have to be aware of the fact that every new injection to reality – every change contains a potential danger of side effects. It is like in medicine. Pharmaceutical companies invest billions in developing cures for known illnesses. Even when they have a solution they are not allowed to sell it unless they conduct a thorough experiments and tests to ensure that the medicines do not contain any negative side effects. The same is correct with improvement initiatives. The recent history of improvements in manufacturing companies has shown that in many cases these initiatives have caused lay-offs of employees without any opportunity to be reemployed. This is an example of a Negative Outcome, known in the TOC terminology as **NBR – Negative Branch Reservation**.

It is the responsibility of the designer of a solution to think about the potential negative outcomes even though the intention of the solution is to produce good outcomes for the benefits of the system. As such there is a need to develop more elements for the solution to prevent the negative outcomes. These elements will join the "package" of the solution – the group of the injections for the improved performance.

Figure 4: Injections and Negative outcomes

The injections – the new entities into the system provide the answers to the question of "what to change to?" – What do we have to do in order to improve the performance of the system? Yet – the solution is the response to the problems preventing the systems form achieving higher performance.

What to change – What is the problem?

We know that systems can perform better. This is the major drive guiding managers on the continuous improvement. Managers also experience sporadic situations in which their systems perform better. But – they find it difficult to repeat these experiences permanently. These experiences set higher level of performances that managers strive to achieve.

The starting point is the performance of the system. The system was built for a purpose. The performance measurements have been developed in order to measure how well the system performs versus its objectives. The expectations are that systems continuously improve their performances.

When a practitioner is called to improve a system it is because the performance measurements are "low" according to the owners or managers views. There is no criticism of the efforts and achievements up to this point. The call for professional assistance is an outcome of a strong conviction that the system can do better.

The difference between the level that the system can perform and the current level of performance is the GAP. Even though gaps may cause frustration to the managers of the system they also provide the stamina and the energy to strive for the improvements. Once we recognize that there are gaps we can ask the question – why do they exist? What prevents us from closing the gaps?

The reasons that are given to the existence of the gaps are called – Undesirable Effects – UDEs in the TOC terminology. These are facets of reality that are undesirable as they cause the system to perform at a lesser level. The UDEs are like the symptoms in the medical analogy. They indicate that the system is not well. The practitioner conducts investigation and through the cause and effect reveals the Core problem – the reason for the existence of several gaps and UDEs. This analysis is called CRT – Current Reality Tree, and appears on the U-shape as a gap analysis or diagram connecting the UDEs.

The core problem can be verbalized in three ways:

- An erroneous assumption that is used extensively by the managers of the system in managerial decision making
- A conflict between two types of conflicting tactics
- A core cloud presenting the core conflict

The left side of the U-shape deals with the question – "What to Change?" It covers the current level of performance measurements, the gaps – the undesirable effects (UDEs), the gap analysis through the Current Reality logical analysis (CRT) and the Core Problem.

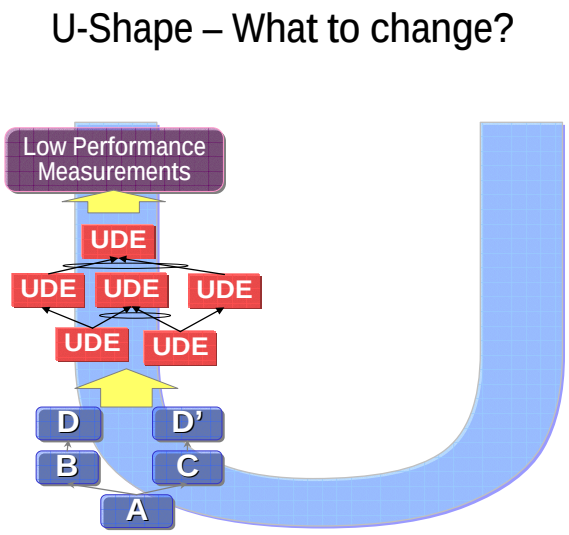


Figure 5: The left side of the U-shape – What to change?

By now we have finished to describe the full U-shape. The left side deals with the current reality, the right side deals with the future reality that emerges after the successful implementation of all the injections of the solution and in the center of the U – the pivot – Management the TOC Way.

At this point every practitioner can arrange the TOC knowledge in a U-shape. By that one can master the knowledge and be prepared for questions on any issue regarding the problem and the solution. The U-shape is valid for one problem as well as for the entire system.

Traditionally, in teaching TOC for specific areas such as operations, distribution, project management etc., the material is organized according to the U-shape but in big "bulks". This is like production processing in large batches. We used to cover first all the typical UDEs, go through the CRT, the FRT and end up with list of injections. Yet – in preparation for the implementation there is a need to deal with every injection on its own. The U-shape provides us the platform to organize the knowledge and use it for the implementation.

Every Injection that is a part of the solution is directly linked to one or more gaps and undesirable effects (UDEs). The U-shape helps us to establish these links. There is a need to conduct a Current Reality Study (CRS) to investigate and find evidences in the system to indicate the existence of the gaps and the UDEs. Once the UDEs and their implications have been established – the practitioner can proceed to plan for the implementation.

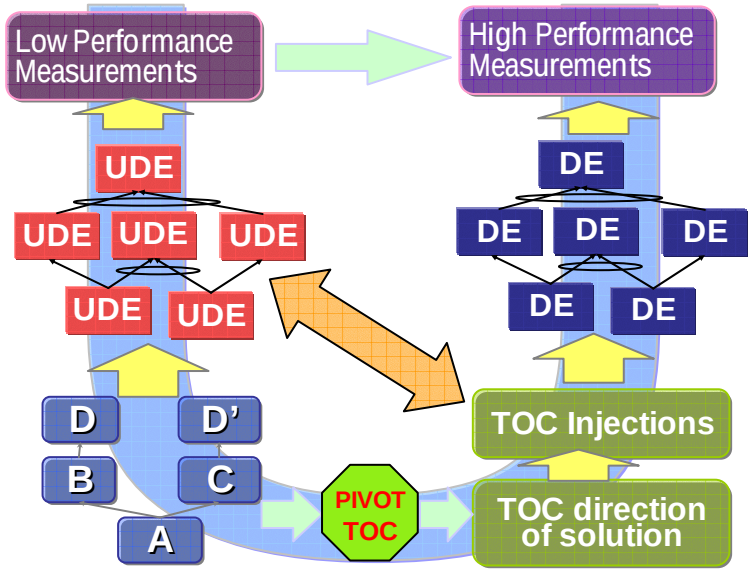


Figure 6: The full U-shape with the connections between injections and UDEs

In preparation for the implementation we consolidate all the relevant knowledge that is needed for the injection. It includes:

- What is it – what is its essence?
- What UDE does it address?
- What is the positive outcome of implementing it?
- What is a potential negative outcome and how to prevent it from happening?

This completes an Injection “flower”:

Injection Flower

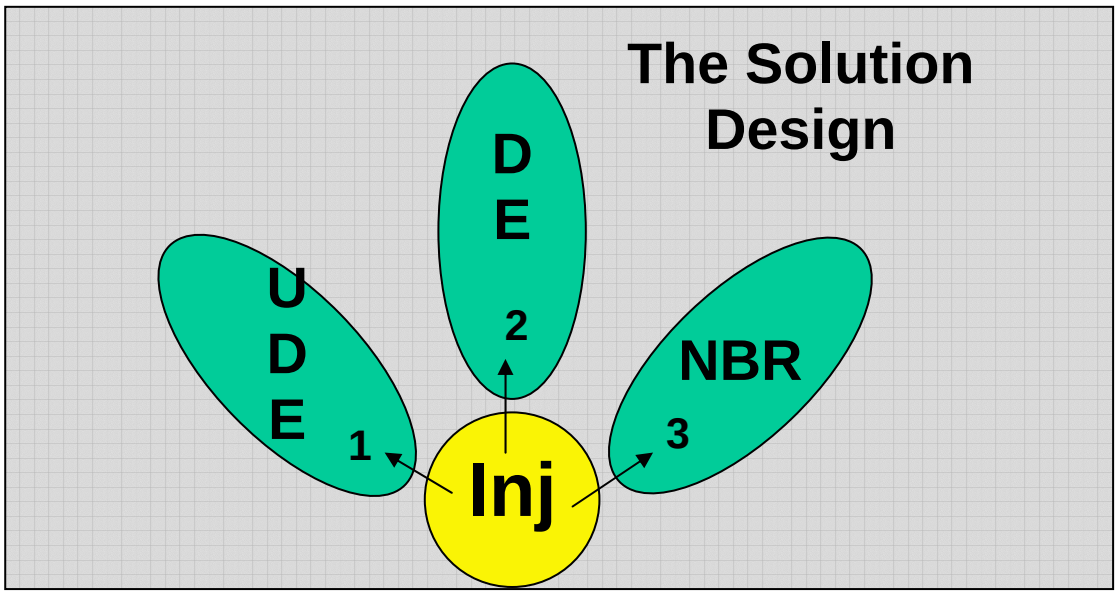


Figure 7: The Injection "flower"

Part 2

Improving with TOC

Once the TOC knowledge is organized in the U-shape it is ready to be used for 'making it happen'. This means the design of a solution for a specific system and the development of a detailed implementation plan to achieve the desired improvement.

We start with defining the boundaries of the system we want to improve.

> *In single project management the boundaries are:*
> *all activities associated with managing a single project from the point the project has been authorized until it comes to its full completion to the satisfaction of the customer (external or internal).*

Then – we agree on the system performance measurements.

> *For single project they are:*
>
> - *On time completion (due date performance)*
> - *Project budget*

- *Project specifications (commitments and promises to the customers)*

We get indication for the current performance as per the above measurements and we set a target to get higher performance. It is well known that it is rarely that projects finish on time, in full and within budget (OTIFWB). As such it is fair to say that many project environments are good candidates for improvement.

The Body of Knowledge of TOC can be found in books, videos and self learning media. It contains the traditional structure of TOC of:
What to change:

- List of UDEs
- CRT – Current Reality Tree
- Core problem
- Core cloud
- Criteria for judging solutions

What to change TO:

- Direction of the solution
- FRT – Future reality Tree
- NBR – Negative branch reservations
- A list of injections
- Criteria check

It is expected that the TOC practitioner planning to implement CCPM in a project environment has learned the above knowledge and has access to all its parts in order to use them in the construction of the U-shape for the implementation design.

TOC Solution for Single Project Management – implementation template

We are about to present an implementation template. This is a structured approach to the design of the TOC solution and the foundation for the implementation plan ("IP").

This template is aimed at environments that generally fit the reality described in the knowledge regarding ‘what to change’. This means that there is evidence for the existence of the UDEs, that key causalities have been proven to be accepted as common logic of the system and that certain key characteristics are "live and kicking" in the project.

Before suggesting a TOC solution, the practitioner conducts a visit to the environment. After a short visit to the premises (to get the flavor of the work conditions, the technology and general atmosphere) they conduct several interviews with key managers in the environment, such as project sponsor, sales manager (for projects for external customers), project internal customers (for internal projects), project manager team leaders and resource managers. In some companies there is a special unit for planning and control of several projects. We should meet them as well as they hold a lot of knowledge about the way projects are management in the organization. This visit is called CRS – Current Reality Study.

In preparation for the CRS the practitioner constructs a list of questions to verify, validate and collect evidences for the existence of certain UDEs, causalities and entities. Special attention should be made to the existence of typical behaviors and modes of operation that are mandatory for validating the solution such as: the student syndrome, bad multi-tasking, Parkinson law for task completion time, estimation processes for task duration, reward system etc. These entities are major drivers in causing the UDEs as explained in the Current Reality Tree (CRT).

With the data gathered in the CRS we can fit the template for the specific environment and populate some parts with items relevant for them.

The starting point for the template is the pivot.

To organize and structure the gathered data and to design the solution in a systematic way we use the first three of the five focusing steps:

1. Identify the system's constraint
2. Decide how to exploit the system constraint
3. Subordinate everything else to the above decision

1. Identify the system constraint:

We choose customers orders (market) as the constraint.

The objective of a project environment is to design, plan and deliver a product or a service for a certain date or as soon as possible. At the completion of the project throughput is generated for the company. In simple terms a company that conducts the project gets paid at the successful completion of the project and in many times at key contractual milestones (against partial delivery).

The quicker we finish the project or the more projects the company can do with the same resources – the higher the contribution of the project environment to the company.

2. Decide how to exploit the system's constraint

When the project does not finish on time or the customer has to pay more than planned and or the project does not deliver all the promised specifications – the customer is unhappy. Unhappy customer is a risky situation as the customer may decide to withdraw their existing business from the company, not to continue for future projects and create bad reputation for the company in the market place. This is the opposite of exploiting the constraint.

The decision how to exploit the market constraint should be: the mechanism for fully delivering projects on time, in full & within budget is in place – single project management the TOC Way

3. Subordinate everything else to the above decision

This means that the project environment adopts the proper mind-set and puts in place what ever is necessary to achieve the exploiting decision. This includes processes, decision making behaviors of the entire system and the top management commitment to these three steps (and the acceptance of the TOC pivot).

Making it happen:

We follow the structure of managerial decision making: Strategy, Tactics and Operational levels

Strategy: Projects are delivered on time, in full & within budget (OTIFWB)

Tactics: The project organization implements critical chain project management (CCPM)

Operational level: Implement a set of 12 injections covering the overall mind-set, planning and the control of the execution.

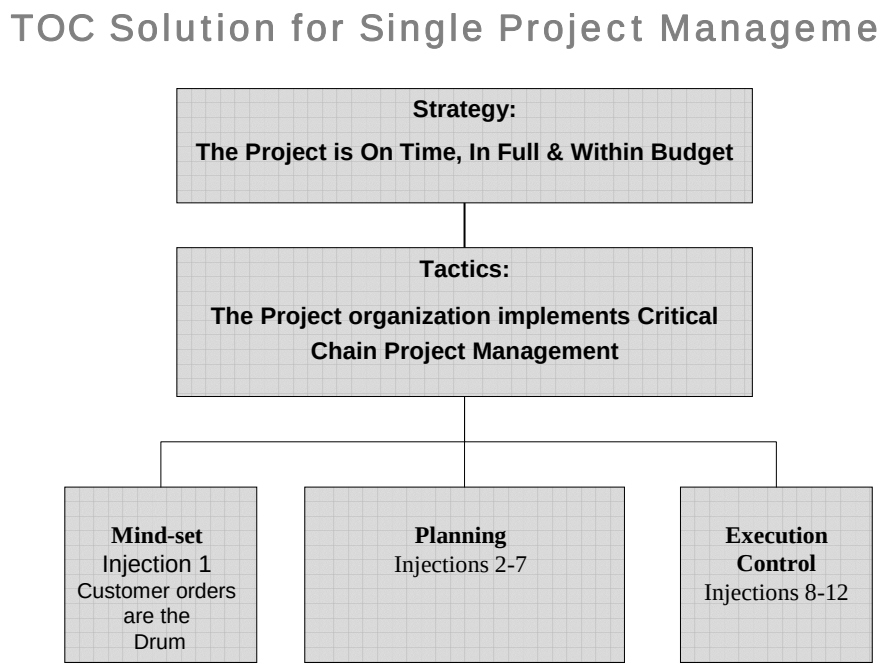


Figure 8: The general structure of the TOC solution

The full list of injection for the solution is:

Mind-set

1. Customers orders are the Drum

Planning injections:

2. Project Planning Diagrams are in place
3. Tasks are resourced and estimated for duration
4. Resource Conflicts are removed from the plans

5. Critical Chain is determined
6. Buffers are inserted in strategic points
7. Estimates of durations are “challenging but achievable”

Execution control injections:

8. Tasks are performed according to the status of their corresponding buffers
9. Resource Availability is monitored in anticipation of a new planned task
10. BM for corrective actions (expediting) is in place
11. Buffer penetration reasons are reviewed weekly for POOGI
12. Resources are monitored as potential CR – Critical Resources

Implementing the TOC solution

Implementing TOC is a project on its own. It contains the technical activities as well as communicating with the relevant people in the organization who are going to implement the technical part as well as the managerial and behavioral facets of the injections.

As such it is recommended to address each and every injection on its own according to the sequence suggested by the template for the TOC solution. For every injection we collect and present the necessary knowledge to ensure the understanding of what is the injection and how are we going to implement it.

The **WHAT** is taken from the U-shape and it covers the essence of the injection itself, the major UDE(s) it addresses, the DE – the Desired Effects – the positive outcome of the existence of the injection in the system, the logic of closing the performance gaps and eventually the improved performance.

The **HOW** contains all the practical aspects of the implementation. It deals with the technical parts and also suggested ways to overcome obstacles – both technical and behavior. The necessary deliverables (I.O. – Intermediate Objectives) are suggested based on experience of implementing injections in reality. The tasks to be performed to achieve these IOs help to transfer the know-how, so practitioners do not need to reinvent the wheel. The end result of the How part is a mini-project that contains the skeleton of the activities and deliverables of the implementation of the injection.

The WHAT and the HOW are captured by the full "injection flower".

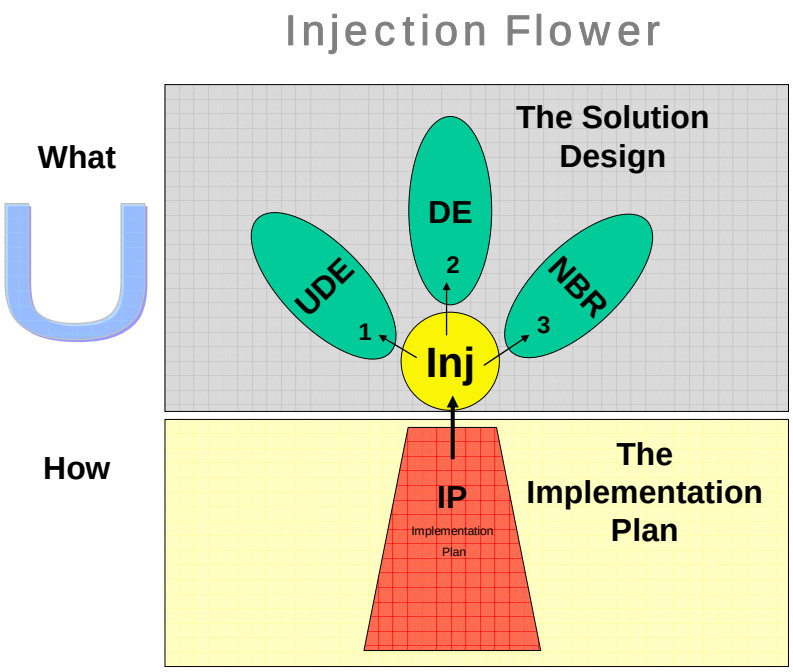


Figure 9: The injection flower

The suggestion to deal with one injection at a time constructs a **modular** implementation process with a mechanism to capture all the relevant knowledge, experience and know-how associated with the injection. Every injection is developed and implemented as a module on its own. This is a base for databank that can grow and incorporate the experience while the project is in progress. This is also a good mechanism to share the experience with the entire TOC community.

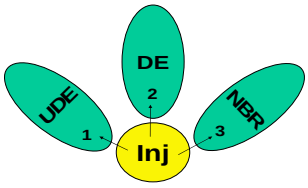
Let's take injection number one to demonstrate the use of the injection flower for the implementation of CCPM.

Injection 1: Customer orders are the Drum

What – The knowledge associated with the injection

This section of the Injection module contains the following parts of knowledge:

- The essence of the injection
- The Current reality – the relevant UDEs and their impact on the gap
- The Future reality – the DE – the positive outcomes of the injection
- Potential NBR – potential negative outcomes of the injections and the suggested way to prevent them form happening



Injection 1 - The essence of the injection

The injection is about setting up the proper mindset within the project environment to support the strategy of delivering projects OTIFWB – on time, in full scope and within budget. The mindset is about accepting that Customers Orders are the prime driver for managing projects and dictate the project planning and the control of the execution. The project leaders, the team members and the officers of the company have to consider the three above measurements – when making decisions that influence the projects.

The analysis of the project environment shows vividly that the major reasons for going over budget and the unavoidable decisions to cut in the specifications and the original promises of the project is due to lateness in the progress of the project. Because of this – managing the project lead time to meet the promised completion date (Due Date) is critical.

Measurements have significant impact on the way people operate and behave. That is why we have to adopt the measurements to fit the new paradigm. The new measurement has to reflect what is important – on time delivery.

When we start the TOC implementation not too many project finish on time – actually, very few of them. The Company has to establish reliability in the market place by ensuring on-time delivery of the existing open projects. As we progress with the implementation of the TOC solution more and more projects have to be completed and delivered on time. In the transition fewer and fewer projects are late and for less time.

The new measurement has to highlight the projects **that are late** and **reflect their level of lateness**. The lateness of projects has two aspects – the value of the late project and the number of days it is late. The new measurement is called T$D or TDD – **Throughput Dollar Days -** it calculates the depth of lateness of every project which is not on time.

When we sum the T$D for all the late projects we can provide top management with the overall picture of the performance of the entire project environment. The objective is to promote managerial decisions and actions that will cause the overall lateness to drop – ideally, be close to zero.

Measurements are also expected to provide a bridge between the local actions and decisions and the global performance of the system. Any action or decision that will cause the T$D to drop, is having a good impact of the performance of the entire company.

In figure 10 there is an example of an implementation of T$D and the evolution over a period of 36 weeks. Form the graph it can be seen that management has taken correct actions that eventually caused the completion of projects with very high T$D. It shows also that "Murphy" still exists and projects may face problems that are not easily solved. In weeks 22-23 we see a jump in the T$D. This can be due to one or two major reasons. First – projects that were a bit late were not delivered and hence their T$D went up. Another reason can be that projects that were due to finish became late. Nevertheless – the overall progress is impressive.

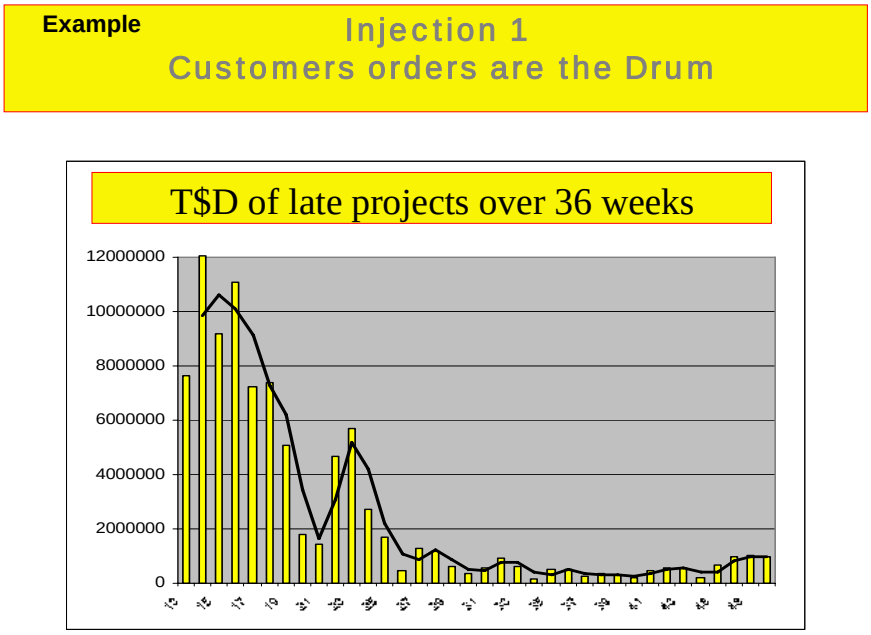


Figure 10: Example of evolution of T$D over 36 weeks

Calculating T$D.

For example – an IT service company has 20 to 30 open projects at any given time. Project durations range from 10 to 50 days. Among the **late** projects there are two that we want to measure: project "A" is for $50K and is already 10 days late and project "B" is for $150K and is 20 days late.

T$D for project "A" is $50Kx10 = 500K $days,
for project "B" is $150Kx20 = 3M $days
Total for the two projects is 3.5M$days.

The actual number is not important. Many times people are thrown by the actual figures thinking that the company loses millions of Dollars. Therefore – it is recommended to normalize the T$D numbers and to divide the resulting T$D summation by power of 10 to bring the value to be between 0-100 or 0-1000. In the

example of figure 10 we can divide the value by 10,000 and get the range between 0 to 1200.

When the injection is in place management is using the T$D to monitor the overall situation of the project environment. They can see the progress that is achieved by the implementation of the other injections of the solution.

The Current reality – the relevant UDEs and their impact on the gap

The typical UDEs that are addressed by this injection

1. We have too many cost overruns against budget
2. Existing projects are disrupted by 'extra work'
3. Many projects take longer than expected
4. We often struggle to hit intermediate deadlines
5. Revisions for late changes to the scope hold us up
6. Top management is under pressure to add more resources

Injection 1 is relevant to all of these UDEs. The most important contribution of the T$D measurement is the ability to see the impact of each one of these UDEs on the performance of the system. When the T$D report is in place the project manager can bring to the top management different alternatives for handling project problems with their corresponding impact on the T$D. With T$D top management can make better decisions on allocating resources and funds.

Later on – when the injection is functioning and project managers take corrective actions to speed up the completion of critical projects – the level of severity of these UDEs is getting reduced until they become non-issues.

We use the CRS – Current Reality Study to establish that the current situation of the specific area we address fits the generic environment in which the injections will operate well.

Current Reality (questions to be asked to validate the UDEs)

- **Current on-time delivery** – How many projects are delivered on time? What percentage? How many were delivered as per the ORIGINAL date requested by the customer?
- **Damage to the customer** – What are the difficulties that were caused to the customers (internal or external) due to the lateness of the projects?
- **Perception of the market** – How does the market perceive the company in terms of reliability performance? Does the company get new customers and how difficult is it to retain existing customers?
- **Damage to the company** – Are there any penalties associated with late deliveries? How much money has the company lost due to late delivery?
- **Expediting** – How many managerial efforts, negotiations and extra expenses are associated with trying to meet the project due dates?
- **Quality problems** - Because of constant pressure to rush the delaying projects are there situations by which quality or features are compromised?

The most important data to verify is the current level of on time delivery and the potential damage it causes to the customer. Once this is established we can be assured that the implementation of the injection will bring significant benefits to the project environment we address.

The first injection is a governing injection and due to that the investigations we have to make are more thorough and detailed.

The Future reality – the DE – the positive outcomes of the injection

When describing the future reality we portray the vision of how the environment will operate once the injection is fully implemented.

There is a technical procedure that calculates the T$D value for every late project. This procedure is run periodically but very frequently (once or twice a week). The results are distributed to all top management, project managers, resource managers and control room members. The reports provide also statistics on the source of the delay and the resources or departments that are holding up the projects at the time of the report is produced.

Usually, people do not like to see that they are causing difficulties to the company. They do not want to be the ones who are holding the projects with the highest T$D. Therefore, the human tendency is to take actions that remove this uneasiness. The only way to get rid of the burden of the high T$D is to complete that holding task in a proper way and according to the specs. So, when the person or department gets the late order with high T$D, they want to get rid of it and therefore give it priority and complete is as soon as possible. The project tasks are handled as "hot potatoes" that are moved quickly form one person to the next. By that we get a built-in automatic self-expediting mechanism that causes the late projects to be completed quicker than before without the need for external expediting.

We expect top management to behave and manage in accordance with the T$D. They have to use every opportunity to check the status of the project in terms of its progress, probe into late projects, suggest help when needed and endorse proper behavior of expediting high T$D projects. Consistency is critical for such a change.

Based on the above vision we can expect the following **positive outcomes**:

- Established reliability by on-time delivery of projects
- Improved focus due to clear measurement of the magnitude of lateness of projects
- Improved project planning and execution control by knowing the status and the position of every project
- Less need to expedite
- More stability of the process
- Increased profitability
- Improved communication with customers, clearer and more reliable information about the progress
- Potentially more sales

Please note that even though we record the above positive outcomes as directly linked to the injection - the injection on itself is not enough to achieve these outcomes and we will need to implement other injections in order to establish these results. However, injection 1 is instrumental and significant in achieving the results.

Potential NBR – potential negative outcomes of the injections and the suggested way to prevent them form happening

NBR – Negative Branch Reservation - is sometimes a confusing concept of TOC. The official definition of the NBR is 'negative outcomes that may appear due to the injection AFTER the successful implementation of the injection'. If the negative situation occurs while implementing the injection and blocks the implementation of the injection it is an **obstacle** and not an NBR.

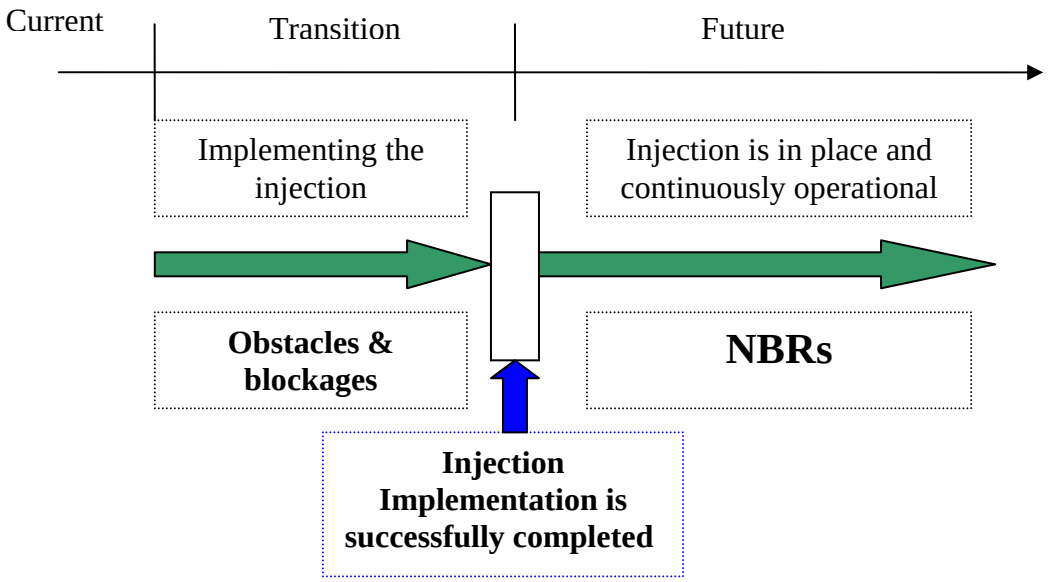


Figure 11:The timeline of implementation of an injection

An injection is an entity that we put in reality and is continuous in time. It is expected to keep on pumping a new life into the reality. We can imagine the future reality as a hot air balloon. The current reality is that the balloon is on the ground. Once we inject hot air it can float and fly up. However, if we stop pumping in hot air the air inside the balloon will get cold and the balloon will come down. So – the hot air is the injection.

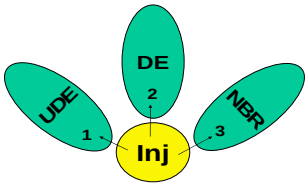
The injection is successfully implemented when the T$D reports are produced, project managers use them and top management use them. Thereafter, we can experience the NBRs.

Potential NBR - Even though the injection is critical for the well being and the growth of the company – it can happen that managers and employees may lose their intuition about the new reality (after the implementation) and may drop important issues that they pay attention to today. The Current reality is run be PMB – Policies,

Measurements and Behaviors. It may be risky to lose what has been developed over the years.

Suggestion: Listen to the people and record any concern that is dealing with the PMB. Carefully examine the formal and the informal communication regarding the performance of the projects. Many companies have KPI – Key Performance Indicators. Some have even a daily Scorecard. Find them and gradually move them to fit the market lead mind-set.

Re-enforcement of Injection 1 is critical!



By now we have completed the injection knowledge

HOW – the mini-project to implement the injection

This section on HOW TO IMPLEMENT the injection contains the deliverables, the tasks and the implementation plan.

Deliverables – are major milestones in the implementation of the injection. They are tangible and can be measured. In the plan to implement the injection they are the intermediate objectives – marking the steps towards the completion of the implementation.

T$D report is available weekly

- T$D – Throughput Dollar Days - collection and analysis are established for measuring reliability of the company in DDP – Due Date Performance - and for monitoring the progress of the change implementation.
- T$D is displayed in key areas for all employees to see the current status and the progress made.

T$D report is available weekly and is formally used

- T$D is regularly used by the entire management team.

T$D report is fully integrated with the project management execution control

- Project managers accept the mindset that MEETING the customer due date is the MOST important measurement they should work for.
- T$D has become the tool for relationship between Project management, Top management and Sales.

Tasks – are all the activities that are needed to be taken by the project team in order to achieve the deliverables. They are actions, performed by resources and can be estimated for the time duration to completing them.

Deliverable - T$D report is available weekly

Task 1. Global awareness

- Make necessary changes to the project control so that it ensures that the current system (computerized or manual) clearly shows the customer due dates in all internal reports.

Task 2. Report Structure

- Learn the structure of the T$D report
- Develop analysis of the lateness with relevant statistics
- Provide weekly reports
- Provide analysis over time to evaluate the trend (it is a measurement)
- Develop a report with the data on how many projects are open – get the DD, value of the project and any additional data that is relevant for the reports (such as department, resource, supplier etc.)

Task 3. Data collection – computerized

- Develop the procedures to collect the relevant data from the IS (open projects that are late, their value, the promised DD, project type, etc.)
- Record the data on the agreed excel file for T$D

Task 4. Investigation

- When a project is late – detect where the project is held and record the location at the moment and the major reason. Produce pie charts
- If more than one resource, department or location is holding the project – when it is significant we may double record for both locations
- Provide the ability to probe into specific projects to ensure that the situation is under control while identifying the person that is in charge of sorting out the issue

Deliverable - T$D report is available weekly and is formally used

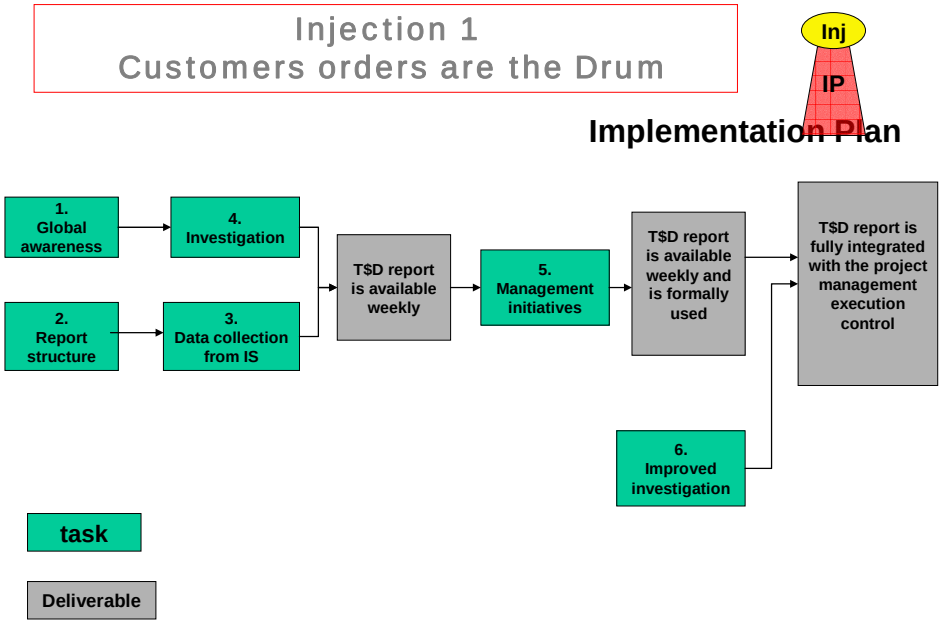
Task 5. Management Initiatives

- Develop the mechanism of assigning and passing T$D from one resource to another as per the planned flow
    - Create a special taskforce of 6-8 people including top management, representatives of project managers and heads of functions (resource managers). This team meets regularly (at least once a week) and identifies problematic areas that need special managerial attention and support. Prior to the meeting the T$D reports and analysis is produced and disseminated to all participants.
    - T$D is used for global management to close the gap with the late open projects. We ensure that all top management get regularly the T$D reports and analysis. We urge them to refer to these reports in their regular executives meeting. It is recommended that the chairman of the T$D taskforce gives report on the work that is done by the taskforce.

Deliverable - T$D report is fully integrated with the project management execution control

Task 6. After Buffer Management injection is in place – provide the ability to probe into the situation through the Link to the Action log.

Implementation plan – is a dependency diagram that presents the connections between the tasks. The dependency denotes that a task cannot start before the completion of the previous task. If no connection exists between the tasks – they can be performed in parallel.



With that we have concluded the plan for the mini-project for implementing the injection. We repeat the injection implementation process – the WHAT and the HOW for each one of the injections in the template. We end up with 12 mini-project plans. We integrate them together deciding on the sequence. The consolidated plan can be coded into project plan software such as MS-Projects. The TOC implementation project should be managed the TOC Way. We must "Walk our Talk". We should set an example for the use of CCPM for our own projects.

Before we start a TOC journey with a company… (Personal suggestion)

If you have reached this point in the article it indicates that you are serious about learning more about TOC and wanting to implement some of its solutions. Here are some of my views regarding basic conditions that can determine the success of a TOC implementation.

Implementing TOC is not just another consulting or managerial job. When successful – the level of personal professional satisfaction is very high. But, it is also hard work! So, before you start this journey I suggest you check that you have the right partner for this project.

It does not matter if you are the boss or you are a consultant with proven track record, not every environment is conducive for change (any) and especially not for TOC.

How to check compatibility or readiness for TOC?

TOC is a method of system thinking. System thinking can be valuable for managers who want to improve. Being a manager is an opportunity and can be considered as a professional gift. Many times the personal career starts with acquiring a profession (engineering, finance, marketing etc.), practicing it and naturally progressing to managerial positions. Usually, the job promotion is associated with good performance and attitude of the individual that is well appreciated by the company. As such managers will adopt the fundamental attitude of wanting their "kingdom" to be run well within the expectations of the profession and the organization.

Therefore, we establish the following statement:

The role of a manager is to ever improve the performance of the system under their responsibility

This helps us to establish a common ground for the joint venture - the TOC Journey. We, the TOC scholars, have a lot of knowledge and experience in developing solutions and implementing them. The managers have the desire to improve and the opportunity – as they are in charge of their systems. We will need to remind the managers of their commitment to ever improve – especially when reaching low point in the implementation project that demand leadership, efforts and energy.

Improving systems performance needs a blend of three ingredients:

1. A good relevant solution – a solution that is applicable for the specific situation of the system
2. Leader and leadership – to point the direction and to pave the way for the others to be able to move in the new direction
3. Supportive culture – to provide proper subordination to the set direction and for actively participating and contributing in making the vision a reality

The design of the solution is the responsibility of the TOC practitioner. The other two elements are a part of the culture of the "family" (or a tribe) that we are getting into. I highly recommend ensuring that our TOC job is in line with leadership and the culture. Past experience has demonstrated to us that in the cases that we were caught between the leader and the culture – we could not successfully complete the implementation.

My recommendation is to find a mechanism to detect when there is a mismatch between the TOC solution and the leader or between the TOC solution and the culture. You should conduct the CRS – current reality study and personal interviews for this process. If you find such a mismatch you better shy away from a project to implement TOC. Trying to push the project against the leader or the culture will probably not work and you will be hurt and disillusioned.

Conclusion

Embarking on TOC is a personal choice. My view is that – TOC you do seriously or you do not do at all. The strength of TOC is its knowledge and the methodology for understanding and developing new knowledge. The processes suggested in this article are quite demanding in terms of the amount of personal preparatory work that the TOC practitioner is expected to do.

I hope that the U-shape helps you to arrange the relevant knowledge on any subject you want to deal with and for every level of depth you elect to go. The modular approach suggesting the development of the entire project plan one injection after another has potential to ease the work with the implementation team. Our recent experience shows that through the modular approach we can focus the attention of the internal project team throughout the workshop for developing the implementation plan and transfer the ownership to them. We can cover 2-3 injections per day (in 4-5 hours session per day) and use the last day for consolidating the mini-project into the full project plan, assigning responsibilities and agreeing on task durations.

Finally, this structure can accumulate knowledge, know-how and experience of the TOC practitioners implementing the injections in reality. I will welcome any feedback, suggestions and expansion to this article and I will incorporate them in my next revisions or next articles. Please write to me on oded@goldratt.co.uk with the key word in the subject: the U-shape article.

The real joy in working with TOC is – Making it happen. It comes when you can see that the injection is live and kicking in the system and the people are happy to testify that the injection has brought them real benefits – proving the Future Reality Tree (FRT) is valid!