Theory of Constraints
And
Thinking Processes
In Academia

Preprint

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PREFACE –

Thinking is fundamental to being human. The Theory of Constraints (TOC) has Thinking Process (TP) tools to help people think systematically about how to manage real life constraints. A constraint is something that stands in the way of achieving a goal. The tools used are based on logic. They are simple enough to be used by kindergarten children for modifying their own behavior and sophisticated enough to be used by CEOs to bring their corporations out of bankruptcy.

This text is especially intended for the higher education community - students, parents, mentors, educators, counselors, administrators or anyone interested in the Process of Ongoing Improvement. It purposely includes all these audiences since they form components of the “Student Success” system. It is designed to teach methods for conflict resolution, decision making and problem solving using TOC’s powerful logic-based graphical Thinking Process tools. These tools may be applied rigorously to a course content issue, a personal issue, an interpersonal issue, a departmental issue or an institutional issue. The tools can be used to find win-win solutions for conflicts without compromise or loss for any party. In writing this book, we also hope to encourage open communication between practitioners of TOC around the world.

It is very troubling to see so many young men and women leave school and settle for less than what they are truly capable of accomplishing in their lives. This work is the result of several years of research on implementing the Theory of Constraints (TOC) by two faculty members in an urban undergraduate college, who share the common goal (Ambitious Target) of wanting to stem the tide of student attrition. The authors are aware that this goal cannot be achieved by only one or two people working together, but can be accomplished easily when the entire institution participates in the effort. They feel fortunate that they work in an institution where everyone shares this goal. They know that high attrition is due to many factors, and is not unique to their college. Attrition is common to many public undergraduate institutions around the country and around the world. It is the authors’ belief that their initiative will be replicable in many other institutions that are also struggling to improve retention and graduation rates.

Many educators do not know what to do when their best curriculum developments and well-funded enrichment programs do not vastly improve retention. Their reaction is to blame the secondary schools for social promotion. They blame the distracting TV, the Internet, cell phones, social networking, I-pods, I-phones and I-pads. They blame the social structure, or community, or someone else. If such programs do succeed, they are local in the sense that they depend on the personality of the initiator, and do not apply globally to the institution. The first thing we learn in Theory of Constraints is not to blame anyone, except perhaps “Murphy’s law,” and to provide for it. TOC has a unique way of bringing in both the student’s personal and academic needs, not just his/her academic needs. TOC establishes communication between various stakeholders so that they can work as a unit to address the problem at hand. In that sense, TOC also stands for Theory of Communication!
TOC asks three basic questions: 1. What to change? 2. What to change to? 3. How to cause the change? TOC considers the issues of all stakeholders – students, faculty, administration, family, and community. Each stakeholder focuses on his/her area of direct control or influence. This means that the President’s issues are different from student’s issues. Regardless of who is addressing the problem, TOC has the same logical Thinking Process (TP) tools. In other words, the same TP tools can be used to solve institutional -- academic or non-academic-- as well as personal problems. Since the tools are logical, they transcend the personalities involved. Anyone considering the same issues, and having an intuition about them and following the TOC roadmap will come up with equivalent solutions. Once mastered, TOC becomes a part of the learner’s general approach toward resolving any conflict with a win-win solution, solving problems systematically, and making long term decisions that do not lead to negative consequences. TOC yields insight into any problem situation. Using TOC and their professional expertise, counselors, faculty or administrators can resolve the problem in a more organized and cohesive manner instead of wasting resources on isolated efforts or duplication.

Our experiment with using TOC to address attrition in mathematics courses began in January, 2002. Darius Movasseghi, then Chair, Joshua Berenbom and the first author, all faculty in the Department of Mathematics, Medgar Evers College (MEC), participated in formal Jonah training at the Avraham Goldratt Institute (AGI) Academy, New Haven, CT. Tracey Burton-Houle and Steve Simpliciano were the facilitators. The training was funded by an institutional grant for 2001-2004 from the Minority Science Engineering Improvement Program (MSEIP) of the U.S. Department of Education. The attendees used the entire TOC Roadmap (described on the last page of the fourth chapter of this textbook) during a two week intensive workshop to develop a detailed project plan for the Mathematics Department. Their findings were discussed informally by the Chair with other faculty in the Department, devoting a few minutes in every monthly departmental meeting during the Spring, 2002, semester. As the major issues of the Department were brought out and discussed in the open, a congenial environment developed in the Department that attracted a large number of students to become mathematics majors. The Department developed new curricula and improvements in mathematics tutoring. They developed Departmental Guidelines that helped all faculty and support personnel work towards student retention.

TOC analysis addressed the needs of the “whole” student, not just his/her academic needs. The project plan showed how and where the academic advisors, personal counselors and the Basic Skills Department could participate with the Department of Mathematics to address the problem of attrition. The facilitator, Steve Simpliciano, made a presentation to the College President, Edison O. Jackson, and his key cabinet members in May, 2005, about what the team had learned, and offered the Departmental Guidelines as a deliverable. President Jackson approved the guidelines and expressed his desire that everyone in the College should learn TOC, starting with the Basic Skills and Freshman Year Program faculty. Two additional institutional Federal grants (MSEIP 2004-2007 and Women’s Equity in Education Act (WEEA) 2005-2007) facilitated the formal Management Skills Workshop (MSW) training at AGI of key
individuals and more faculty. The grants also provided resources to hold various campus workshops for tutors, academic advisors, personal counselors and Basic Skills instructors from 2005 to 2007. In the Spring, 2008, semester, President Jackson himself, along with his senior administration, reaffirmed his commitment to implement TOC to address institutional issues. He laid out a logical procedure that transcends personalities for all administrators and middle management to follow in order to tackle the problem of student attrition as Freshman students move into their academic disciplines.¹

Among the faculty receiving the formal TOC Management Skills Workshop in December, 2005 – January, 2006, was Nancy Oley, the second author. Actually, as early as 1999 she encouraged the first author in applying TOC to the problem of student attrition. After formal training, she has supported all TOC workshops in the college and made several presentations at conferences. She started using TOC from January, 2006, in faculty development workshops, in her Faculty Senate activities, and in her courses in Psychology. She has already applied more TOC tools than anyone else in the College. She is the leader in implementing TOC within content areas in an academic discipline. She has helped to develop and edit the TOC in Academia website under construction. She has edited and contributed to the current textbook. Dr. Oley received the TOCICO Jonah certificate after completion of the online course EM 526 Constraints Management offered at Washington State University at the end of Spring, 2008.

TOC empowers a person to lead a successful life without compromising personal needs or studies. This textbook is the only available textbook at present at the college level that can be used for a systematic study of TOC and its application to students’ chosen major or discipline. It can be used by a Freshman Year Program to empower the student to resolve conflicts, make decisions and solve problems. If a TOC course is taught by a team of academic advisors and academic instructors in different disciplines using examples of TOC in content areas, the freshman student has an opportunity to interact with both the faculty in his/her chosen major and his/her academic advisors. Hopefully, this will increase student’s motivation to continue on in their chosen major.

The textbook has five chapters. Chapter 1 is the overview of TOC and its thinking process (TP) tools and explains the importance of studying TOC. Chapter 2 answers the question “What to change?” using mainly the Evaporating Cloud to resolve various types of conflicts. Some clouds show students how to resolve daily conflicts. If students solve a conflict a day, they will quickly learn how to come to win-win solutions in their lives. Some clouds resolve chronic conflicts. Some clouds empower students. The Current Reality Tree (CRT), an example of a Cause and Effect Tree, is introduced, to develop a holistic picture of the person’s or institution’s current situation. The Evaporating Cloud and the Current Reality Tree together answer the question:

¹ These efforts have received another boost from two grants of MSEIP – Institutional and Cooperative for 2010-2013-- thanks to the reviewers and program officers of US Department of Education. The authors also acknowledge the support of colleagues at MEC and Queensborough CC from the Mathematics Department, Freshman Year Program, Counseling and SEEK Departments, and encouragement from the administration, especially the new MEC President, Dr. William Pollard, and Provost, Dr. Howard Johnson.
“What to change?” completely. Chapter 3 answers the question “What to change to?” It teaches cause and effect relationships through which students can see the likely consequences of their actions. They are introduced to Negative Branch Reservations (NBR), the Future Reality Tree (FRT) and the Transition Tree (TrT) as additional examples of Cause and Effect Trees. The Future Reality Tree and Negative Branch Resolution answer the question “What to change to?” completely and show how to avoid negative consequences of the strategies suggested. Chapter 4 introduces the Prerequisite Tree to answer the question “How to cause the change.” It describes how to uncover the often hidden obstacles that are in the way of achieving goals, and shows how to prepare project plans. There are several appendices on everything one needs to know about achieving academic success, critical chain project management of a course, how to study any course, and why and how to study mathematics. This should help students to take responsibility and use the college resources to achieve their goals and not settle for anything less. Chapter 5 can be used for solving institutional problems using the five focusing steps of TOC. One major example continues throughout the five chapters showing the systematic logical link.

The Theory of Constraints (TOC) was developed by Eli Goldratt around 1980. TOC has an established track record in industry and the school systems of Singapore, Malaysia and the Philippines. It is also used in Asia, Europe, Africa, and South America for instruction and community work. In Singapore, TOC is used to produce “paradigm change” in prisoners: TOC changes the way the prisoners think about themselves so that a high percentage do not return to prison and live a productive life in society. Fifteen percent of the world’s businesses currently use TOC for their operations. TOC is also taught as a required subject in most business schools’ MBA programs. In most academic institutions, TOC is taught as only an academic subject. But there are several well known business schools that use TOC or constraints management for all their operations. Medgar Evers College where the authors work is the first and only liberal arts college where administration, faculty, staff and students showed willingness to apply TOC to address the problem of student attrition. It is well on its way to a systemic resolution of the problem.

The authors acknowledge the collaboration and support of their colleagues, especially Darius Movasseghi and Joshua Berenbom. Quite a few figures in the textbook are from the joint work of the authors with them at AGI. It was Darius who took the leadership to promote TOC in the Department and participated in many international presentations. They also received constant encouragement and support from President Jackson. The authors offer their thanks to all at Medgar Evers College for their continued support.

Many facilitators were responsible for providing the TOC training in various workshops: Howard Meeks of Iowa State University; Kathy Suerken, President of TOC for Education, Inc.; Belinda Small of the Florida School system; Danilo Sirias of Saginaw Valley State University Michigan; and Janice Cerveny of Florida Atlantic University, Port St. Lucie, Florida. Many advisors, counselors, tutors and faculty participated in these workshops. We thank them for their support. Alan Barnard of Goldratt Research, South Africa, made an important theoretical
presentation in TOCfE 10th International Conference, Florida in 2007. Some slides from his presentation are included in the textbook. James Holt offered an online Constraints Management course (EM 526) from Washington State University, Vancouver, WA, free of charge to academics, which triggered a flurry of TOC activity around the college, including Presidential retreats to complete the homework of the course. Many screens from the various workshops for Medgar Evers College are included in the textbook with the facilitators' permission. The authors are indebted to them. The first author worked with Eva Chan, Director of The Office of Institutional Research, and Janice Cerveny to develop feasible numerical measures for Throughput and Return on Investment in Academia discussed in Chapter Five. These are important measures and not just the number of graduates. Thanks to Eva Chan and Janice Cerveny.

Tracey Burton-Houle and Steve Simpliciano were instrumental in covering the TOC roadmap by assigning a lot of homework in the Jonah course in January, 2002. The project plan developed at that time is still unfolding systematically, which indicates the robust nature of TOC solutions. Steve Simpliciano introduced TOC free of charge to the first author in 2000, and facilitated the development of the Current Reality Tree (CRT) that matched the CRT developed in the Jonah program. Thanks to Tracey and Steve for getting TOC started at MEC. The websites www.TOCICO.org and www.TOCforEducation.com, International Conferences and TACTICS newsletter edited by Alan McTavish of the TOCforEducation have been very useful for dissemination and communication of our research worldwide to TOC practitioners in Education, the Community and in Prisons. Many educators from the U.S. and abroad have been encouraging the authors to write a book for educators in higher education. The authors are grateful to all the people who made these opportunities available and the conference audiences. They are especially grateful to Howard Meeks and Choi Wonjoon of South Korea who provided detailed improvements in the text. The contribution of Chuck Gauthier of Vancouver, WA, toward improving the TP tools discussions was invaluable.

The authors express their gratitude to late Eli Goldratt for discovering TOC and for encouraging us by saying that we are doing important work for the College. We are sorry that he could not see this book...

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CHAPTER 1 - OVERVIEW OF THE BOOK

1.1 Reasons for writing this book
1.1.1 The College as a System
The College/University is a complex dynamic system with multiple stakeholders, multiple components and multiple processes focused on a single goal: student success. Each institution is deeply committed to attracting students to its campus, educating the enrolled students, retaining a maximum number of them in various disciplines so that they progress towards their graduation in a timely fashion, graduating them with good grades and a degree, and placing them in careers in industries or graduate/postdoctoral programs in good schools. Each College wishes to have industries and graduate/professional schools come searching for their graduates. But does each institution reach its goal?

There are many obstacles that the multiple components of the System find in the way of reaching their goals. Each component tries to do its own best with the resources available. For example, the Faculty Senate of our college, in a sincere effort to stem its attrition problem, came up with over thirty concerns of students that needed to be addressed. Collectively the members found that many students have non-academic as well as academic issues. To address each issue they proposed a remedial action and the corresponding agency/department in the college to take appropriate action. But who can oversee such a massive effort? Who can tell the department/agency that something needs to be improved? Is there a duplication of effort? Are there enough resources to address all the concerns? Who will assess the improvements made?

The academic departments of a college are not equipped to handle students’ non-academic issues. They can only put all their resources into making the curriculum world-class in terms of process and content of instruction. They can form an articulation with other academic institutions and industries to recruit or place their students appropriately. The Dean of students, counselors and advisors are specialized in their own functions and can address students’ non-academic issues, once the students come to see them. It is the instructor with knowledge of the functions of various resources at the college who can direct the students needing help to the correct place. If the students are aware of these resources, they can themselves approach the agency that can help them in their non-academic or academic need. But most instructors, especially adjuncts, do not know what resources the college has to help their students outside of their own department or school. They have an obligation to finish the course syllabus and do not have the interest, time or expertise to deal with students’ non-academic issues. Our College and University policies do not require students to attend class or come on time. The instructor therefore does not have to take attendance, and may not be aware of students’ absences or, if aware, can complain but cannot do anything about it. Since each student pays approximately five thousand dollars in fees per year, if 100 students do not return to the college the following year, the college loses $500,000 by not graduating these students. Can anything be done about this typical scenario?
The Theory of Constraints (TOC), properly implemented, establishes the communication necessary among the stakeholders in the system. Each stakeholder becomes a link in the chain, doing its part “thinking globally and acting locally,” and not working in a “silo.” Using TOC we can find the core issue underlying myriads of academic and non-academic issues. We can see how the issues are logically connected with the core issue, and thus know what needs to be changed. TOC tools show what we should change to, and how we can cause the change, all in a very systematic manner.

A typical college system has a hierarchical organizational chart. Credit for the following figures goes to Janice Cerveny [MEC workshop, Spring, 2007]

Figure 1.1 Partial Organizational Chart
In Figure 1.2, the actions/entities in the lower two lines are conflicts, indicated by a double-ended arrow. In the first silo, note that to establish a program takes a considerable amount of time and many resources to run the program. But there is also a push from the faculty or administrators to launch the program as quickly as possible. This causes a conflict in terms of the agenda of the two sets of stakeholders. Similarly, actions taken by those working in other silos lead to conflicts. TOC resolves these and other such conflicts by looking at the educational institution as a system. The word UDE, pronounced “oo’dee,” stands for UnDesirable Effect, defined later in the chapter.
Figure 1.3 Colleges and Universities from a systems point of view

In Figure 1.3 Throughput is the number of graduating students, while the steps in processing form the throughput chain.

1.1.2 Members of the community at all levels bemoan the failures of the “system” to perform at its best.

1.1.2.1 Students of mathematics, for example, complain that...

1. I cannot follow the lecture.
2. I feel I am not capable of doing mathematics.
3. I do not work hard in mathematics.
4. I don’t do the homework/or prepare for the course.
5. I do poorly on tests.
6. I feel that the exam is too hard.
7. I have difficulty learning the material (in math classes).
8. I have difficulty taking tests.
9. I do not attend my mathematics classes regularly.
10. The instructor moves too fast for students.
11. The instructor cannot teach his/her subject matter.
12. I am not prepared for course (prerequisites for class).
13. I don’t have time to do the homework.
14. I don’t see importance/relevance of mathematics.
15. I am unable to attend class on time.
16. I have to take care of my family/personal problems.
17. The instructor does not care about me.
18. There isn’t help outside of class when I’m free.
1.1.2.2 Faculty complain that …
1. Students do not prepare for class.
2. Students don’t attend regularly or on time.
3. Students do poorly on tests.
4. There is not sufficient time to cover all material in the course.
5. Students register late for semester. (They don’t start at the beginning of the semester.)
6. Students do not have prerequisites for class.
7. Students aren’t learning effectively.
8. I receive very little satisfaction from my work.
9. We feel pressure to pass students who are not adequately prepared for the next course.
10. Students haven’t mastered all the prerequisite topics needed for my course.

1.1.2.3 Staff/counselors/advisors complain that...
1. Students do not keep the area clean.
2. Administrators do not respect me.
3. The non-academic challenges of students are often not addressed.
4. The difference between an academic advisor and a counselor is not known.
5. More and more students have mental health challenges.
6. There are many turf wars.
7. Students don’t see connections.
8. The student services department experiences many disruptions.
9. Students come to school hungry (no food, transportation, etc.)
10. College faculty are dismissive of students’ personal issues.
11. Students who identify as LGBT are victimized.
12. Part-time faculty often do not attend to students’ needs.
13. Some students fall between the cracks (Freshman seminar is not required of all students.)
14. There is a large dropout rate in science classes.
15. There is inconsistency of outcomes from Freshman classes.
16. Staff morale is low.

1.1.2.4 Administrators complain….
1. There is a lack of cooperation by some faculty to carry out departmental agenda.
2. Too many students fail.
3. There is insufficient input by some faculty to address major departmental issues.
4. Some faculty are apathetic.
   More concerns can be added. But the reader will get the point that the “system” of a College/University needs a lot of improvement to perform at its best.

1.2 Who this book is intended for
1.2.1 This book is written for professionals working in the college/university environment who desire to fully understand their environment and to improve it, i.e., faculty, counselors, advisors, staff, administrators. Students and people who have worked with students and who have experienced the issues listed earlier can use this book. Parts of
the book where individual tools are discussed are also useful for students, parents, community workers, youth counselors, male initiatives, churches and people trying to reform jails. A companion preliminary website www.tocia.com is being constructed and will be launched sometime in July, 2011, and a less formal version of the text is available on the website.

1.2.2 Some of the concerns of academics might be how to: develop courses and curricula; help students resolve their personal conflicts and make good decisions; present material in class; improve processes like registration; improve morale; and improve the overall functioning of units such as departments, programs, etc.

1.2.3 A Reference book
This book is intended as a reference for those seeking to understand and apply TOC and TP to the academic world. Most TOC texts are designed for management and industrial settings and do not have any direct application to academia. We discuss individual Thinking Process tools and show how to apply them in a variety of situations ranging from personal life issues to overcoming departmental and institutional constraints.

1.2.4 What this book is NOT intended for
This book will not be of any use to the people who want to make ad-hoc decisions. Studying TOC makes one aware of the consequences of any action, and ad-hoc decisions many times result in unintended consequences. This book is useless for the people who make systemic decisions to serve their personal interests; these decisions often times prove detrimental to the system. If they have no interest in the common good of the system, this book is not intended for them. TOC is ethical and will not harm anyone. If a person is looking for a biased solution, TOC will be useless, since TOC produces win-win impartial solutions and will not favor anyone.

1.3 Defining and solving a problem
Before beginning to solve a problem, it is necessary to define the problem. Ask yourself, “What is my problem? What is the issue? What action taken causes the UnDesirable Effect that bothers me?”

“Define a problem precisely and you are half way to a solution.” --Dr. Eli Goldratt, Founder of TOC

Is every issue a problem? No. It is a symptom that indicates that there is a problem. By treating symptoms alone, you cannot solve the problem. The problem arises when there is a conflict. It is the conflict that gives rise to issues/concerns. Therefore the problem needs to be defined as a conflict. A discussion of the conflict leads to a definition of the problem.

The set of concerns stated in 1.1.2 are effects or symptoms of some causes that need to be addressed. A cause leads to a conflict which defines the underlying problem. But is it necessary to find a cause for every concern? No. The experience of people who have worked in
TOC indicates that just three important concerns from diverse areas in the list are enough to find the basic or core conflict and the real problem. Eli Goldratt, in conversation with the first author, gave credit for this observation to Efrik Goldratt, his daughter, and Dale Houle of Avraham Goldratt Institute, who independently noticed that one comes to the same root cause regardless of how many concerns one considers, and that a minimum of three concerns should be considered. The second chapter is all about how to define the problem, or what we need to change (“what to change”).

We first review the way the concerns are stated in 1.1.2. Each concern is called an UDE or UnDesirable Effect.

**Definition of an UDE**

An UDE should be serious, be a condition not a lack of an activity, not blame anyone, happen frequently, have a serious negative outcome, [and] not incorporate the solution within the statement. - TOCICO² Thinking Process Committee, Nov, 2007

Each concern is a simple statement without any connectives such as “or”, “but”, “and”, “if-then”, etc. It should never blame anyone, explicitly or implicitly! It is often very common. For example, when the first author presented his research at an international TOC for Education conference in Leon, Mexico, in September, 2007, one of the professors from Pueblo, Mexico said, “I thought you were talking about our students!” The statement of a concern should not contain a solution to the problem at hand. An UDE is a condition, not an action. It does not describe any lack of activity. Each UDE has a serious consequence.

This and other such definitions come from the TOCICO dictionary, whose conventions we follow in the text. When a term is not defined in the dictionary we follow the usage of experts in TOC.

**1.3.3.1 Span of control**

Any improvement can only be made in the area of one’s control and/or in the area under one’s responsibility. One must start with the area of control, because rapid progress is possible in areas about which one has intuition and expertise. Occasionally some individuals are themselves involved in external constraint analysis involving, for example, such interdepartmental concerns as recruitment or placement in internships, jobs, or cooperative work with industries; or college wide committees, whose mission is to promote the welfare and interests of people in all areas of concern.

A student’s area of control is his/her attitude towards education, the number of courses the student takes, study habits, time management, balancing the time between study of various courses and personal tasks. Any immediate improvement in these areas will be reflected in the students’ grade point average. The student’s area of responsibility is communication with all

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the human resources that support his/her studies – family, fellow students, peer tutors, instructors and staff. Since there are only a few people involved in the student’s success system, once the student becomes proactive, progress can be very rapid.

For an instructor, curriculum development, delivery of curriculum, and working with students are under his/her control. Working with colleagues in the discipline; referring to tutors, counselors, advisors; and meeting various obligations determined by the Department and College are areas of responsibility.

The following diagram describes three areas where changes can be made.

![Diagram of areas of influence, responsibility, and control]

1.3.3.2 Sphere of influence
In order to make lasting progress in a department or institution, one must have buy-in from senior management. For example, once the Chair of the Department buys in, the Chair can then influence other people involved with the Department to bring about the change thought out by the instructors. An example follows.

First, the unique features of the College/University system need to be considered
In industry or government, a directive given by superiors is explicitly followed by subordinates.

In primary or secondary school, the Board of Education or Principal decides on new initiatives and teachers are expected to adopt them.

But at College level, no professor will change behavior or adopt new pedagogical strategies, however wonderful, by decree of the Department chair or a college administrator.

Considering union regulations and academic freedom, senior faculty do not feel obliged to accept any modifications in their normal activities and changes in the curriculum.

Any perceived activity extraneous to instruction is usually regarded as an impediment.

Thus, faculty acceptance of any new initiative is of paramount importance in a college setting.

After formal training, the key personnel followed the steps given in Figures 1.4.

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3 From a TOCICO International Conference 2007, Las Vegas, Nevada presentation by MEC. Credit: Darius Movaseghi
Figure 1.4 a, b  Example of buy-in.

Steps to Winning Acceptance

• Informally train Grant Team members who did not participate in formal training. (Spring 2002)
• Introduce issues (UDEs) & findings (DEs) informally to Department Faculty (Spring 2002)
• Prepare Departmental Guidelines & get Departmental consensus (Summer and Fall ’02)
• Have trainer, Dean Steve Simpliciano of Goldratt Institute, make a presentation to the College President and his cabinet (May 2005)
• Provide Management Skills Workshop (MSW) course for other grant personnel and directors of Freshman Year Program (FYP) and Post Secondary Readiness Center (PSRC) (Dec. 2005)

Steps to Acceptance (Contd.)

• Give TOC Workshop for tutors, counselors (April 2006)
• Give Refresher TOC Workshop for tutors (March 2007)
• Provide TOC Workshop for new FYP director and academic advisors, FYP counselors, Women’s Center counselors (April 2007)
• Develop a TOC course at Freshman level: Creative Thinkers Toolkit (2010-11).
• Conduct workshops to train advisors and counselors to teach the course and establish communication with academic faculty (July 2011)
• Mount TOC Website for college level audiences. (www.TOCIA.com) (July 2011)

Any initiative takes time to get established in a college, since there are so many people with academic freedom involved and there are many layers of resistance to change. But the people initiating changes should not give up.
As improvements are made in the area of control, recognition of this improvement leads to improvement in areas of responsibility. The area of influence also improves. For example, we wanted to stem student attrition, so we first directed all our efforts toward building an open environment by discussing various related concerns in the Department of Mathematics. Then we made improvements in curriculum content and process, tutorial services, assessment procedures, and use of technology-- whatever the Department had direct control over. There was a marked improvement in retention, but the Department could not go any further. With buy-in of the administration, the area of influence increased and the Department could then reach other departments that dealt with different aspects of student life. Finally, the College-wide effort could be launched to stem overall student attrition. The methods of TOC are so robust that the project plan made ten years ago is still viable and the Process Of OnGoing Improvement (POOGI) is a satisfying experience. The influence of the initiatives reaches a different dimension. The area of influence becomes the sphere of influence!

1.4 What is TOC, TP and why is it being used?

1.4.1 Theory of Constraints (TOC) and Thinking Processes (TP)

Theory of Constraints teaches how to identify and remove a constraint. A constraint is something that stands in the way of achieving a goal. But it is not just any obstacle! It is a special one, that when addressed, gives us leverage to achieve a goal.

Definition: A constraint is the most important factor in the organization (or personal life) that needs attention. Giving that attention, dedicating resources to improve that factor, will bring about the greatest change in the organization (or personal life.)

For example, a chain is as strong as the weakest link.

At any given time there is only one weakest link. The weakest link is the constraint. By strengthening the weakest link, the performance of the entire chain improves. A system is like a chain. A typical University/College system is described in Figure 1.3.

In order to move toward improvement of any situation, TOC asks three basic questions:

1. What needs to be changed? (What to change?)
2. What should it be changed to? (What to change to?)
3. How can we change it? (How to cause the change?)

TOC is based on logic. Every logical process is based on assumptions.
The assumptions on which TOC is based are as follows:

1. People are good.
2. Every conflict can be removed.
3. Every situation, no matter how complex it initially looks, is exceedingly simple.
4. Every situation can be substantially improved; even the sky is not the limit.
5. Every person can reach a full life.
6. There is always a win-win solution.

- Eliyahu Goldratt, 1947-2011, founder of TOC

These assumptions have been verified by the experience of successfully resolving thousands of problems around the world in all kinds of situations.

In any problematic situation there are various issues as seen in 1.2. Instead of addressing different issues in separate ways, TOC shows how to find the Core Conflict. However complex the issues are, or however large the system is, it has been found in practice that there are no isolated issues. In fact, all the issues can be connected logically with the Core Conflict. By directing all efforts to resolve the Core Conflict, resources and time are saved, and all other issues also are resolved very effectively, since they are consequences of the Core Conflict.

TOC has Thinking Processes (TP) tools. These tools are aids to communicating underlying logic. Using TP tools one can find solutions that boost total “system performance” instead of optimizing individual processes. The “system” in academia consists of students, faculty, services, staff, administration, and their interactions. The “system” for a person is all the people related to his/her interpersonal and personal issues. “Performance” success is measured in learning, passing rates, graduation rates, being more successful in achieving goals, etc. “Performance” improves due to the “paradigm shift” in how we view the underlying issues, and results in changing various policies, measures and behaviors that are restricting or constraining that improvement.

“(Paradigms are) frames of references we use to “see” the world and make decisions. Paradigms let through data that match our “expectations” and block data that don’t. What may be impossible to do with one paradigm may be easy to do with another…”

Joel Barker, Discovering the Future: The Business of Paradigms, 1986

“(Paradigms are) sets of assumptions we believe are valid. We go through ‘paradigm shift’ when we realize one or more of our assumptions are (no longer) valid”  Eli Goldratt, The Goal, 1986

- Quoted from Alan Barnard’s presentation “The bottleneck is at the Top.” [Barnard, 2007]
There are many Thinking Processes. If we are dealing with a personal or interpersonal issue, only one or two of the following Thinking Processes and tools are sufficient. **But to resolve a group’s, institution’s or department’s issues, most of the tools are necessary.** TOC provides a holistic solution; so, whether the issue is personal or of a group nature, we call it a system issue. How this is done will be explained through step by step discussion with examples.

The Thinking Processes were designed to answer three questions, in order:

1. **What to change?** This step identifies the problem. Answering this question utilizes both “hard” data **and** “soft” feelings and intuition to bring to the surface the root cause or the constraint of a current state of the system (or current reality). In TOC, the existence of a constraint inhibits “flow” or performance of the system. In this way, TOC tends to view a constraint as positive since its identification and subsequent treatment results in an order of magnitude improvement in performance. **The Thinking Process (TP) tools that we use here are the “Cloud” and the “Current Reality Tree” (CRT).**

2. **What to change to?** This step discusses the Strategy of a TOC solution to a problem. Once we find the constraint, we apply another thinking process tool robust enough to develop an indisputable solution that avoids any unintended, undesired consequences. It allows us to decide what we intend the system to be in the future (future reality) by achieving the identified strategic objectives, the desired effects. Here we use the tools called the “Future Reality Tree” (FRT) and “Negative Branch Reservations” (NBR).

3. **How to cause the change?** This step discusses the Tactics of a TOC solution to a problem. Implementing TOC allows us to determine systematically what obstacles lie between present and desired realities, explain why those obstacles exist, define the steps that will overcome the obstacles, define the order in which those steps should be taken, and recognize when the plan should be altered. We use three TP tools here: the “Prerequisite Tree” (PrT) also called the “Ambitious Target Tree” (ATT), the “Project Plan” and the “Transition Tree” (TrT).

**1.4.2 TOC with TP is a proven method for solving systemic problems**

**1.4.2.1 History**
The Theory was developed by Dr. Eliyahu (Eli) Goldratt (1947-2011), a physicist, while solving business problems in the early 1980s. In conversation with Eli in 2007, the first author learned that about 15% of the world businesses are currently run using TOC. Specific business applications can be found on the websites [www.TOCICO.org](http://www.TOCICO.org), [www.EliGoldratt.com](http://www.EliGoldratt.com), [www.goldratt.com](http://www.goldratt.com) and many more.

**1.4.2.2 Success in other educational settings**
This TOC text subscribes to the following observations of TOC for Education, Inc ([www.tocforeducation.com](http://www.tocforeducation.com)), an organization founded in 1995 to which Dr. Eli Goldratt has donated his knowledge.
In spite of all the changes and good intentions of those bringing changes to education, we still have too many problems that prevent us from achieving our "Ambitious Target" in education: Educators must ensure that all the learning and personal needs of all of their students are addressed. Obstacles such as...

1. Many students do not know how to solve their own problems.
2. Many students cannot control their impulsive behavior.
3. Many students memorize, rather than understand what they are taught.
4. Many students cannot apply what they learn to other situations.
5. Many students do not see the relevance of what they learn to their everyday lives.
6. Many students do not accept responsibility for the consequences of their behavior.
7. Educators are expected to meet the learning and needs of all their students without sufficient resources - time, money and stamina.

But limited resources frequently require them to prioritize these needs. If there is a possible solution: “Develop all students’ ability to take responsibility for their own learning and behavior,” such a solution would mean that all who lead students will have more time and energy to teach and attain the ambitious target.

We need a set of simple yet powerful thinking and communication tools. The answer is TOC Thinking Tools.4

TOC Thinking Tools are:

- Simple (they apply to all levels of students and are visually appealing).
- Taught through existing curricula to achieve academic standards and benchmarks to which schools are held accountable.
- Applicable to cognitive skills as well as to the behavior and emotional needs of the students.

[This book is written for students, counselors, faculty and administrators at the college level and community organizers, to make them proactive in their success. It also adheres to the following mission of the TOC for Education and the ethical code of TOC.]

MISSION STATEMENT of TOC For Education Through the synergy of the TOC tools and visionary educators worldwide, TOC will significantly improve education

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4 These were called Thinking Process (TP) tools earlier, and the authors prefer this term.
by enabling learners to think and communicate effectively. Working together toward shared goals, TOC and all who champion students will leave behind a better world. See http://www.tocforeducation.com/foundation.html

The Ethical Code of TOC for Education
The TOC tools were created to find and implement win-win solutions in which no one is harmed through our actions. As we strive toward the goal of bringing significant improvement to education, the people of TOC for education will use TOC tools in the spirit in which they are intended.

Users of TOC in education
Who can use TOC in education? All stakeholders in education including teachers, students, administrators, curriculum developers and policy makers and parents can use TOC in education. In other words…. Anyone who is concerned about the quality and the function of education. Anyone who wants himself or herself and others to be better in carrying out their various functions in education as well as in their personal lives.

How is TOC applied?
Within education, the generic TOC thinking tools are applied in three areas:

- **Behavior**—human interrelationships.
- **Curriculum**—teaching and learning.
- **Administration**—systemic improvement.

Why is TOC important?
According to Florida teacher, Belinda Small, a facilitator at a Medgar Evers College TOC workshop:

- The STUDENTS think of the solutions.
- The STUDENTS use THEIR logic.
- The STUDENTS make the connections between the external Academic Standards such as GRE, MCATS, GMAT, NCATE and various questions in college course exams.
- The most important fact is: STUDENTS HAVE USED IT™

Within only a few years of its founding, the TOC for Education organization has been able to improve the education of millions of children in twenty two countries on five continents. It must be that educators find the TOC For Education methods exceptionally practical and powerful!

The TOC thinking process tools are generic and work without regard to age, culture or political differences. Applications in education improve student
behavior, academic learning and school governance. Millions of students around the world use TOC to resolve conflicts and become better problem solvers.

Public school education in Singapore, Malaysia and the Philippines ranks very high in the world according to various studies on International education\(^5\) over twelve years. TOC for Education has initiated successful programs in support of improved curriculum delivery and student conduct, sponsored and acclaimed by their Ministries of Education in Singapore, Malaysia and the Philippines.

The TOC for education website [www.tocforeducation.com](http://www.tocforeducation.com) has testimonials from all stakeholders in education (students, parents, counselors, teachers, principals, superintendents, Ministers of Education) from many nations including Colombia, the United States, Singapore, Israel, Mexico, Serbia, Philippines, Venezuela, the United Kingdom, Malaysia, Russia and the Republic of South Africa. The TOC website [www.tocia.com](http://www.tocia.com) contains several PowerPoint presentations given by educators from these countries at TOC for Education, Inc., international conferences.

More than 100 universities and schools, including the University of Michigan, Ohio State University and Wayne State University in the US and others abroad use several TOC tools. Many well known “Ivy League” business schools use constraint management to run all of their operations. It is a required course in business graduate courses for MBA’s around the U.S. and abroad.

1.4.2.3 Success at MEC

In earlier discussions (Section 1.2), we described various steps of TOC implementation taken by the Department of Mathematics of Medgar Evers College\(^6\). Here we make historical remarks. Some repetition is necessary for the sake of completeness. The grant team considered the Goal: “To reduce student attrition.” To confine it to the faculty’s area of responsibility, the team restricted itself to the goal “To reduce student attrition in mathematics courses.”

Our experiment with using TOC to address attrition in mathematics courses began in January, 2002. Darius Movasseghi, then the Chair of the Department, Joshua Berenbom, and the first author-- all faculty of Department of Mathematics, Medgar Evers College (MEC)-- participated in formal Jonah training at the Avraham Goldratt Institute (AGI) Academy, New Haven, CT. Tracey Burton-Houle and Steve Simpliciano were the facilitators. The training was funded by an institutional grant for 2001-2004 from the Minority Science Engineering Improvement Program (MSEIP) of the U.S. Department of Education. The attendees used the entire TOC Roadmap (described on the last page of the fourth chapter of this textbook) during a two week intensive workshop to develop a detailed project plan for the Department. Their findings were

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\(^6\) As far as the authors know Medgar Evers College of CUNY is the first college to use TOC to address the problem of student attrition.
discussed informally by the Chair with other mathematics faculty, devoting a few minutes of every monthly departmental meeting during the Spring, 2002, semester. As the major issues of the Department were brought out and discussed in the open, a congenial environment developed in the Department that attracted a large number of students to become mathematics majors. The Department developed new curricula and improvements in mathematics tutoring. They developed Departmental Guidelines that helped all faculty and support personnel work towards student retention.

TOC analysis addressed the needs of the “whole” student and not just his/her academic needs. The project plan showed how and where the academic advisors, personal counselors and the Basic Skills Department could participate with the Department of Mathematics to address the problem of attrition. The facilitator, Steve Simpliciano, made a presentation to the College President, Edison O. Jackson, and his key cabinet members in May, 2005, about what the team had learned, and offered the Departmental Guidelines as a deliverable. President Jackson approved the guidelines and expressed his desire that everyone in the College should learn TOC, starting with the Basic Skills and Freshman Year Program faculty. Two additional institutional Federal grants (MSEIP 2004-2007 and Women’s Equity in Education Act (WEEA) 2005-2007) facilitated the formal Management Skills Workshop (MSW) training at AGI of key individuals and more faculty. The grants also provided resources to hold various campus workshops for tutors, academic advisors, personal counselors and Basic Skills instructors from 2005 to 2007. In the Spring, 2008, semester, President Jackson himself along with his senior administration, reaffirmed his commitment to implement TOC to address institutional issues. He laid out a logical procedure that transcended personalities for all administrators and middle management to follow in order to tackle the problem of attrition as Freshmen move into their academic disciplines.7

1.5 Organization of the book
This book is organized into 3 major sections, dictated by the 3 basic questions of TOC: What to change, what to change to and how to change.

Within each section, there is first a discussion of a specific thinking process tool used to answer the 3 basic questions, as it applies to understanding and dealing with simple problems. If the knowledge of standalone tools is sufficient, the reader can skip some material to study those tools as directed. Then, the tools are used formally to solve complex system problems within the broader context of TOC.

1.6 Conventions used
1.6.1 Terms are defined according to the TOCICO Dictionary, except as specifically noted.
1.6.2 Graphical representations are based on the work of various TOC experts, as noted.

1.7 Logical Foundations of TOC and TP

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7 These efforts have received another boost from two grants of MSEIP – Institutional and Cooperative for 2010-2013, thanks to the US Department of Education.
Theory of Constraints is based mainly on “cause and effect” logic. We will discuss two types of causes, Necessary condition or necessity-based causes, and Sufficient condition or sufficiency-based causes. A cause may be a condition, state or action. A necessary condition is a requirement that must be fulfilled in order to achieve a result. If the condition is not met, the result is not achieved. For example, in order to graduate from college, a minimum of 120 credits is required. In other words, completing at least 120 credits is a necessary condition. This means that if a student earns 119 credits, the student does not graduate from college. We can also say, “A student graduates, only if the student completes 120 credits,” or “In order to graduate from a college, a student must earn 120 credits.”

Graphical notation for a necessary condition:

Graduate from college \rightarrow \text{The student earns 120 credits.}

Each sentence is in a rounded box. It is called an entity. We use “back” arrows \rightarrow to indicate a necessary condition instead of words. The head of the arrow is the effect and the tail the cause, in this case, a necessary cause (or condition). The figure above can be read “the student will graduate from a college only if the student earns 120 credits” or “in order to graduate from college, the student must have 120 credits.”

A sufficient condition is a condition which by itself, if met, will definitely achieve the result. There may be many such conditions. For example, there are several ways for a street to become wet. For the result “a street is wet,” one sufficient condition is “it rains.” Another sufficient condition might be “the pipe underneath the street is broken.” We say, “If it rains, then the street is wet,” or “If a pipe underneath the street breaks, then the street is wet.” The result is the same under both of these two conditions.

Graphical notation for a sufficient condition:

A pipe underneath breaks \rightarrow \text{The street is wet.}

We use “straight” arrows \rightarrow to indicate a sufficient condition instead of the words “If ... then...” Here again, the head of the arrow is the effect and the tail the cause.

A necessary condition or cause may not be a sufficient condition or cause, i.e., the necessary condition may not be enough by itself to attain the result; there might be several more conditions needed for the result to happen. For example, if a student takes 120 credits any way he/she wants to, he/she may not graduate. Another requirement for graduation is to complete the credits as recommended in a particular discipline. Here, taking recommended courses in a discipline is an additional cause or required/necessary condition. We connect the two entities with “and” or what we call a “banana”. This usage is consistent with computer science.
Thus, if a student earns 120 credits and if s/he takes them as recommended in a particular discipline, then he/she can graduate.

Here “the student earns 120 credits recommended in a particular discipline,” and “the student can graduate” are both necessary and sufficient conditions for the other. Both have the same meaning. We say: “A student graduates if and only if the student earns 120 credits recommended in a discipline.” We write, using a double-headed arrow:

Graduate from a college $\iff$ The student earns 120 credits recommended in a discipline.

One sufficient cause may have more than one result. We could also write, changing tense for the logic to make sense,

A student graduates $\implies$ The student has earned 120 credits.
A student graduates $\implies$ The student took courses recommended in a discipline.

Thus, if a student graduates, then the student has earned 120 credits and has taken the recommended courses in a discipline. A student graduating is a sufficient condition for both “results” to take place.

A sufficient condition may not be a necessary condition. There might be several ways to achieve the same result. For example:

A student studies hard $\implies$ She gets a good grade.

Here the “student studies hard” is a sufficient condition, but not a necessary condition. A student may already know the subject, and she might not have to study hard.

A student knows the subject $\implies$ She gets a good grade.
Let us consider the statement, “If the temperature is around 32° F and if it rains, then it is a freezing rain.” The freezing rain cannot happen without the temperature being around the freezing point of water and raining. Both are necessary causes. If it does not rain and the temperature is around 32° F (or for that matter, whatever the temperature), then there cannot be freezing rain. If the temperature is lower, then the rain would turn into snow. If the temperature is higher, then the rain water cannot freeze.

We can write the two necessary causes using arrows as follows:

\[
\text{There is a freezing rain.} \quad \Rightarrow \quad \text{It rains.} \quad \Rightarrow \quad \text{The temperature is around 32°F.}
\]

In this vertical orientation, there is some ambiguity about whether these are forward or backwards arrows. Thus, one must think carefully about the logical relationship among the entities. Here, we read the diagram as follows: In order that there is a freezing rain we must have the rain and the temperature around 32° F.

In summary, a necessary condition is a required condition for the result, but does not guarantee the result, and a sufficient condition is one of several possible conditions that guarantee the result.

We do come across necessary conditions, sufficient conditions, and necessary and sufficient conditions in Mathematics, since Mathematics is completely based on logic. A student majoring in Mathematics who knows the differences between them can very easily master the discipline. An example of a necessary and sufficient condition is the statement: “a number is divisible by 5” if and only if “a number ends (its one’s digit) is either 0 or 5.” Here “a number is divisible by 5” is both a sufficient and necessary condition for the number to end in 0 or 5. Similarly, “A number ends in 0 or 5” is both a sufficient and necessary condition for a number to be divisible by 5.

Conflicts arise because people confuse necessary and sufficient conditions. For instance, assume John and Mary are travelling in a car and want to reach a destination. John knows at least two roads. Mary insists on using a particular road to reach the destination. Because she does not know about other roads, a conflict may arise between John and Mary. Here, the road Mary knows is a necessary condition for her, whereas for John, the road Mary knows is only a sufficient condition, since there are other roads to reach the destination.
Another example of a conflict that often happens between a husband and wife is about ways to save money. The goal of saving money can be reached in many ways, but if the husband insists on a way that the wife does not agree with, conflict arises because each person thinks that the only way (meaning necessary condition) to save money is the way he/she knows.

Examples of the uses for conditional or cause and effect statements:
1. “If you smoke, then you will get cancer.” Smoking is a sufficient cause of cancer. This means that smoking is enough, by itself, to cause cancer. Smoking produces cancer. This is represented as:

   ![You smoke. You will get cancer.]

   In order to check the validity (correctness, or truth) of the statement, you will have to do an experiment on yourself that might be quite risky or observe data from others who have cancer, and draw a conclusion. At the same time, to get cancer, there might be several other causes, such as prolonged exposure to ultraviolet rays. Smoking is not necessary.

2. Among the tools of TOC, the Cloud and the Prerequisite Tree (an Ambitious Target Tree) are based on necessary condition logic, while the Current Reality Tree, Future Reality Tree, and Transition Tree are based on sufficient condition logic.

The following example shows that we use logic to make everyday decisions.

### 1.7.1 An everyday decision using logic

This example was developed by Ernits Gracia, Math Lab Technician, as the first assignment in the online course on Constraints Management of Washington State University, Vancouver, WA taught by Dr. James Holt. The storyline is useful and is as follows:

“Today it has been snowing. Students and instructors are expecting that the classes will be canceled. But the classes are in session. The secretary is out on leave. There are some added responsibilities I need to take care of. I am not sure whether I should check my voice mail, since I need the time. But, instructors may be calling in to cancel their classes. Students must be informed of canceled classes. So I check my voice mail.”

He came to justify his decision of checking his voicemail and explained his decision by the following “branch” or “logical twig” called “Checking Voice Mail” using “if...then” logic. Notice how he wrote each fact of the storyline in a rounded box or entity. He arranged the
entities, and connected the entities with arrows to indicate the cause and effect, and combined several causes together (to make one sufficient cause) with the connective “and” or “banana.” The rectangular box is called the “injection” or “decision.”

### Checking Voice Mail

Logical “AND” connector, two causes together are sufficient to arrive at the effect.

- Departmental secretary is out on leave
- Classes are in session
- It is snowing today.
- I have to take care of some added responsibilities.
- Instructors are calling to cancel classes.
- The voicemail needs to be checked.

- I don’t have time to check my voice mail.
- I need to choose between checking and not checking my voice mail.
- Students must be informed about cancellation.
- I feel justified in my choice.

I choose to check my voice mail.

1.7.2 **Summarizing a paragraph using cause and effect logic**

We will show how to summarize various points of the following article. The main tool we use is the “branch” or “if...then” logic. This should give the reader some training on writing summaries.

**To Be Happy Today and Tomorrow**

The ultimate goal for a human being is to be happy today and tomorrow. We want to be happy. With our unlimited potential to tap, there should be no need to limit our happiness to any one thing or wait to be happy until some goal is attained or until we have lots of money or fame. Instead, our experience so far in life indicates that when we have “meaningful” time in a day we feel satisfied or happy. On the other hand, when time is wasted in doing something meaningless we feel lousy. We feel our time is meaningful when we accomplish something, even a simple chore completed to our satisfaction. Inner stirring to do something creative makes us constantly restless to perform different activities. We must know how to channel our energy to finish the big and small activities we undertake. We have to demand the best of ourselves

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8 This is a chapter in a Motivational Guide given in the Appendix of this book, which discusses Self-image, How to be happy, How to be healthy, Critical Chain project Management (CCPM) of a course, Why and how to study mathematics, Techniques of Tranquility as an aid to focusing on the task at hand, how to work collaboratively, Process Of Ongoing Improvement (POOGI) – a brief introduction to TOC for students’ personal use,
and attain our goals to our satisfaction. Otherwise, we will feel frustrated. Regardless of whether our goal has been attained or not, our constant goal should be that we live a meaningful life -- today and tomorrow. It is the yesterday that we cannot do much about except to take appropriate corrective action, instead of brooding over it or blaming someone or ourselves. If our efforts towards achieving a goal have not been sufficient, instead of feeling dissatisfied or unhappy, we should take into account how much we have accomplished and be satisfied with our work so far and continue working. We have to be proactive. Being “proactive” means acting in anticipation of future problems, needs or changes.

This paragraph can be summarized as follows. In order to be happy today and tomorrow, I must use my time meaningfully and must take creative actions.

Education brings a meaning to our life. It helps us equip us with mental tools to express our innate talents. It gives us choices. It helps us to achieve our goals. It helps us to widen our horizons. That is the reason we need to study various subjects. We come to college with some goal in our mind. We want to get our degrees: B.A., B.S., M.A., M.S., Ph. D. and we have to attain our goal. Education can show us to how to be creative and to use our time meaningfully.

To summarize the above paragraph: If we have education we learn how to use our time meaningfully. If we have education, we learn how to take creative actions. But we cannot necessarily attain both, unless we are “proactive.’

We must discover what obstacles prevent us from achieving our goals. One obstacle is that we have to take care of so many things every day that we first consider the thing that needs our immediate attention. While doing that we are reminded or told of another important thing that needs to be done or another deadline to meet and our attention gets diverted. Now we have to do two things. Thus we constantly keep on doing different things without accomplishing our major goals. Everything remains incomplete. That leads to frustration and stress. What we are doing is called bad multi-tasking. Instead, everything we do and which takes some amount of time and effort must be considered a “project.”
At this point, we need to define a project. A “project” is a sequence of logically arranged tasks to achieve some goal. A project is also an example of “cause and effect” logic. If one task ends, then the next begins. For example, a syllabus for a course is a project. A “task” is a unit of activity. The tasks cannot be rearranged in a random manner. Each task has to be carried out “sequentially” one after another as in the diagram that follows. There is a finished product at the end of the project. It is called a “deliverable.” It may be tangible, such as an object or a gadget. Sometimes it is just acknowledgment by someone (including ourselves) that an intangible goal has been attained. There is some payoff as a consequence of completing the project. It may be a monetary reward. Whatever the project, once we finish it, there is a kind of satisfaction (happiness), accompanied by an increase in confidence and a sense of accomplishment. That is also our payoff. We can then start another project.

<table>
<thead>
<tr>
<th>Task 1</th>
<th>Task 2</th>
<th>Task 3</th>
<th>Task 4</th>
<th>Finished Product</th>
<th>Payoff</th>
</tr>
</thead>
</table>

In short, in doing creative actions we have a choice. We can do multitasking or we can carry out a single project. Multitasking is a major obstacle. In order to use time meaningfully, we must carry out the most important needed action as a project without multitasking. Note that the line drawn vertically through the arrow negates the relationship.

In summarizing the article: In order to be happy today and tomorrow, we must use our time meaningfully and perform creative actions. In order to use our time meaningfully and perform creative actions, we must have good education and we must be proactive. In order to use our time meaningfully, we must also do the most important action (there can be only one at any time) of the day as a project and finish it. We could start another one. But, finishing a project gives satisfaction and other payoffs.

### 1.7.3 Solution of a Mathematics problem using sufficient condition logic.

Example: A woman had $10,000 that she invested in two funds, a fund that earned 9% and one that earned 7%. If she earned $880 in interest from the two funds, how much was invested in each fund?

Solution: Usually a figure or a chart helps to analyze the problem. We usually do not draw entities and arrows, but in this example we will. First we will solve the problem without using entities.

Given (Assumptions): The woman invested $10,000, some of which earned 9% interest and the rest, 7%.  

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If x is the amount invested at 9%, then the rest of the amount is 10000 – x at 7%, because both investments must add up to 10000, or (x + (10000 – x) = 10000). The interest of each investment is given by: .09x and .07(10000 – x). The total interest in algebraic terms is .09x + .07(10000 – x), and the total actual interest is $880. We equate them. .09x + .07(10000 – x) = 880

To solve this equation we get rid of decimals by multiplying every term by 100 to get

9x + 7(10000 – x) = 88000
9x + 70000 – 7x = 88000 removing parentheses
2x = 18000 simplifying
x = 9000

The woman invested $9000@9% and 1000@7%
1.7.4 Assumptions and Injections in Thinking Processes

Assumption: The word assumption comes from the verb to assume. To assume something means that we regard it to be true, often without evidence or proof. If we question the assumption, we might find that it is really not true. Our opinion or belief about something is our assumption about it. We make our decisions based on our assumptions. Assumptions are the foundation of our personality, our paradigm or perception of the world, and our transactions with others. Our thinking depends on the assumptions that we have made. Conflicts often arise due to wrong assumptions, which are mostly hidden. Assumptions are
“surfaced” (brought to the surface) using Thinking Processes, and are then challenged. This changes our thinking, and leads to conflict resolution.

Examples:

1. It was a common belief in Europe at the time of Galileo that the Earth was at the center of the universe. He showed that the sun is the center of the universe and the earth and other planets orbit around the sun. Galileo showed that the generally accepted earth-centric assumption was no longer valid, but people in power could not accept that. For challenging the popular belief, he was put under house arrest.

Galileo 16th Century

2. Another assumption is that the Earth is flat. People believed this because, locally, the earth appears to be flat. This assumption can be challenged in many ways. For instance, we can look at a satellite picture of the earth, or travel from east to west and finally return to our starting point.

3. It is a common assumption that mathematics is hard. If we question this assumption—spend some time with peers or mentors who are good in mathematics, study some of its ubiquitous applications in any modern field, and spend some time on a regular basis with it—our assumption may prove to be invalid. Since mathematics is logical, if we have some logical gaps in our knowledge we might find it difficult. If our previous experience with mathematics has been negative, we may assume that mathematics is difficult. But we should recognize that we are not the same person we were before. We are mature and we have a better understanding of the world and the importance of mathematics in the world. Thus we can challenge our assumption.

4. In a cause and effect statement, an assumption is “a statement, condition, or belief about why a logical relationship exists between entities” (TOCICO dictionary). In sufficiency-based logic, an assumption is generally considered to be valid for the system and is taken at face value. Take, for example, “If I have a cat, then I have a feline, (because all cats are felines).” The underlying assumption is that all cats are felines. The assumption is generally accepted to be true and does not need to be documented or challenged. Here is another example of an “if...then” statement:

A pipe breaks underneath the street. The street is wet.
The assumption here is that water from the broken pipe will reach the street. One could question this assumption. The water might dissipate into the soil and not affect the road.

5. For example, “In order for the student to graduate from college, it is necessary for him/her to complete 120 credits.” “The student earns 120 credits” is the assumption. (‘Necessary’ is not always ‘sufficient.’)

Injection: Conflicts can be resolved by challenging their underlying assumptions. A challenge to an assumption in Thinking Processes is called an injection. An injection can be a condition (state) or an action. A condition can be only a logical statement. This will be explained in the next chapter. An action may be required to invalidate an assumption. In Example 2.3, the actions taken to dispute the assumption that mathematics is difficult are all injections.

We will also use the word injection as an additional cause for making something positive happen or for breaking a negative cycle of UDEs or events in our current reality.

1.7.5 Checking the Validity of Logic – Categories of Legitimate Reservation
Before we deal with a branch or “if ...then...” statements, we must check that they are legitimate statements or cause and effect pairs. The following discussion provides a guide as to how to check the validity of the logic. A challenge to the validity of an implication or the logic of an “if...then...” statement, is called a “legitimate reservation.” We must “raise the categories of legitimate reservation” in the most respectful and unemotional way possible.

This is group work. As the trees connected with “if...then...” are presented, the scrutinizer/s in the audience should scrutinize the logic. There are three levels consisting of seven steps of Categories of Legitimate Reservation.

Level I: Clarity Reservation -
Level I seeks clarity and understanding of the tree builder’s intentions. (TOCICO dictionary)

Sometimes people make statements which need clarification to be understood.
1. The student says, “I freeze when I see a word problem.” Or, “If I see a word problem, then I freeze.” A clarity reservation such as “I don’t understand what you mean,” makes the student restate, without emotion: “I have difficulty in doing word problems.” (Clarity in Entity)

Sometimes the cause-effect relationship is not clear. By asking questions such as, “What does this mean?”, “Is that really so?”, “Does this really cause that?” can make clear the cause and effect relationships. Here are some examples:
2. The student says, “Mathematics is not for girls.” Or, “If you are a girl, then you can’t do mathematics.” “Why is that so?” or “Is that really so?” Some of the well-known mathematicians are women. If you think that “mathematics is not for girls” then that is your assumption,

3. “If I did not do well in science in high school, then I will not do well in science in college.”

“Does your past experience really lead to your future experience? Does it really cause that? What about your effort in the present? Can you not do anything now?”

**Level II: Causality Existence and Entity Existence reservations.**

Level II examines the validity of an entity: Does the entity really exist; and, does the causal relationship between specified entities really exist. (TOCICO dictionary)

1. **Entity Existence Reservation** - “Does it exist?” “How is it possible?”
   
   A City University of New York freshman says:
   
   ![Entity Existence Reservation Diagram]

   Scrutinizer asks, “How is it possible?” All colleges of the University require at least one course in mathematics. If the student’s statement comes from an assumption that mathematics is difficult for the student, let the student restate the condition.

2. **Causality Existence Reservation - Sometimes** the effect is not a direct effect of the cause.

   We need to add further explanations to make the effect logically flow from the cause. In fact, we might have to add a whole series of cause-effect entities. Again, an entity is a box that contains a simple statement, whether it is a cause, effect or fact of life (FOL).

In the following example, the effect is not a logical consequence of the cause. Such an arrow is called a ‘long arrow’.
I have to request Instructors give make ups and INCs, ABSs

I cannot keep up with all aspects of the course.

It needs several more steps called intermediate cause-effect entities such as “I do not know the subject.” This cause-effect relationship is discussed in detail in Chapter 2.

**Level III:** Cause Insufficiency, Additional Cause, Predicted Effect Existence, and Cause-Effect Reversal (tautology) reservations.

To use Level III’s four reservations, the scrutinizer must actively assist the presenter by proposing a change such as adding or changing some words and/or suggesting a missing condition or an entity that appears to be omitted. (TOCICO dictionary)

1. **Cause Insufficiency Reservation - Sometimes insufficiency** in logic can be challenged. Here insufficiency means that the cause is not sufficient for the effect. The first example we discussed was “Earning just 120 credits does not guarantee that you will graduate.” The added condition or cause was “earning the credits in a recommended coursework in a discipline.”

   A student says, “If I have to attend to my personal responsibilities, then I cannot get good grades.” We challenge this only in a friendly helpful manner.

   The mentor says, “Why can’t you get good grades?” “How does the effect follow from the cause?” “The logic does not flow. Is it because you do not get time to study?”
2. **Additional Cause Reservation** - An “if...then...” statement may not fully account for the “effect” unless an “additional cause” is supplied. There might be several sufficient conditions to produce this effect. By removing one of the conditions, the effect is still attained. Here the additional cause is “or” (and not connected with a banana).

If you know the material, then you do not need to study and still get good grades.

3. **Predicted Effect Reservation** - Sometimes the cause and effect statement cannot be checked directly. But another effect for the same cause can be checked. If the second effect cannot take place, then the cause entity does not exist.

Here it would be disastrous to wait to see the first effect of getting cancer! Instead, if there do exist toxic pollutants in the air, the samples of the air can be checked for toxins by analyzing them using chromatography and Principal Component Analysis.

3. **Cause-Effect Reversal Reservation** - Sometimes people confuse the cause – assumption--with the effect-- conclusion. Sometimes the cause and effect are reversed.
We cannot conclude that the car is being burglarized. If the car is being burglarized, then the alarm will, of course, sound, but it is possible that someone bumped into the car and the alarm is activated and there was no burglar.

Sometimes a direct cause and effect relationship may be in “an infinite loop.” That is, both statements are two different ways of saying the same thing. This is called a “tautology” in logic.

In mathematics, various laws, such as an associative law, and identities, such as a trigonometric identity are “tautologies,” meaning in each of these that the left side is the cause for the right side and vice versa. A mathematician, while proving an identity, might take one side as an assumption and, using various facts, draw the right side as the conclusion. In TOC, we say one side is the cause and the other the effect. Thus, if you get “half a dozen” oranges or six oranges it is the same thing.

To summarize:

Level I seeks clarity and understanding of the tree builder’s intentions, that is, finding out what the words and phrases in the logic diagrams’ entities really mean and how they are being used. Level II examines the validity of an entity: does the entity really exist; and, does the causal relationship between specified entities really exist.

In each of Level III’s four reservations, the scrutinizer must actively assist the presenter by proposing a change such as adding or changing some words and/or suggesting a missing condition or an entity that appears to be omitted. Scrutinizers should precede from level I to level II to level III reservations until they have satisfied their concerns. That is, they should first seek clarity, next assure appropriate causality, and finally propose improvements in a logic diagram. Note that the tree builder is free to accept or reject any reservation at any level. (TOCICO Dictionary)

This concludes the discussion of categories of legitimate reservation of “if...then...” pairs.

Practical note: Discussing a logical chain of “if...then...” or cause and effect statements -- a logical twig, branch or tree -- with others requires making many changes, insertions and deletions. Having a large poster board on an easel or a smooth wall and a set of “Post-it” notes (or notes with a sticky back for ease of moving around) of different colors at hand is very helpful. For example, you can use magenta for Undesirable Effects (UDE’s) and for “Desirable Effects” (DE’s), yellow for Injections, blue for Actions planned or existing facilities, and green
for “Strategic Objectives” to construct branches or trees on the poster board. Terms not discussed so far will be discussed in later chapters.

Exercises

If you are an instructor, assign the following exercises to your students.

1. Make a list of issues that prevent you from achieving a goal. Rewrite the issues as UDEs.
2. Select a paragraph from a newspaper. Make a list of conditional statements involving i. necessary conditions and ii. sufficient conditions
4. Develop a storyline for a decision you had to take in your life recently. Use “PowerPoint” to illustrate the story using a logical twig as in the example, “Checking Voice Mail”.
5. Solve a word problem in mathematics, showing the “if … then …” logic.
6. Describe a set of five popular assumptions which are wrong or detrimental, (misconceptions). Show how you will challenge them.
CHAPTER 2 – WHAT TO CHANGE?

2.1 Overview
TOC asks three questions: What to Change? What to change to? How to cause the change? This chapter develops the TOC Thinking Processes needed to answer the first question: what to change. We need to solve a problem whose symptoms we have listed. As seen in Chapter 1, we need to address the constraint of the system. Here we learn to find the constraint or problem.

In the second section we see how to describe the issues in a simple non-emotional non-confrontational manner. When you ask some people what needs to change, they get emotionally charged, start blaming people and circumstances, policies and laws, and say that we don’t have this or that, it ought to be this way or that, and suggest ways to improve. Instead, TOC goes coolly about the improvements in a logical and systematic manner and suggests win-win solutions that last. We review how an issue must be defined as an UDE – UnDesired Effect. We also define a Desired Effect (DE)

In the third section we observe that the issues are never isolated, that some or all are logically connected, and that we can start a chain reaction of improvements by treating the one issue from which the chain originates. It is possible the issues may form a loop as in Example 2. We can then break the chain by an injection in one or several places in the chain. We call the chain of ‘if...then...’ statements a Current Reality Tree (CRT), which might also consist of disconnected branches. The CRT can be used as a standalone tool. But used this way, it does not give us a complete understanding of the problem with the system from which issues arise. We will use it to deal with whole systems later on. In the fourth section we study a thinking process (TP) tool called ‘the Cloud’ or ‘Evaporating Cloud’ based on necessary condition logic, and different types of clouds. We review how to correctly state a logical statement involving a necessary condition. Then we develop the Cloud. We see how it is a great tool to describe logically the conflict underlying an UDE. The cause of the UDE is an action or want. We have a conflict only if two people (or parties) have a common goal relating to the UDE, but opposing wants. If there is no common goal, there is no conflict. We surface and analyze the assumptions behind the opposite actions that seem to satisfy or fulfill our differing needs. We challenge these assumptions. That leads to the resolution of the conflict or evaporates the cloud.

In the fifth and sixth sections we study five different types of Clouds. We introduce the idea of a Negative Branch to visualize the consequences of the UDE and the Positive Branch with injections to visualize the positive effects of the corresponding DE. Both Negative and Positive branches use ‘if... then ...’ or sufficiency-based logic. These branches are useful in resolving ‘chronic conflicts.’ The Cloud is a standalone tool, but it can also be used to resolve complex systemic issues.

In the seventh section we select three important diverse or representative UDEs from a list of UDEs of a system, and develop clouds. From these clouds, we develop a generic or Core Cloud. We check, if necessary, whether a similar core cloud results when a different set of three
representative UDEs is selected. We thus ascertain for ourselves that the Core Cloud is the systemic cloud that represents all UDEs. We surface the assumptions underlying the various necessary condition statements contained in the Core Cloud. We then provide the Core Cloud as a visual and logical base to the CRT. We find then that all UDEs are connected within the CRT. We call this the Conflict/Communication Current Reality Tree (CCRT). The CCRT provides the deepest insight into the Core Problem or the Constraint of the system, and includes all the UDEs. It is used to communicate with stakeholders. The CCRT has important regions which give additional visual insight into negative feedback loops that are maintaining the negative current reality. This is explained with a simple example.

The eighth section discusses “evaporating” or resolving the Core Conflict Cloud of the system. We can come up with an idea called the “Bright Idea” to break the core conflict by examining the assumptions surfaced in the Core Cloud. Once you have found the Bright Idea, you are on your way to proposing ways to achieve it. Pursuing the Bright Idea is the subject of the third chapter: What to change to?

The ninth section summarizes the concept of the Cloud. The tenth section summarizes the steps to answer the first question: What to change?

2.2 Undesirable Effects (UDEs) and Desirable Effects (DEs)
What are the problems in our system that need fixing? What keeps the system from performing at its best? What are the issues at hand? As seen in the first chapter, a system is a chain and not every link needs to be strengthened to improve performance. We can get the quickest and most significant improvement by concentrating on the weakest link or constraint of the system. Thus the most negative condition is the first to be addressed. We list the issues in a non-threatening way as UDEs. We first prepare an environment to state the issues as UDEs. We review the definition of UDE.

**Step 1:** This is the most important step. If there is a conflict with another person on some issue, make sure you remember that clear thinking can happen only when there is no ‘heat’ generated in the argument. Therefore, instead of ‘fueling the heated situation’ or keeping the argument going, or thinking about who is winning, put the issue on pause. If the conflict is within you, don’t get frustrated or angry with yourself. Take a break. If you feel like it, discuss the issue with a friend, a mentor, a guide, an elder calm person, or a counselor whom you trust, even if the person does not know TOC. If the issue is too personal to discuss with anyone, then write the various issues down clearly as UDEs.

**Step 2:** Write your issue as an undesirable effect (UDE).

**Definition of UDE**
An UDE should be serious, be a condition not a lack of an activity, not blame anyone, happen frequently, have a serious negative outcome, and not incorporate the solution within the statement. - TOCICO Thinking Process Committee
State what bothers you in a simple, clear, complete sentence, not a compound sentence using "but," "and" or "because." It is not a negative effect or a symptom in itself. It should be a ‘benign’ statement, that is, it should not hurt anyone. It should have no emotion. An issue creates a want or action or caused by a want or action. The UDE should focus on a current fact. Focus on the ‘action’ or ‘want’ that creates the issue.

Examples of UDEs:
1. Robby takes too much time to get ready in the morning. – Unacceptable UDE. This is how a counselor feels about his son. It includes judgment - ‘too much’.
2. I am disturbed by students talking in my class. – UDE of an instructor.
3. I have no prerequisites for this class. – Student’s UDE
4. I don’t have time to do the homework. – Student’s UDE
5. I am not capable of doing mathematics. – Unacceptable UDE. It’s not a benign sentence.
6. I am not prepared for my math course. – Unacceptable UDE. It is a lack of activity.
7. There is no communication between instructors and tutors. - Instructor’s UDE:
8. I am unhappy because of your unnecessary activity. – Unacceptable UDE of a married couple. It is not a simple statement. It also blames another person.
9. I cannot attend my classes on time. – Student’s UDE.
10. I am not authorized to hire a tutor. – A tutorial coordinator’s UDE.
11. I am not up to taking Mathematics as my major. – A student’s UDE.

A Desirable Effect (DE) is the logical opposite of an UDE.
For example, if the UDE is “I cannot attend my classes on time.” Then the DE is “I attend (or do attend my classes on time.”

A DE plays an important role in discussing a Positive Branch while resolving a ‘chronic cloud’. We discuss a Positive Branch in Section 2.5. It is also useful in answering the second basic question: What to change to? We will discuss this in detail in the third chapter.

2.3 Current Reality Tree (CRT) as a Standalone Tool
Try to link the UDEs using sufficient condition (if...then...) logic, providing additional causes to make the logic solid. This gives rise to a Current Reality Tree (CRT). The CRT may not necessarily be one single tree, but a bunch of branches. The CRT shows that the UDEs are not isolated.

2.3.1 Example of CRT
Consider a few student UDEs from Section 1.2, Chapter 1.

1. I cannot follow the lecture.
2. I feel I am not capable of doing mathematics.
3. I do not work hard in mathematics.
4. I don’t do the homework/or prepare for the course.
5. I do poorly on tests.
6. I feel that the exam is too hard.
7. I have difficulty learning the material (in math classes).
8. I have difficulty taking tests.

When we link these UDEs as in Figure 2.1, we get a loop. This is the current reality tree (CRT) for the student. Not every current reality tree ends in a loop. This loop can be broken by an injection at any one of many places. For example, between UDE 5 and UDE 8, introduce an injection: Have practice tests available and make sure that the student takes them as mock tests.

**Figure 2.1**

We read this loop as follows: If I don’t do the homework/or prepare for the course, then I have difficulty learning the material (in math classes). If I have difficulty learning the material (in math classes), then I have difficulty taking tests. If I have difficulty taking tests, then I do poorly on tests, etc.

For any set of UDEs, a Current Reality Tree (CRT) can be constructed easily as shown above. The UDEs may not all connect in one tree and might be disconnected branches. This CRT does not have a root. Making a single CRT out of a set of UDEs needs additional work and knowledge of an additional tool called a Cloud (described in Section 2.4).

**2.3.2 CRT as a standalone tool**

A CRT can be used as a standalone TP tool. It is simple enough for kindergarteners and sophisticated enough for corporate/institutional use.

With practice, you will be able to see connections after looking at a set of issues – UDEs--without drawing the CRT. In addition, by looking at a possible forthcoming action, you will be able to determine the consequences of that action without verbalizing them or drawing a logical twig.
If this satisfies your need, you can skip to the Section 2.4 on the Cloud as another standalone TP tool. If not, continue reading.

A CRT does not give insight into the whole system. We only learn that the UDEs are logically connected; we do not know how to fix them in the system and how to resolve conflicts so that these UDEs do not arise. A CRT partially answers the question: What to change? This is not good enough. TOC gives a complete logical answer to this first basic question. It shows not only how to resolve conflicts, but also how to create a positive alternate reality in the future involving Des, the opposites of UDEs.

2.4 The Cloud as a Standalone Tool

2.4.1 TOC has a TP tool called “the Cloud” or “an Evaporating Cloud.” It is a communication tool to describe a conflict clearly. The Cloud uses necessary condition logic. To recall how such a statement is formed, consider the statement: An instructor says: “In order that my students have a quality education, I can (must) not communicate with tutors.” We replace the set of words “In order to ... I can (must) ...” by a backward arrow.

Example 2.4.1.1
Consider an instructor’s UDE: There is no communication between instructors and tutors. Why should there be a conflict? A storyline explains why this is a conflict. Usually developing a storyline helps to develop a cloud from an UDE.

Storyline: Suppose that an instructor wants to do all the instruction himself and does not want to use tutoring or any other supplemental help that would be beneficial to students. Thus s/he does not communicate with tutors. The department insists that it is important for all faculty to use these resources. The common goal for the department and the instructor is, of course: Be a responsible instructor. This creates a conflict.

Instructor’s UDE: There is no communication between instructors and tutors. This is a condition.

There are two sides to the UDE - the instructor’s, and the Department’s. The instructor does not communicate with tutors although the Department requires that s/he should. Each party acts this way because of certain needs.

The instructor’s side stated earlier:
Here the result “My students have quality education” is the need. In the instructor’s words, “In order to fulfill my need/requirement/belief that my students have quality education, I can (must) not communicate with tutors. There are assumption/s or perception/s of the instructor that underlie the arrow in this necessity-based logic statement, but we will discuss them later in this section.

The Department’s necessary condition statement is:

\[
\begin{align*}
\text{Need} & \quad \text{Want/Action} \\
\text{Make all resources/supplementary instruction available.} & \quad \text{Communicate with tutors.}
\end{align*}
\]

The Department policy says: Instructors should communicate with tutors (a resource) in order to make all resources/supplementary instruction available to students. (Note we can state a necessary condition this way also.)

Each of these needs statements is itself a necessary condition to achieve the common goal: Be a responsible instructor. This discussion can be put together as a Cloud, described below:

### 2.4.2 The Cloud – Definition and Structure

**Definition:** An Evaporating Cloud (EC) or a Cloud is a TOC thinking process tool that analyzes the details of a conflict, meaningful action and a decision in a concise and non-provocative way.

The Cloud helps to define and analyze a conflict. A conflict is well defined when two possible opposing actions (wants) are presented to achieve a common goal. We must convert the UDE in question into a conflict. The UDE considered from two different viewpoints creates the negative outcome of two logically opposed actions that are in conflict. Both actions are logically linked to the common goal by two different needs. Again, the Cloud uses necessary condition logic.

The Cloud analyzes the details of the conflict in terms of wants by studying the five aspects of a conflict: If there are two parties, X and Y, with opposite wants and a common goal, we consider

- X’s Want (Action), Y’s Want (Action), X’s Need, Y’s Need and the Common Objective (Goal).

The conflict may be internal to an individual. For instance, the conflict: “I must attend to my family responsibilities or I must study.” is internal. The cloud may be between two parties: For
instance, in the example in 2.4.1, an instructor and her/his department. “Instructor must communicate tutors on a regular basis and the instructor feels s/he cannot do so.”

The Cloud’s structure is built of five entities (boxes) connected by logical arrows. The arrows indicate the four ‘necessary condition’ statements – two on X’s side and two on Y’s side with the common Goal or Objective. Each box addresses one of the five aspects to help describe the conflict. The following figure describes the structure of a Cloud.

**Figure 2.2 Structure of a cloud/evaporating cloud:**

Here the entities A, B and C are conditions, B and C are non-conflicting needs, and D, D’ are logically opposite wants or actions. A conflict arises when there are two opposite actions. We read the cloud from left to right, first the top side and then the bottom side: “In order to have the objective A we must have the Need B, and in order to fulfill (have) the Need B, we must have D. At the same time, in order to have the Objective A, we must have the Need C. In order to have C, we must have the D’. D and D’ are logically opposite and are in conflict (or this is a conflict.)”

Using the 5 entity structure, we can formulate the example in 2.4.1.1 as a cloud in Figure 2.3:
Figure 2.3

Evaporating Cloud

UDE: “There is no communication between instructors and tutors.” (Instructors’ UDE)

In order to (satisfy that)... I must (can)...

My students have quality education.

Communicate with tutors.

All supplementary instruction is available.

Not communicate with tutors.

Be a responsible instructor.

In order to...

I (instructor) must

In order to...

I must

But in order to...

Common Objective

In order to...

I must

In general, an UDE is caused by an action/want. At the same time, there is a more desirable action/want that is opposing it. A conflict arises within a person internally, between two persons, between a person and a group, or within an institution, when a decision is needed as to whether or how to perform the desirable action instead of the undesirable one. Regardless, there is always a common goal or objective for an issue/UDE. The goal is attained when the need on each side is satisfied. These non-conflicting needs are generated because each side looks at the issue with certain, often differing assumptions. Each side wants to fulfill those needs in a particular way. In a conflict, the two wants are specific actions and are opposites of each other. Needs are conditions and they never oppose each other. But the satisfaction of need B is jeopardized by carrying out or having D’, and the satisfaction of need C is jeopardized by carrying out or having D. We say “need B is ‘jeopardized‘ by D’,” and “need C is ‘jeopardized‘ by D” as a shorthand.

Before we can resolve the conflict we must ask why each action fulfills the corresponding need. This questioning surfaces the assumptions. We should not be critical of any assumptions raised.
at this point; that will come later. This process gives rise to a fully developed cloud as shown schematically in Figure 2.4 and applied to our current example in Figure 2.5.

Figure 2.4

Figure 2.5 Example (continued)

Evaporating Cloud – Surfacing Assumptions

B-D: because
- Tutors might misinform students.
- I prefer to do all instruction myself.
- I don’t know whether tutors can provide correct understanding.
- I don’t know whether adequate tutoring is available for my course.

D-D’:
- We have a structured curriculum. Obligation to finish syllabus
- A structured curriculum doesn’t permit customization or doesn’t accommodate students with special needs.
- Students cannot take the responsibility to finish the syllabus their own.

C-D’: because
- Peer tutors can be effective additional resource for students.
- Students need to do the work outside of class to learn the material.

D’:
- Communicate with tutors.

Conflict:
- My students have quality education.
- Not communicate with tutors.
- All supplementary instruction is available.
- Communicate with tutors.
Exercise: Surface the reasons/assumptions for the two necessary condition statements: A ← B and A ← C.

We should not be critical of any assumptions raised at this point. That will come later. We read the cloud: "In order to be a responsible instructor, I must have that my students get quality education. In order to have my students getting quality education, I must (can) not communicate with tutors, because

- Tutors might misinform students,
- I prefer to do all instruction myself,
- I don’t know whether tutors can provide correct understanding.
- I don’t know whether adequate tutoring is available for my course.

At the same time (But), in order to be a responsible instructor, I must have all supplementary instruction available. In order to have all supplementary instruction available, I must communicate with tutors, because

- Peer tutors can be effective additional resource for students.
- Students need to do the work outside of class to learn the material.

Not communicating with tutors and communicate with tutors are in conflict, because

- We have a structured curriculum. Obligation to finish syllabus
- A structured curriculum doesn’t permit customization or doesn’t accommodate students with special needs.
- Students cannot take the responsibility to finish the syllabus their own."

Since needs never oppose each other in any conflict, if we consider the needs of both sides and fulfill them by one want or action – injection - agreeable to both sides, then the conflict evaporates! Or, to put it another way, if even one assumption is shown to be invalid and an appropriate injection for it is accepted, then the conflict is resolved. No compromise is necessary. A win-win solution arises.

Resolution of Instructor’s conflict in Example 2.4.1.1 - Now that most assumptions are surfaced for the instructor we are ready to find an injection so that the instructor’s conflict is resolved.

Finding Win-Win solutions

A Win-Win solution is a solution that fulfills both side’s needs. The problem is that in order to satisfy its needs, each side usually insists on getting its conflicting wants. The UDE, a cloud to communicate the conflict, and uncovering assumptions without blaming anyone are the keys to conflict resolution.
Thinking within a Win-Win framework requires us to shift the focus from getting what we want to obtaining what we need. For the above example, in satisfying the instructor’s needs, the assumption that “Students cannot take the responsibility to finish the syllabus on their own” was considered, and a ‘student-centered’ syllabus with detailed day-to-day course outlines including exam dates, resources available, grading and attendance policies was prepared. The instructor’s assumptions regarding tutors were considered by making adequate well-trained tutors available and advertising about tutoring. A booklet entitled, “Departmental Guidelines” was developed and presented in a meeting to explain to all stakeholders the roles of the students, instructors and tutors (supplemental instruction). This made students proactive in their success. A win-win solution was obtained. A structured curriculum is an essential part of course with multiple sections and is a fact of life.

2.4.2.1 Developing a cloud step by step from an UDE.
We will now discuss how to develop the Cloud in terms of actions. We use the following steps to examine the conflict using the Cloud with another person. An injection, an action to make the issue disappear, may occur at an appropriate time. But do not lose focus on resolving the conflict and achieving the objective.

With practice, you will not need to draw a cloud every time there is a potential conflict; you will be able to discern the issues - assumptions on both sides—mentally, and find a win-win solution to your potential conflict, so that no one has to compromise. Thus there will be no actual conflict.

**Step 1**: State the UDE. An UDE relates to two opposite wants. Wants are actions to be taken.

**Step 2**: Start with D, the specific action that caused the UDE.

**Step 3**: Write its opposite action in D’. D’ prevents the UDE. An action D fulfills a need and D’ fulfills a different need.

**Step 4**: To fill in B, write the general need for the want D. Do not rehash D, the want. D is specific. B is general or generic. B is also the need that D prevents us from fulfilling (according to the assumption of B-D).

**Step 5**: Fill in C. Again, C is general; D’ is specific. C is the need that D prevents us from fulfilling (according to the assumption of C-D’).

**Step 6**: Fill in A, the Common Goal or Objective that will be achieved if the needs of B and C are both satisfied. This can be summarized by the Cloud in Figure 2.4.

This will be explained further through specific examples.
This section describes five different ways a cloud can be used to resolve different types of conflicts.

1.4.2.2 Presenting a Cloud to another person.

The order in which we develop and analyze a cloud is not always the most effective way to communicate the cloud to another person. The other person probably has more interest in resolving the conflict on his/her side of the cloud than on yours.

Step 1. So, start by reaffirming your collective Common Goal.

Step 2. Then state the other person’s side, A-B, B-D. This shows that you have thought carefully about his/her needs and wants. If you have stated his incorrectly, get clarification and restate it.

Step 3. Then present your side, A-C, C-D’. This shows the other person why the conflict exists.

Step 4. Let the other side come up with injections or erroneous assumptions if he/she can.

Step 5. Continue to surface assumptions, and identify the one(s) you think you can invalidate.

Step 6. Invalidate as many assumptions using appropriate injections as you can with the other person’s help. Voila! The conflict is resolved.
2.4.3 Examples of Evaporating Cloud (EC), also known as a Conflict Cloud or a Cloud
We start with two very simple examples from personal experience that will give the reader the “feel” of how the process works. We also consider several examples pertaining to major issues of concern in a college/university setting, e.g., student attrition, that can also be addressed using clouds. The Cloud tool is simple enough to be used by kindergarten children, prison inmates, and so on, and is sophisticated enough to be used by corporate offices and educational institutions for conflict resolution and breakthrough solutions.

2.4.3.1 Resolving Day-to-day Problems

Example 2.4.3.1.1: A Mother’s Problem
The following example is an example of a day-to-day conflict. It was developed by Prof. Kareen Odet about a conflict between her and her eight-year old son, Robby. Kareen wants Robby to get ready in the morning on time so that both can leave the house on time. The result is that Kareen yells at Robby to hurry up and Robby complains.

A poorly stated UDE:
Kareen yells at Robby in the morning.
Or Robby complains in the morning.
This is a “symptomatic UDE,” meaning a reaction or secondary action rather than the actual action. **We must remove the emotion.** We correct it as follows and write it as a “systemic UDE,” meaning the actual action.

**UDE:** Robby is not ready on time in the morning.

In order to resolve the conflict we examine the two sides of the issue. “Breaking the cloud” leads to a win-win situation. The following steps can be followed to analyze any day-to-day conflict. In each step, just look at the relevant parts of the Figure 2.5 and not the entire figure.

**Step 2:** We write complete sentences clearly describing the two conflicting behaviors/opinions/situations/procedures in two boxes, D and D’, with the unwanted action in D and the desirable action in D’. Start with D. Then write its logical opposite, D’.

D: Robby must take more time to prepare.
D’: Robby must take less time to prepare.
These are in direct conflict with each other. These boxes describe the two opposing “Wants.”

**Step 3:** Now to see the needs that require the actions in D (Robby’s, son’s) and D’ (Kareen’s, mother’s), we write the two **needs** in boxes labeled B and C as shown. Remember: A need is something you must fulfill, and in your/their view, D or D’, a particular action, does so. The

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9 Prof. Kareen Odet is a counselor from the Freshman Year Program of Medgar Evers College of CUNY who developed this example in an April 2007 TOC workshop at MEC.
logic arrows are right to left. You are writing the necessary action that fulfills your need. Start with B.

As a general rule, after finishing every step, we read it aloud: “In order to fulfill the need B, I must perform or have D.” We must see that the logic makes sense. Otherwise, reword the statements so that each statement is logically sound.

(Robby’s side:) In order to be prepared to leave on time, I must take more time to prepare.

B ← D

Then fill in the box C. On the other hand, in order to fulfill the need C, I must perform or have D’.

On the other hand, (Kareen’s side) in order to fulfill the need C, I must perform or have D’.

Step 4: There is a common objective in box A: “To start the day out right.” The two logic arrows are placed right to left from B and C, respectively, to A.

We read aloud: “In order to attain the objective A, Robby must have or satisfy B. On the other hand, (or at the same time) in order to attain the objective A, Kareen must have or satisfy C.”

More specifically,

(Robby’s side:) “In order to start the day out right, I must be prepared on time. At the same time, (Kareen’s side:) in order to start the day out right, I must also have Robby and I are prepared to leave on time.” (We can adjust the language later as needed to flow more smoothly.)

After developing the Cloud (Figure 2.5), Kareen brought to the surface the assumptions on both sides. She had heard Robby’s usual complaints (assumptions B-D.) Then she also verbalized her own assumptions C-D’; she had explained assumptions 1 and 2 that morning to Robby. These assumptions are read as follows:

Robby: “In order to be prepared to leave on time, I must take more time to prepare.

…… because I need more sleep.
…… because Mommy can help me more.
…… because I can’t give myself enough time to do everything I need to.”

Similarly, the complete sentences C-D’ and Kareen’s assumptions must be read aloud before we proceed to resolve the conflict.
Kareen developed a solution to the problem on her own by challenging two of her own assumptions and also considering Robby’s assumptions, i.e.:

- Everything usually done by Robby has to be done by him (it doesn’t).
- Robby has to do everything that very morning (he doesn’t).
- Robby wants Mommy to help him more (and Mommy can do that).

Figure 2.5

**Robby’s Cloud – Getting Robby ready in the morning by Kareen Odate (FYP Counselor)**

**Issue:** “Robby (8-yr old son) takes more time to get ready in the morning.”

1. I need more sleep.
2. Mommy can help me more.
3. I can’t give myself enough time to do everything I need to.

**Resolution:** Robby does not have to do everything that morning. He can be told to prepare the previous night the clothes he is going to wear the next day. I must help him more to get ready in the morning. I must make Robby breakfast so that he will have fewer things to do by himself to be prepared in the morning. This will enable him to be ready at the required time.

A, B and C are conditions (states) and not actions. D jeopardizes C, because when Robby takes MORE time it makes him late and makes Kareen also late. D’ jeopardizes B, because Robby is not properly prepared if he doesn’t have enough time and taking LESS time is not an option. B and C do not oppose each other. The injection is that Robby does not have to do everything that morning. This idea comes from looking at the surfaced assumptions on both Robby’s and Kareen’s sides. Read the resolution in the above figure. In the proposed solution Robby has fewer things to do by himself every morning. He would naturally take less time to do his things to prepare. Kareen has found a ‘win-win’ solution. Read the cloud and the resolution again to see that there is no compromise made by either Robby or Kareen. At this point there is a paradigm shift that occurred due to challenging the assumptions on both sides. The paradigm shift resolved the conflict.
Example 2.4.3.1.2: Instructor’s Cloud – “Talk, no Talk” problem:
Dr. Christina Mouser\textsuperscript{10} developed this cloud and resolution.

UDE: Students talking in my class is disruptive.

The first step is to write a brief explanation of the UDE. Questioning offers another technique to develop the Cloud. In order to verbalize the needs she asked herself and answered the following questions:

- **What important need are you having trouble achieving because the issue or UDE exists?** – This is B.
  - I have the need to cover the syllabus.
  - It is necessary for students to hear the lesson without noise distractions.

- **What do you often end up doing to deal with this problem?** This is D.
  - I keep asking my students to stop talking.
  - I talk to the disruptive students out of class.

- **Why do you have to deal with the problem? (Or, what sometimes happens when you DO try to deal with the problem?)** - Assumption for B.
  - Students who are talking disrupt my thinking. I won’t be able to cover the material
  - Students who want to learn also get annoyed. They don’t hear the lesson.

- **What action do you sometimes (often?) PREFER to be taken?**
  - I talk to the disruptive students outside class without embarrassing them in the classroom.

The D’ box is the logical opposite of D. She filled out the box C and assumptions for C, needs and assumptions for students, from her observations and having spoken with the students outside class. A is the common goal for students and the instructor.

\textsuperscript{10} Dr. Christina Mouser, a faculty member in the Department of Mathematics at Medgar Evers College of CUNY, developed this cloud and resolution in a TOC workshop in April, 2007.
Observe that B and C are general, D, D’ are logical opposites. D’ jeopardizes B and D jeopardizes C.

Did Christina or students have to compromise? Students talked in their groups and while answering Christina’s questions satisfied their need to have a favorable learning environment by interacting with one another. Christina held students’ focus on the lesson by engaging them. They stopped talking to one another disruptively and the conflict was resolved.

2.5 Addressing Chronic Conflicts

Definition: Chronic Conflict - A conflict for an individual is a chronic conflict if the person feels trapped, does not see any other choice and feels powerless to remove the conflict. The individual submits to the reality unwillingly. The issue is long term, highly emotional, with little effort being given to addressing the issue. The issue may be personal or interpersonal. – (AGI)

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11 AGI – Avraham Goldratt Institute, New Haven, CT. The authors had their training in TOC at AGI in 2001-2002 and 2005 with funding from MSEIP (Minority Science and Engineering Project) and WEEA (Women’s Equity in Education Act): two US Department of Education grants.
Any conflict not addressed directly has a tendency to become a chronic conflict, unless, because of time or change in the situation or maturity, the issue no longer exists. An emotional exchange and underlying conflict between two spouses can also be solved using this technique.

Remember a Cloud has box A as the common goal, boxes B and C as general needs, and boxes D and D’ as specific, logically opposite wants. D-D’ causes the conflict, while A, B and C do not. For the student, for example, who has the chronic problem and wants to resolve it, the Cloud must be broken on his/her side, the B-D side. He/she doesn’t want D to happen. However, s/he has to accept the other person’s side, the C-D’ side, without neglecting his/her own need. B. This Cloud requires the use of the Negative Branch (to be defined and discussed later) to improve the solution. This also requires help from people representing the other side for support. To complete a solution, the Positive Branch (to be defined and discussed later) is also necessary. How to present the cloud to the other party is discussed at the end of this section.

Examples of Chronic Conflicts:

Example 2.5.1: A Student’s Dilemma:
UDE: “I cannot attend my classes on time.”
This is an example that requires a student to help his or her college to take some action to address student attrition.

Storyline: Marie is a student with family and personal responsibilities and cannot attend her math classes on time. Sometimes she has to be absent, and many times she is late for her class. But she and her course instructor (or College) want her to attend classes on time. This creates a conflict in the student’s mind. Marie works with the instructor or a counselor on this Cloud.
The numbers above indicate the order of steps we take to create a cloud. Remember that after finishing every step, we read it aloud to make sure that the logic makes sense; otherwise we reword the statements so that each statement is logically sound. Each statement is simple and grammatically complete.

Observe that D and D' are logical opposites of each other. The statements B-D, C-D', A-B, A-C have been reworded after several tries to make them logically sound, by reading aloud “In order to”... “we must have/do” ...

Then the entire cloud is read aloud by Marie. “In order to have success in personal life,” I must “be responsible to take care of family/personal problems.” And in order to “be responsible to take care of family/personal problems,” I must “remain absent or be late to my classes.” At the same time, in order to have “success in personal life” I must “know course material.” And in order to “know course material” I must “attend classes on time.” D and D’ are in direct conflict. “I don’t know what to do.” – Marie opined.

Once we have created the cloud, we must find various assumptions underlying the logic arrows: B ← D, C ← D' and the conflict, D ← D'. Surfacing these assumptions takes time, and might seem tedious, but it is essential. Challenging these assumptions leads to breaking the cloud and resolving the conflict.

There are two scenarios: institutional and personal. If there are many students in the College like Marie, it is necessary for the College to make certain changes. However, that takes time, since there are many individuals and departments involved. But an individual student can make appropriate changes more rapidly.
For example, Marie feels that there is no one else to fulfill her obligations at a certain time. This is included in the analysis as: In order to attend to family responsibilities or personal problems, I must remain absent or be late to my classes because there is no one else to fulfill my obligations at a certain time.

A detailed discussion of Marie’s case involving mathematics faculty and some students revealed the following assumptions described in Figure 2.8.

In the following case let us also consider the assumptions underlying the logic arrows: A ↔ B and A ↔ C.

**Figure 2.8**

Here we are using the idea of surfacing assumptions between D and D', i.e., why there is a conflict in the first place. Surfacing these assumptions reveals some institutional policies, written or unwritten, which can be addressed by the institution. Otherwise, most other assumptions just indicate why it is a conflict and provide no further information.
On the institutional side, two bolded statements in the reasons (assumptions) for D-D’ led to a viable strategy for improvement for the department: The department offers programs tailored to the needs of the students. Classes can be easily switched without damage if a student’s work schedule changes. Support services will be offered if needed. Intervention occurs when a student remains absent or is not performing, by the faculty member contacting the counselor or talking to the student. This way the student could be in a ‘win-win’ situation. In the Mathematics Department, this approach has led to synchronization and enhancement of support services.

The student herself could break the cloud if she saw the importance of both sides and arranged her situation or classes with the help of her family members, if necessary, in such a way that she could both study and take care of her personal responsibilities using different options. She does not have to sacrifice one for another. A college education offers the student the means to improve her financial situation, to have a broader perspective and to help her family. This observation is derived from the assumptions for the logic arrow A ← C, A ← B.

Fleshing out the different assumptions in the above diagram is the hard part. Only a group discussion, in the case of the department, and discussion of the student with the family members or a counselor can uncover the various assumptions.

There are many other examples of a Cloud developed in workshops and presentations on the website: (under construction)

Exercises -
1. Develop a cloud to resolve some day-to-day conflict on your own. Use the template provided at the end of the chapter. Use the reasoning above to form the cloud.

2. Prepare one cloud a day for a different conflict that you face. Surface the assumptions and suggest a resolution to the conflict. Scrutinize the clouds of fellow classmates or friends if you are studying TOC in a class.

Example 2.5.2: Keeping up with the coursework:
UDE: I cannot keep up with all aspects of the course.
Gary is a college student. He always attends his classes regularly. But he finds that he is overwhelmed with the coursework. Whenever he is home he has to deal with either personal or family problems and he does not get much time to do the homework. He does not know how to keep up with all aspects of the course. He would like to keep up with the coursework to get A’s and B’s, but under his current conditions he feels helpless. Getting A’s and B’s seems elusive. The college is ready to help, but he feels that no one can help him and he is hesitant to ask.
UDE: I cannot keep up with all aspects of the course.

Gary’s Cloud

```
A
Enjoyable educational experience.

B
Responsive to family/personal problems.

C
Have A’s & B’s on periodic tests and projects.

D
Not keep up with the coursework.

D’
Keep up with the coursework.
```

The complete cloud is read as follows:

“In order to have an enjoyable educational experience, I must be responsive to my family and personal problems. In order to be responsive to my family/personal problems, I cannot keep up with the coursework. At the same time, in order to have an enjoyable educational experience, I must have A’s and B’s on periodic tests and projects. In order to have A’s and B’s on periodic tests and projects, I must keep up with the coursework. And "Not to keep up with the coursework" and "keep up with the coursework' presents a real dilemma.”

Now let us look at the assumptions behind each of the arrows. Again this requires work and discussion with a counselor or mentor.
Having surfaced the assumptions, Gary reads aloud the cloud with assumptions again: “In order to have an enjoyable educational experience I must have A’ and B’s on periodic tests and projects, because achieving high marks makes education an enjoyable experience, and so on.”

It is not hard to see that the action D results in negative consequences. We will address these using another tool, the Negative Branch Reservation.

**Negative Branch:**
Let us look what undesirable effects (UDE’s) or consequences arise as a result of Gary’s conflict, from Gary’s point of view.

1. I start preparing at the last minute for the tests or projects.
2. I do not perform well on my assignments and tests.
3. I have to request make up exams.
4. I have to drop out from courses important for my major, or take longer to finish.
5. I have to ask instructors to give make ups and INC’s (incompletes), ABS’s (absent grades).

Any of these UDE’s could be arranged in any order, but the following logic tree called “Branch” in general, or “Current Reality Tree” in particular, arranges them in a logical order with a sufficient condition or ‘if ... then ...’ logic. They are numbered consecutively here for...
convenience. In this case the branch is called a **Negative Branch** because the UDEs represent negative effects. The logic is made robust with additional statements of justification, or supporting statements, labeled a, b, c, d and e, (we used letters instead of numbers and square cornered boxes to distinguish them from the UDEs.) Here, these letters are used differently from those for the cloud. The flattened oval or “banana,” first used in Chapter 1, is for the connective “and.” **After observing the Negative Branch, we improve the situation by “trimming” the branch by intervening between two consecutive UDEs (joined by an arrow). This intervention is called “injection.”**

**Figure 2.11 A Negative Branch**

If Gary cannot keep up with all aspects of the course and if his grade depends on the exams and projects in the course, then he starts preparing at the last minute for the exams or projects. If he starts preparing at the last minute for the exams or projects and because there is not much time to understand the topics on tests and projects, he does not perform well on his assignments and tests. (Read the entire branch aloud.)

This negative branch can be read also as follows: (Gary reads:) “If I cannot keep up with all aspects of the course then I start preparing at the last minute for the tests or projects, because
my grade depends on the exams and projects in the course. (This means I cannot escape taking the test or doing the project.) If I start preparing at the last minute for the tests or projects, then I do not perform well on my assignments or tests, because there is not much time to understand the topics on tests…”

In order to arrive at a resolution to Gary’s problem, it is a good idea for him to work with a counselor, role model, or guide at the college representing A-C-D’ part of the Cloud in figure 2.9, who wants him to keep up with the coursework and to get A’s and B’s so that he has an enjoyable educational experience. He cannot do it alone.

*To repeat: In case of chronic conflicts, the choice of D’ is the opposite of the current choice that causes the UDE and is the only desirable choice. A guide or a counselor or someone representing the side A-C-D’ of the cloud can help the person with conflict to choose D’ and resolve the conflict faster by showing him/her that D is no longer valid.*

In order to arrive at a win-win resolution, Gary must not neglect the boxes B and A, or the need in B and the common goal of the Cloud, i.e., he must address family/personal problems so that he can have an enjoyable educational experience. He must also resolve to achieve D’, i.e., keep up with the coursework.

**Positive Branch:**

**Developing and trimming a Negative Branch is not enough to resolve a chronic conflict. It is necessary to construct a Positive Branch.**

Let us now construct an Institutional solution to the dilemma faced by all students who are like Marie (Example 3) or Gary (Example 4). We will develop a “**Positive Branch**” that reinforces Marie and Gary’s resolve to adopt D’ (see Figure 2.12).

**Direction of the Solution:**

**Definition:** An Injection is an intervention that breaks one of the arrows in the Negative Branch to help escape the dilemma.

**Can you think of an injection into the situation that will negate or invalidate Gary’s assumptions?** This injection (or injections) would help resolve the issues that students such as Gary (Example 2.5.2) and Marie (Example 2.5.1) have.

Gary or Marie’s College has the motto: “Success, one student at a time.” It has a mechanism in place to support the “injections.” The College’s injections are as follows:

**INJECTION 1:** The College Administration/Faculty have a mechanism to: 1. Inform students that the College is ready to help address their personal and academic concerns and follow up
with students and 2. Monitor student attendance and daily/weekly performance and contact the student if necessary.

Where did this injection come from? The college has made a commitment to reduce attrition, improve passing rates and graduate students who will be successful, responsible members of society. Before implementing that injection, the college must make all the prerequisite preparation through the next two injections.

**INJECTION 2:** The College through its offerings, curricula, guidance and teaching develops its students’ confidence in their ability to achieve success in life and in school.

**INJECTION 3:** Through TOC and its TP tools, students get training and guidance in time management and conflict resolution to help them balance coursework and personal responsibilities.

This injection addresses the assumptions that students such as Gary and Marie have regarding needs in their personal lives:

- Correctly resolving family/personal problems interferes with keeping up with coursework.
- The personal responsibilities don’t get fulfilled on their own.
- I have to take time from school work to do those things.
- There is no one else to fulfill my other obligations.
- My other obligations can’t/won’t go away.
- I can’t postpone my other obligations.

**INJECTION 4:** College faculty understand that the contributions they make to helping students solve or get insight into their difficulties are recognized as meaningful by the administration.

This injection is essential for the faculty, who spend more time helping students and therefore less time doing research and publishing in refereed journals. If the college does not recognize their time and their work with students, they will feel their time is wasted and that they had better turn to doing research. But again, there is another injection which can get rid of this fear. That injection is:

**INJECTION 5:** Faculty can work with students on publishable research that can be brought to the students’ level. This injection has rewards for both students and faculty.

**INJECTION 6:** Faculty and advisors help students get the academic skills to keep up with the coursework.

Where did this injection come from? This injection addresses the assumption:

C-D': The only way to achieve A’s and B’s is to keep up with the coursework.
This injection cuts or breaks the negative branch, Figure 2.11, at the first box 0.

The UDE also requires Gary (and Marie) to see the “positive branch.” This doubly assures that if students such as Gary focus on their coursework without neglecting their personal problems or obligations this will bring the college and them to a win-win solution. This positive branch comes from the “injections” in place at the college.

**Desired Effects:**

*Definition:* A “Desired Effect” (DE) is a statement which is the logical opposite of an UDE.

Let us now develop Desired Effects (DEs) for Gary’s and Marie’s UDEs. The College may state the DE more generally to cover all students like Gary and Marie. Hence these DEs are stated in general terms, not just logical opposite of UDE.

<table>
<thead>
<tr>
<th>UDEs</th>
<th>(Generalized) DEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I start preparing at the last minute for the tests or projects. – Gary</td>
<td>1. Students are good at keeping with all aspects of the course they are taking.</td>
</tr>
<tr>
<td>2. I do not perform well on my assignments and tests. – Gary</td>
<td>2. Students perform well on regular tests.</td>
</tr>
<tr>
<td>3. I have to request make up exams. – Gary</td>
<td>3. Students do not need to take make up exams.</td>
</tr>
<tr>
<td>4. I have to drop out from courses important for my major, or take longer to finish. – Gary</td>
<td>4. More students graduate in larger rates and College has low attrition rate.</td>
</tr>
<tr>
<td>5. I have to ask instructors to give make ups and INC’s (incompletes), ABS’s (absent grades). – Gary</td>
<td>5. Students get good grades.</td>
</tr>
<tr>
<td>6. I cannot attend my classes on time. – Marie</td>
<td>6. Students are keen on attending their classes on time.</td>
</tr>
<tr>
<td>7. I must attend to my family responsibilities. There is no one to help me. – Gary and Marie</td>
<td>7. Students keep in touch with faculty and counselors as they progress. (This addresses the second UDE in 7.)</td>
</tr>
</tbody>
</table>

*A Positive Branch consists of Desired Effects linked with cause-and-effect logic and with the injections.*

We usually write injections on a color (shaded) background and in square boxes (also called entities), write the DEs in boxes with rounded corners in another different color (shade) background and intermediate effects to complete the logic in boxes (entities) with white background and rounded corners. We might rearrange the numbers of DEs in the process.
A Positive Branch

In the above diagram DE 5 summarizes DE 2, DE 3 and DE 5.

Consideration of the negative and positive branches completes the discussion of chronic conflicts. Both the branches need to be developed and discussed for a lasting effect.

The solution of chronic conflicts requires a considerable amount of work by both parties involved. The party of C-D’ must help the party B-D with injections and work. The list of injections and actions brings about a “paradigm shift.”

The chronic conflict is always between two individuals, or one individual (upper side) and the other (lower) side, where the other side is an institution or department. A conflict full of emotion between two family members can also be resolved in this manner. The common goal for the family is to be happy. Conflicts will not arise between two members of the family if the person who is the student of TOC keeps in mind the needs of both family members and fulfills...
them. In addition, while fulfilling his/her own needs, the other family member should provide support. The following steps resolve a chronic conflict. Note that the strategy involved in presentation of the cloud and its resolution to the other party is different from the one that you used to analyze the conflict.

1. Let’s assume that you are a student of TOC and wish to resolve the chronic conflict. In this case, the arrow B-D (your side) has to be broken. The entities or boxes B and A should not be neglected.
2. The other side’s want or action, D’, has to be accepted, meaning that D’ is will be desirable or changed or new behavior after discussion.
3. Write the assumption B-D.
4. Think of an injection to break B-D.
5. Construct a Negative Branch arising from the injection that you have thought of.
6. Communicate the chronic conflict in a meeting with the other party as follows:
   i. Say: “I would like to make a fresh start.” Present the A-C-D’ as you see it. Ask if this adequately represents the other side’s viewpoint. If not, adjust the entities as needed.
   ii. Find out the other party’s issues (UDEs) that your want (D) has caused. The other party may be suspicious of opening up, but your genuineness will keep the communication channel open.
   iii. Present your side A-B-D and the assumption B-D: “In order to fulfill my need (B), I have D, because I feel…(See Assumption B-D.)”
   iv. Present the injection that you are willing to make.
   v. Present the Negative Branch you have constructed. Ask the other side to help you figure out how to avoid the negative consequences of your injection.
   vi. Your solo work is over at this point. Now both parties must exert an effort to move forward. Be patient and allow the other party to think about an injection to trim the negative branch, unless the party has already thought out an injection.
   vii. Maintain communication with the other party and observe the relationship. If there have been arguments, mentally go over the mistakes you may have made in anger or without considering the other side’s assumptions.
6. Trim the negative branch at different arrows. It is better to trim the earlier arrows with injection/s with the help of the other side. If the other side doesn’t come up with injections, focus on the common objective and remain sensitive to the other party’s need. Stay open and do not force the solution. Never go back to want D. A conflict does not exist if there are no opposing wants. Even though at present there is no solution to your liking, stay focused on a win-win situation with the common objective. Your positive efforts will never be wasted.

__Exercises__

1. Do you have a chronic conflict that you are afraid to work with? Work through a cloud and discuss it with your academic counselor or personal counselor.
2. From [www.autosocratic.com](http://www.autosocratic.com) select a chronic cloud in any area related to your major and present it to the instructor.
2.6 Empowerment Clouds
The conflicts we have seen so far empower each of the people involved in a conflict when the conflict is resolved. That is what ‘winning’ does to a person. It generates a feeling of confidence, a feeling of empowerment. Since no one loses, it is empowerment for both parties.

Here are other examples for empowerment:
In the following example, a student wants to select mathematics to major in, but is hesitant. The argument can be similarly developed for any other major.

Example 2.6.1: Empowering a student to select a major
Create the cloud: Shanaya wants to major in mathematics, but, given her past experience in mathematics, feels that she is not up to it. She does not have confidence that she can do it. She wants to get A’s and B’s, and she feels that she can do it easily in other majors. She does want to go into a challenging or technical career. She comes to a mentor who develops a cloud and finds her reasons or assumptions for not being a math major by asking her questions. The numbers in Figure 2.13 below indicate the order in which the mentor develops the cloud for Shanaya. She checks the logical to make sure that the need in the box B is jeopardized by D’, Shanaya’s proposed choice.

Figure 2.13
Cloud for: “I feel I am not up to taking mathematics as a major.”

She knows that the Department has taken the following measures to overcome students’ fear of learning mathematics.
Injections:
1. The Department of Mathematics, through course offerings, curriculum, guidance and teaching, imparts confidence in all its students in their ability to achieve success in school and life.
2. Through TOC and its TP tools, students get training and guidance in time management, problem solving and conflict resolution to address negative experiences and deficiencies.
3. By remaining in the department and working constantly with teachers and students who love mathematics, Shanaya will also love mathematics.
4. The department believes that anyone can excel in mathematics, provided there is a favorable learning environment.

The injections above address the assumptions that prevent Shanaya from becoming a math major and pave the way towards achieving her goal. For example, staying in a favorable learning environment, Shanaya can overcome her fear of mathematics. Regardless of her past experience with mathematics, she should know that the department wants her to succeed. She could make a fresh start, seek the help of instructors and follow their directions.

Actions Shanaya must take:
Shanaya’s goal is a long term goal. She needs to apply consistent effort. She should create an Ambitious Target Tree (ATT) discussed in Chapter 4 to list her obstacles and perform the actions to attain the Intermediate Objectives (IOs) that it indicates to overcome them. In order to work with faculty, Shanaya, with an open mind, should ask other students and have interactions with all faculty before selecting a mentor. Not all department faculty like to work with, guide, and do undergraduate research with students. She should find a faculty member with a compatible personality. She should work with a mentor to plan her coursework and undergraduate research. Being consistently in company of lovers of mathematics will help her to focus on the goal. She can learn how to study mathematics and get good grades. She should take each course as a “project” and make a project plan for the entire semester even before she has a mentor. See in the appendix of this chapter how to study a course as a project, how to study any subject, and how to study mathematics.

Presenting the Cloud:
Once the cloud is constructed as above, to discuss the cloud with Shanaya, the guide starts in a different order. She starts at the Goal A and reads the cloud. "In order to succeed in a technical career (A), you must do well in a challenging curriculum (B). And in order to do well in a challenging curriculum, you must take mathematics major (D) because mathematics provides tools, concepts and skills to succeed in a challenging curriculum—(assumption B-D not written.) On the other hand, in order to succeed in a technical career, you must get A’s and B’s. And in order to get A’s and B’s, you must not become a mathematics major (Opt for some other major), because you did not do well in mathematics in the past, etc. Becoming a mathematics major and not becoming a math major is a conflict. In order to break the conflict you must break the link
between C and D’, i.e., you must be able to get A’s and B’s in mathematics courses also. That is the reason the plan of action suggested earlier is necessary. The numbers in Figure 2.14 indicate the order in which the mentor discussed the cloud with Shanaya.

**Figure 2.14**

Empowering Cloud: “I feel I am capable of taking mathematics as a major.”

Using the Cloud to take action:
The order in which Shanaya should interpret the cloud from the point of view of action is as given in Figure 2.15 and is different from the way it was developed or discussed with Shanaya. She should break the connection of C with D’ with an injection to resolve the conflict.

**Figure 2.15**

Empowering Cloud: “I feel I am capable of taking mathematics as a major.”
The above cloud was written for a student who wanted to be mathematics major. Similar empowerment clouds can be developed for any other subject.

**Example 2.6.2: Empowering a person in a job position**

Conflicts arise when a person feels inadequate in a job position because of certain official or unofficial rules. We want to develop a conflict resolution paradigm which empowers a person in such cases.

Charles is a senior who has been appointed as a tutorial coordinator by Dr. Kelly, chairperson of the Department of Biology in an urban college. Dr. Macy is in charge of tutorial services. Charles is talented, trustworthy, responsible, well versed in computers, and does research with Dr. Kelly. He is well liked by all students. Dr. Macy has made a rule that all tutors must be approved by him. He has been sick for two days and the midterm test week is coming close. Students are coming to the department for tutorial help. There is a great need for a tutor and a tutor is available. But because of Dr. Macy’s rule, Charles cannot by himself hire a tutor. He comes to Dr. Kelly for help.

Dr. Kelly tries to contact Dr. Macy several times but he is unreachable. Dr. Kelly guides Charles to come to a decision using what is called the “fire-fighting” or “Lieutenant’s cloud.” It is an empowerment cloud. Figure 2.16 shows the initial cloud.

**Figure 2.16**

Charles’ cloud: “**I am not authorized to hire a tutor.**”

After constructing the cloud, Dr. Kelly first brought out the assumptions, which allowed him to come up with injections, as shown in Figure 2.17:
Injections:
1. Hire a tutor only with a good academic record and interpersonal skills.
2. The Chair will explain to the faculty supervisor for tutoring the overarching goal of the Department and monitor objectively the quality of tutor’s work and his/her students’ performance (along with other tutors’ work) documented by the tutorial database.
3. A ‘bad’ tutor does not reflect poorly on supervisor’s performance but on the department.
4. The Chair recognizes faculty supervisor’s efforts and concerns to maintain quality and assures him that the same standard will be followed by the department even in Dr. Macy’s absence.

Assumptions:
1. A complaint against a tutor reflects poorly on Dr. Macy’s performance.
2. Dr. Macy is the only person who is experienced in judging quality of tutoring.

Figure 2.17
Charles’ cloud: “I am not authorized to hire a tutor.”
The injections above assure a quality of tutors that will not bring a complaint. The quality is not judged by a person, but objectively by documented performance record of all tutors, so that the Chair does not need to “fight this fire” again. The ‘win-win’ effort helps the department to maintain harmony among the faculty.

The order of the boxes in Figure 2.17 was used to develop the cloud, by first making sure that the proposed need B is jeopardized by the policy in D’. He explained it to Charles in the order shown in Figure 2.18.

**Figure 2.18**

Charles’ cloud: “I am not authorized to hire a tutor.”

The actions that Charles must take are shown in Figure 2.19: Break the link between C-D’. Read the cloud below in the marked order of the entities to understand why the rule D’ was made in the first place. This conflict is resolved by meeting the needs 1 and 3 to achieve the objective 5.

**INJECTIONS:** Always select a tutor who is sure to maintain quality of tutoring. Present to the supervisor the tutor and tutor’s record, and to the Chair, if the supervisor is absent.

Note that D’ no longer causes a conflict, since it is now not an absolute policy.
2.6.3 If this satisfies your need, skip to Section 2.8 and then to Chapter 4 to learn the Prerequisite (PrT) or Ambitious Target Tree (ATT).

2.6.4 If you are working with children, skip to 2.8 and then go to Section 5.8 of TOCFE.

2.6.5 However, if your situation is more complex, keep reading.

Exercises -
1. Work with your instructor to help empower you to graduate in your major and develop a project plan. (Studying Chapter 4 for this purpose will help.)

2.7 Finding the Core Conflict using the Three Cloud Process
TOC also provides a rigorous way of identifying AND fully understanding a deep or CORE conflict underlying all or most of the System’s UDE’s using clouds.

Example 2.7.1: Institutional Problem Solving –Department of Mathematics, Medgar Evers College
Here we relist some of the UDEs from Section 1.2. 12

Students complain that...
1. The instructor moves too fast for students.
2. The instructor (knows his subject matter but) cannot teach.
3. I am unable to attend class regularly and/or on time.
4. I am not prepared for course (prerequisites for class).
5. I don’t have time to do the homework.
6. I don’t see importance/relevance of mathematics.

12 This work was done at Avraham Goldratt Institute, New Haven, CT, with facilitators Tracy Burton-Houle and Steve Simpliciano, in January, 2002 by the first author and colleagues Joshua Berenbom and Darius Movasseghi (Chair until 2009), with the support of MSEIP grant 2001-2004, U.S. Department of Education.
7. I feel I am not capable of doing mathematics.
8. The exams are too hard.
9. I have to take care of my family/personal problems.
10. I (some students) go blank on exams (poor test-taker).
11. The instructor does not care about me.
12. There isn’t help outside of class when I’m free.

Faculty complain that …
1. Students do not prepare for class.
2. Students don’t attend regularly or on time.
3. Students do poorly on tests.
4. There is not sufficient time to cover all material in the course.
5. Students register late for semester, and don’t start at the beginning of the semester.
6. Students do not have prerequisites for class.
7. (No matter how well I teach,) Students aren’t learning effectively.
8. I receive very little satisfaction from my work.
9. We feel pressure to pass students who are not adequately prepared for the next course.
10. Students haven’t mastered all the prerequisite topics needed for my course.

Administrators complain that…. 
1. There is a lack of cooperation by some faculty to carry out departmental agenda.
2. Too many students fail.
3. There is insufficient input by some faculty to address major departmental issues.
4. Some faculty is apathetic.

2.7.1.1 Developing Clouds for three representative UDEs
We selected three representative UDEs of students since faculty and department UDEs depend on students’ UDEs. The highlighted UDEs are 5, 7 and 12. For each UDE, we developed an Evaporating Cloud.
Evaporating Cloud # 1

Issue #5: “I don’t have time to do the homework.”

- Be a responsible person. (Must)
- Have time to fulfill other obligations. (Must)
- Know the material. (Must)
- Not do the homework. (Must)
- Do the homework (on time).  

Conflict!
We read each cloud aloud and worked on the wording until each necessary conditions sounded logically and grammatically correct.

2.7.1.2 Developing the Core Cloud from three clouds
From the three clouds we developed the Core or Generic Cloud as follows:
Chapter 2 – What to Change?

From the goals A1, A2 and A3 of the three clouds, we form A. We developed a Goal statement sufficiently broad to encompass the goals of the three clouds. From the entities B1, B2 and B3 of the three clouds, we form B. From the entities C1, C2 and C3 of the three clouds, we form C. From the entities D1, D2 and D3 of the three clouds, we form D. From the entities D’1, D’2 and D’3 of the three clouds, we form D’. The resulting cloud is called the Root Cause, Core Cloud or Generic Cloud.

Figure 2.23

We also studied the clouds from another set of three UDEs and found that the Core Cloud was the same. This confirmed what research has shown: only three representative clouds are needed to develop the Core Cloud. That work is not presented here.

2.7.1.3 Surfacing the underlying assumptions for the Core Cloud

The fully developed Core Cloud is shown in Figure 2.24. It lists the assumptions for A-B, A-C, B-D, C-D’, and D-D’.
2.7.1.4 Developing the Conflict/Communication Current Reality Tree (CCRT) for the College System

We developed the Conflict Current Reality Tree (CCRT) using the Core Cloud as the base of the tree. This tree is huge and to present it requires two sheets. Interested readers can request the different trees from the first author.

Here we note that the root of the CCRT is the entity A. It is laid vertically. We read it with sufficient condition logic: “If A then B, and at the same time, if A then C. If B then D. and if C then D’. We rewrite D and D’ as follows.

D: We have pressure to NOT do the required activities for math classes.
D’: We have pressure to do the required activities for math classes.”
(Note that this is different from how the cloud was created using necessity-based logic.)

We found that most UDE’s can be logically connected with D, to yield a single, unified CCRT.
Chapter 2 – What to Change?

Figure 2.25 Legend: Student UDEs are in Magenta boxes; Additional steps and clauses in Yellow; and Faculty UDEs, in Green. (Note: the Preprint version is in grayscale)

A
I want to be a successful and responsible person.

B
I must fulfill other obligations (not my math class.)

C
I must learn the material.

D
I feel pressure to fulfill my other obligations.

D'
I feel pressure to do the required activities of my math class(es).

E
I must work hard in math.

E'
I do not see importance/relevance of mathematics I am taking.

F
My math instructor does not help me realize relevance of math I am taking.

105
I have difficulty learning the material (in math classes.)

106
I feel the instructor cannot teach.

107
I feel the instructor goes too fast.

108
I feel the exam too hard.

109
I feel pressure to fulfill my other obligations.

110
I feel pressure to do the required activities of my math class(es).

111
I cannot drop a class without jeopardizing financial aid.

112
I cannot get help outside of the class when I am free.

113
I do not have time to do the homework/or prepare for the course.

114
I do not know how to manage my time.

115
I have difficulty learning the material (in math classes.)

116
I need all the financial support.

117
I must carry a full load to get financial aid.

118
I do not work hard in math.

120
I am not motivated to learn the material.

121
I am unable to attend regularly and/or on time.

122
I do not have the prerequisites for the course.

123
I do not have time to do the homework/or prepare for the course.

124
I have difficulty taking tests.

125
I cannot follow the lecture.

126
I cannot follow the lecture.

127
I do not know how to manage my time.

128
I am unable to attend regularly and/or on time.

129
I do not have the prerequisites for the course.

130
I do not have time to do the homework/or prepare for the course.

131
I have difficulty taking tests.

132
I cannot follow the lecture.

133
I cannot follow the lecture.

134
I do not know how to manage my time.

135
I do not have time to do the homework/or prepare for the course.

136
I have difficulty taking tests.

137
I cannot follow the lecture.

138
I do not know how to manage my time.

139
I do not have time to do the homework/or prepare for the course.

140
I have difficulty taking tests.

141
I cannot follow the lecture.

142
I do not know how to manage my time.

143
I do not have time to do the homework/or prepare for the course.

144
I have difficulty taking tests.

145
I cannot follow the lecture.

146
I do not know how to manage my time.

147
I do not have time to do the homework/or prepare for the course.

148
I have difficulty taking tests.

149
I cannot follow the lecture.

150
I do not know how to manage my time.

151
I do not have time to do the homework/or prepare for the course.

152
I have difficulty taking tests.

153
I cannot follow the lecture.

154
I do not know how to manage my time.

155
I do not have time to do the homework/or prepare for the course.

156
I have difficulty taking tests.

157
I cannot follow the lecture.

158
I do not know how to manage my time.

159
I do not have time to do the homework/or prepare for the course.

160
I have difficulty taking tests.

161
I cannot follow the lecture.

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I do not know how to manage my time.

163
I do not have time to do the homework/or prepare for the course.

164
I have difficulty taking tests.

165
I cannot follow the lecture.

166
I do not know how to manage my time.

167
I do not have time to do the homework/or prepare for the course.

168
I have difficulty taking tests.

169
I cannot follow the lecture.

170
I do not know how to manage my time.

171
I do not have time to do the homework/or prepare for the course.

172
I have difficulty taking tests.

173
I cannot follow the lecture.

174
I do not know how to manage my time.

175
I do not have time to do the homework/or prepare for the course.

176
I have difficulty taking tests.

177
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178
I do not know how to manage my time.

179
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180
I have difficulty taking tests.

181
I cannot follow the lecture.

182
I do not know how to manage my time.

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184
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185
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188
I have difficulty taking tests.

189
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190
I do not know how to manage my time.

191
I do not have time to do the homework/or prepare for the course.

192
I have difficulty taking tests.

193
I cannot follow the lecture.

194
I do not know how to manage my time.

195
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196
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197
I cannot follow the lecture.

198
I do not know how to manage my time.

199
I do not have time to do the homework/or prepare for the course.

200
I have difficulty taking tests.

201
I cannot follow the lecture.

202
I do not know how to manage my time.

203
I do not have time to do the homework/or prepare for the course.

204
I have difficulty taking tests.

205
I cannot follow the lecture.

206
I do not know how to manage my time.

207
I do not have time to do the homework/or prepare for the course.

208
I have difficulty taking tests.

209
I cannot follow the lecture.

210
I do not know how to manage my time.

211
I do not have time to do the homework/or prepare for the course.

212
I have difficulty taking tests.

213
I cannot follow the lecture.

214
I do not know how to manage my time.

215
I do not have time to do the homework/or prepare for the course.
I feel the instructor does not care from me.

Instructor does not help me. (e.g. does not respond to my questions, etc.)

I feel the instructor goes too fast.

I feel the exam too hard.

Students/I do poorly on tests.

I perceive I cannot capable of doing mathematics.

Sometimes the instructor slows down.

There is not sufficient time to cover the required material in the course.

Students stay in class even though they can’t/don’t do the work.

Dropout rate (in class) is too high.

Level of achievement is too low in classes.

We sometimes pass students even though they have not fully achieved objectives of course.

Incompletes are given incorrectly.

There are too many incompletes.

I am forced to ask for incomplete grades.

Sometimes the instructors do not slow down.

Too many students fail.

Students don’t graduate on time.

Dropout rate (in class) is too high.

Incompletes are given incorrectly.

There are too many incompletes.

Students don’t graduate on time.
Chapter 2 – What to Change?

After developing the CCRT, we discussed whether each UDE relates to a Policy, Measurement or Behavior.

Examples:
Instructors’ UDEs
11. Students don’t attend regularly or on time. - Behavior
12. Students do poorly on tests. - Measurement
13. There is not sufficient time to cover all material in the course. – Policy
14. Students register late for semester, (don’t start at the beginning of the semester.) - Behavior

Students’ UDE 12. There isn’t help outside of class when I’m free. - Policy.

The reason for this discussion is that if it is a policy, it can be changed. Policies give rise to measurements. Measurements give rise to behavior. A change in policy will be reflected in measurements and hence in behaviors. Behavior alone cannot be changed.

Not all UDE’s can be classified as a policy, measurement or behavior. For example,

Students come to school hungry (no food, transportation, etc.)
We have a structured curriculum that cannot be individualized.
These are facts of life (FOL) in our area of control and influence. Our system has to accept these facts.

Looking at the CCRT, we also found several negative feedback loops, one of which was presented in Section 2.3.

Thus the CORE CLOUD and CCRT together answer the first basic question “What to Change?” completely. They describe the System’s constraint and current reality. The base is the constraint and current reality develops from it.

2.7.1.5 Regions in the CCRT
This section is optional. For simplicity, we again take Example 2.4.3.1.2: Instructor’s Cloud – “Talk, no Talk” problem: 13 We show how the CCRT is developed from the fully developed cloud. The CCRT gives rise to negative feedback loops.

“Talk? Don’t Talk?” Storyline: When students talk in my class, I have to stop teaching until I can get my class back under control. If I don’t, the other students can’t hear the lecture and miss the information. These disruptions prevent me from presenting the complete syllabus.
• UDE: Students talking in class is disruptive.
• D: Students do NOT talk in class.

---

13 The credit for this section goes to Chuck Gauthier, Facilitator, January, 2011, TOC workshop in Riverhead, NY.
Talk? Don’t Talk? Cloud

B ← D Assumptions
1. The instructor must stop teaching when students are talking.
2. The entire syllabus cannot be presented.
3. Some students cannot hear the lesson when other students are talking.

A ← B Assumptions
1. Students get the required knowledge.

A. Students know the material.

B. Entire syllabus is presented.

C. The environment is conducive to learning.

D. Students don’t talk to one another in class.

D’. Students talk to one another in class.

D ↔ D’ Assumption
These appear to be mutually exclusive because one can’t talk and be quiet at the same time.

A ← C Assumptions
1. Conducive environments promote better learning.

C ← D’ Assumptions
1. Students can share and exchange ideas.
2. To participate in the learning process.

• D jeopardizes C because without talking they cannot share and exchange ideas.
• D’ jeopardizes B because disruptions prevent the instructor from covering the entire syllabus.
Chapter 2 – What to Change?

Turn it around. Change the arrows.

D. Students don’t talk to one another in class.
D’. Students talk to one another in class.
B. Entire syllabus is presented.
C. The environment is conducive to learning.
A. Students know the material.

Change the logic to ‘if...then...’ and change a few words as shown.

I have pressure that Students don’t talk to one another in class.
I have pressure that students talk to one another in class.
Entire syllabus must be presented.
The environment must be conducive to learning.
We want Students to know the material.
Add in at least one Assumption for each arrow (the one you want to break)

- Students are confused about when they can/can’t talk.
- I have pressure that Students don’t talk to one another in class.
- I have pressure that students talk to one another in class.
- Entire syllabus must be presented.
- The environment must be conducive to learning.
- Students aren’t sure about when they can/can’t talk.
- Disruptions prevent the entire syllabus from being presented.
- Talking promotes sharing and the exchange of ideas.
- We want Students know the material.
- Students need to get the required knowledge.
- Conducive environments promote better learning.
- Students know the material.

Entire syllabus must be presented.

The environment must be conducive to learning.

We want Students know the material.

Students need to get the required knowledge.

Conducive environments promote better learning.

Talking promotes sharing and the exchange of ideas.

Disruptions prevent the entire syllabus from being presented.

We want Students know the material.

Students need to get the required knowledge.

Conducive environments promote better learning.

Talking promotes sharing and the exchange of ideas.

Disruptions prevent the entire syllabus from being presented.

We want Students know the material.

Students need to get the required knowledge.

Conducive environments promote better learning.

Talking promotes sharing and the exchange of ideas.

Disruptions prevent the entire syllabus from being presented.

We want Students know the material.

Students need to get the required knowledge.

Conducive environments promote better learning.

Talking promotes sharing and the exchange of ideas.

Disruptions prevent the entire syllabus from being presented.

We want Students know the material.

Students need to get the required knowledge.

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Chapter 2 – What to Change?

Expand/ Develop the Effects of the Conflict

I have pressure that students don’t talk to one another in class.

I have pressure that students talk to one another in class.

Students are confused about when they can/can’t talk.

Students don’t share and exchange ideas.

Talking promotes sharing and the exchange of ideas.

Talking disrupts the class.

Students may not learn the material sufficiently.

Students are deprived of some of the necessary knowledge.

The instructor doesn’t have time to present the full syllabus.

Students are deprived of a learning opportunity.

Sometimes students don’t talk.

Sometimes students talk.

Identify Regions

Students may not learn the material sufficiently.

Not A

Not A

Not C

Not B

Not D’

Not D

Students are deprived of some of the necessary knowledge.

The instructor doesn’t have time to present the full syllabus.

Students are deprived of a learning opportunity.

Students don’t share and exchange ideas.

Talking promotes sharing and the exchange of ideas.

Talking disrupts the class.

Sometimes students don’t talk.

Sometimes students talk.

I have pressure that students don’t talk to one another in class.

I have pressure that students talk to one another in class.

Students aren’t sure about when they can/can’t talk.
We see above that the original conflict leads to UDE’s that are the opposite of A, B, C, D and D’, arranged in regions. If we don’t see these regions, we have probably missed something in our analysis. Organizing the regions this way will help us to create the CCRT.

We see above that regions tend to create feedback loops, positive or negative, that tend to maintain an undesirable situation. Identifying these is helpful in explaining the situation to others using the CCRT.

2.8 “Bright Idea” to break the Core Cloud

Consider Figure 2.26.
The assumptions D-D’ indicated that the Department could obtain a systemic solution by proposing a “Bright Idea” or main injection: The department offers programs tailored to the needs of its students. This is the start of answering the second basic question, “What to Change to?” We started working from our areas of control and influence, discussed in Chapter 1.

2.9 Summary of Breaking a Conflict
We can summarize “breaking a conflict” cloud in the following manner. The horizontal clouds are placed vertically side by side for comparison.

In any cloud make sure that want D’ jeopardizes the need B and the want D jeopardizes the need C. Since the needs are more general, they should not clash with specific wants. There are four ways to break the conflict shown Figure 2.27.

14 The credit for proposing the Bright Idea goes to Darius Movasseghi.
4 Ways to Breaking any Conflict with a Win/win solution

Method 1. Here D is negated. D’ fulfills both needs B and C. Surface the assumptions B-D and argue why D’ no longer jeopardizes B.

Examples: Mother’s problem:
1) Example 2.4.3.1.1 - Figure 2.5
2) Chronic Conflicts Example 2.5.1 - Figure 2.8
3) Example 2.5.2 – Figure 2.10

Method 2. Here D’ is negated. D fulfills both needs B and C. Argue why D no longer jeopardizes C.

Examples:
Empowerment Clouds
1) Example 2.6.1 - empowering a student to select a major - Figure 2.15
2) Example 2.6.2 - empowering a person in a job position – Figure 2.17

Method 3. Here D and D’ are both allowed, but at different specific times and for specific purposes. Instructor’s Problem Example 2.4.3.2 - Figure 2.6, Example 2.6.1 illustrates Systemic conflicts, as in Examples 2.4.3.1.1 and 2.7, are examples of Method 3. They indicate that a written or unwritten policy forms an UDE, and by changing the policy a resolution can be achieved.

Alan Barnard – [1, 2007]
Method 4. Here D and D’ are both negated and an action E fulfills both needs B and C.
Example: Instructor’s Issue regarding tutoring:
1) Figure 2.3, Example 2.4.3.2:
2) Instructor’s Cloud Example 2.4.1.1- Figure 2.6

2.10 Summary of steps to answer “What to Change?”
The following diagram summarizes the steps to answer the first question of Chapter 2.

1. What to Change?
Identifying the Problem

0. Why change?– Define system, goal, gaps, UnDesirable Effects (UDEs)

1. Three-Cloud Process: What core conflict is responsible for the UDEs?
- Section 2.7

2. Current Reality Tree: Is the core conflict really the core conflict?
- Sections 2.2, 2.7

3. Evaporating Cloud: What assumption(s) are we going to challenge?
- Sections 2.4, 2.5, 2.6, 2.8

Exercises -
1. Write about your experiences in your chosen major. List all issues that you think get in the way of your graduating in your major. Write them as UDEs. Work with members of your group and check the UDEs to see that they conform to the definition of UDE.

2. Give two examples of each of the clouds. Use www.autosocratic.com for examples if necessary.

3. Pick one thing in everyday life that bothers you. Write a storyline using PowerPoint. Develop an Evaporating Cloud. Check your logic to see whether it flows smoothly. Work with your classmates. Surface the assumptions behind the arrows. Suggest injections to resolve the conflict.
4. Write a list of UDEs of the issues in your larger “system” from the points of view of three different stakeholders. From the most important three UDEs and their clouds, prepare a Core Conflict Cloud. Surface the assumptions and suggest injections.

5. Write a summary on Conflict Resolution – Decision Making.
CHAPTER 3 – WHAT TO CHANGE TO?

3.1 Overview
This chapter answers the second question: What to change to? The answer is the Strategy of the TOC solution. If an UnDesirable Effect (UDE) indicates a negative effect in a Current Reality Tree, its logical opposite, a Desired Effect (DE), already considered in Chapter 2, indicates a positive effect in a Future Reality Tree, and tells us what to change to. All the DE’s that arise from the Core Conflict make up the Future Reality Tree (FRT). But a DE by itself is just wishful thinking, popularly called by TOC people a “flying pig.” Injections or interventions or actions must be introduced to make the DEs possible. The FRT uses sufficient condition logic.

In the third section we study the Negative Branch Reservation (NBR). While positive measures are being proposed to attain DEs, there might be negative consequences of a proposed measure. The entities of the Future Reality Tree must be scrutinized using NBR.

The fourth section describes the case study of the Department of Mathematics.

The fifth section summarizes the steps for answering the second question of Chapter 3.

3.2 A Positive Branch
Example 3.2.1 – How Faculty and Counselors can Reinforce the Student’s Positive Experiences (Intentional intervention to sustain a Positive Branch)
We saw in the example 2.3.1 the following UDEs of a student:

1. I cannot follow the lecture.
2. I perceive that I am not capable of doing mathematics.
3. I do not work hard in mathematics.
4. I don’t do the homework/or prepare for the course.
5. I do poorly on tests.
6. I feel that the exam is too hard.
7. I have difficulty learning the material (in math classes).
8. I have difficulty taking tests.

From the UDEs, we can formulate desirable experiences or desirable effects (DEs). These are the logical opposite of the experiences s/he currently has.

<table>
<thead>
<tr>
<th>UDEs</th>
<th>DEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I cannot follow the lecture.</td>
<td>1. I follow the lecture.</td>
</tr>
<tr>
<td>2. I perceive that I am not capable of doing mathematics</td>
<td>2. I am capable of doing mathematics.</td>
</tr>
<tr>
<td>3. I do not work hard in mathematics.</td>
<td>3. I work hard in mathematics.</td>
</tr>
<tr>
<td>4. I don’t have time to do the homework/or prepare for the course.</td>
<td>4. I find time to do the homework and prepare for the course.</td>
</tr>
<tr>
<td>5. I do poorly on tests</td>
<td>5. I do well on tests.</td>
</tr>
</tbody>
</table>
6. I feel the exam is too hard. 6. I feel the exam is reasonable.
7. I have difficulty learning the material (in math classes). 7. I do not have difficulty in learning math.
8. I have difficulty taking tests 8. I do not have difficulty taking tests.

Then we use a branch to connect the DEs logically with “if...then...” logic. Figure 3.1 shows this positive branch or Future Reality Tree. The FRT answers the question “What to change to?” Note that the D” entity in Figure 3.1 is connected with the DE’s. The numbers come from the list of UDEs/DEs above.

Figure 3.1: What To Change To? (Future Reality Tree – FRT)

The loop in the Figure 3.1 needs to be sustained. At this time this branch seems to be only wishful thinking. In order to make it his/her actual experience, the student needs to take certain steps. This involves considering what is called the “Prerequisite Tree” or “Ambitious Target Tree”. See Example 4.3.1 in Chapter 4, The Prerequisite Tree.

3.3. Half-Baked solutions
A Half-baked solution is a solution whose consequences are not all studied. These solutions often lead to unanticipated negative results. Before taking any action, if you study the many possible consequences using a branch, you can avoid the negative consequences and find some actions which can reinforce the positive consequences. Using the branch, your solutions to problems will not be half-baked solutions.
Example 3.3.1 – A Realistic Course Load – Trimming a Negative Branch

The following example is a part of the work to address student attrition in mathematics courses or college, in general. We will consider the Negative Branch Reservations for a branch in a Future Reality Tree (FRT). The actual FRT is too long and beyond the scope of the text. The entity we want to consider is the result in Figure 3.2.

The scenario is as follows: Many students take a course load which they cannot manage due to their personal circumstances or course prerequisites. For example, some students take a course load which is made up of all hard courses, instead of balancing their course load with a few easy and some hard courses. The injection was to advise students to have a realistic course load as in Figure 3.2. Along with this injection, the Department’s injection was that “classes are scheduled to accommodate students.” These injections led to the DE that students are punctual and attend all classes.

Figure 3.2

The Fact Of Life or FOL is related to a full-time student who pays a flat fee per semester. However, for a part-time student financial need must be considered in a student’s workload.
In Figure 3.3 we discuss the negative consequences of the result: “Students have realistic schedules.” By “realistic,” we mean that students balance their science and non-science/hard and easy courses in such a way that they can successfully carry out all the course activities without overloading themselves. If a student has received an incomplete, INC, grade in a course taken during the previous semester/s, that course needs to be added to the course load, even though the student does not register for it. If a student has responsibility for his/her family, this time needs to be considered in developing the workload along with the time needed for homework.

**Figure 3.3**

Figure 3.3 shows how the result 180 of “Students having realistic course schedules” could lead to negative effects such as reducing motivation, students having insufficient income and students dropping out. We can **trim this negative branch** using various injections described by dashed borders such as ‘Provide $ (monetary) support to students’ to prevent the negative effects. In short, the development of a positive branch must be accompanied by a Negative Branch Reservation (NBR) analysis.

### 3.3.1 A Future Reality Tree or a Positive Branch as a Standalone Tool

If this satisfies your need, you can skip to the Chapter 4 – How to Change. If not, read on. The FRT can be used in a complex situation to link injections to the desired effects.

### 3.4 Example 3.4.1: Institutional Problem Solving – Department of Mathematics, Medgar Evers College
Consider the list of UDEs in the Example 2.7.1. Recall that the DEs are logical opposites of UDEs. Here are several slides from TOC For Education International Conference, 2006, in Leon, Mexico.

**Figure 3.4**

<table>
<thead>
<tr>
<th>Students’ Issues</th>
<th>Desired Effects (DEs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The instructor moves too fast for students.</td>
<td>1. Instructor moves at a comfortable pace.</td>
</tr>
<tr>
<td>2. The instructor cannot teach.</td>
<td>2. Students are satisfied with the instructor’s teaching style</td>
</tr>
<tr>
<td>3. Students are not capable of doing mathematics.</td>
<td>3. Students do mathematics well.</td>
</tr>
<tr>
<td>4. Students are not prepared for course (prerequisites for class).</td>
<td>4. Students have all prerequisites for the course.</td>
</tr>
<tr>
<td>5. I don’t have time to do the homework.</td>
<td>5. Student finish all homework on time.</td>
</tr>
<tr>
<td>6. I don’t see importance/relevance of mathematics.</td>
<td>6. Students feel math is relevant for their career.</td>
</tr>
<tr>
<td>7. I am unable to attend class regularly and/or on time.</td>
<td>7. Students are punctual.</td>
</tr>
<tr>
<td>8. Students do poorly on tests.</td>
<td>8. Students do well on tests.</td>
</tr>
<tr>
<td>9. I have to take care of my family/personal problems.</td>
<td>9. I take care of my family/personal problems.</td>
</tr>
<tr>
<td>11. The instructor does not care about me.</td>
<td>11. Instructor helps me to keep up with the course.</td>
</tr>
<tr>
<td>12. There isn’t help outside of class when I’m free.</td>
<td>12. There is adequate help when I need it.</td>
</tr>
<tr>
<td>13. (I don’t know how to graduate from college).</td>
<td>13. I have sufficient knowledge/help to plan my college career.</td>
</tr>
<tr>
<td>14. My course load is too heavy (I’m forced to be full time in order to get financial aid).</td>
<td>14. I can handle my course load.</td>
</tr>
<tr>
<td>15. I do not know how to get good grades in important courses.</td>
<td>15. I get good grades in important courses.</td>
</tr>
<tr>
<td>19. I cannot drop a class without jeopardizing my financial aid.</td>
<td>19. I do not need to drop any class.</td>
</tr>
<tr>
<td>20. I am forced to ask for incompletes.</td>
<td>20. I am able to complete the course.</td>
</tr>
</tbody>
</table>
Faculty/Instructor Issues

21. Students do not prepare for class.
22. Students don’t attend regularly or on time.
23. Students do poorly on tests.
24. There is not sufficient time to cover all material in the course.
25. Students register late for semester, and don’t start at the beginning of the semester.
26. Students do not have prerequisites for class.

Department Chair Issues

27. There is a lack of cooperation by some faculty to carry out departmental agenda.
28. Too many students fail.
29. There is insufficient input by some faculty to address major departmental issues.
30. Some faculty are apathetic.

Desired Effects (DEs)

24. There is sufficient time to cover all material in the course.
25. All students begin at the start of the semester.
28. There is a high rate of passing.

Additional Issues (Reselected)

33. There are too many incompletes.
35. Students don’t graduate from college on time.
36. Drop-out rates (in class) are too high.
37. Level of achievement is too low in classes
38. The exams are too hard.

33. There are very few Incompletes.
35. Most students graduate on time.
36. Few students drop out of classes.
37. Student achievement is high.
When Desired Effects are to be sustained and become part of the culture of the institution, we call them Strategic Objectives.

**Definition:** Strategic Objectives are the long term goals that are attained automatically, as a result of consistent attainment of Desired Effects.

**Figure 3.5**

<table>
<thead>
<tr>
<th>Desired Effects (DEs)</th>
<th>Strategic Objectives (SOs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Instructor moves at a comfortable pace.</td>
<td>1. Instructor allows time for review/enrichment (SI).</td>
</tr>
<tr>
<td>2. Students are satisfied with the instructor’s teaching style</td>
<td>2. Students seek to take more courses in mathematics (D).</td>
</tr>
<tr>
<td>4. Students have all prerequisites for the course.</td>
<td>6. Students incorporate math in their career daily life (D).</td>
</tr>
<tr>
<td>5. Student finish all homework on time.</td>
<td>8. More students pass the course (DC).</td>
</tr>
<tr>
<td>6. Students feel math is relevant for their career.</td>
<td>9. I take care of my family/personal problems.</td>
</tr>
<tr>
<td>7. Students are punctual.</td>
<td>13. Students graduate on time/complete math course requirements (SDC).</td>
</tr>
<tr>
<td>9. I have to take care of my family/personal problems.</td>
<td>15. I get excellent in all courses.</td>
</tr>
<tr>
<td>11. Instructor helps me to keep up with the course.</td>
<td>19. I can perform better in the course.</td>
</tr>
<tr>
<td>12. There is adequate help when I need it.</td>
<td>20. I ACE the course! (S).</td>
</tr>
<tr>
<td>13. I have sufficient knowledge/help to plan my college career.</td>
<td>21. The Department is a Center of Excellence (D).</td>
</tr>
<tr>
<td>14. I can handle my course load.</td>
<td></td>
</tr>
</tbody>
</table>
The “Bright Idea” or “Great Idea” to break the core cloud was used as the base of the Future Reality Tree (FRT) shown in Figure 3.6. The “Bright Idea” for the Department of Mathematics study was: “The department offers programs tailored to the needs of its students.” The Bright Idea to begin with is general. We needed to expand it and make it specific. Thus, several injections or Tactical Objectives (TO) were introduced. For example, 100 Strategic Injection (SI) - Bright Idea: Department offers programs tailored to the needs of students.

105 We have ideal financial, academic, supplemental instruction, career, personal and counseling support when needed.

110 The Department provides guidelines for instruction.

165 Advisors advise students to have realistic course loads.

In order to connect DEs logically we took intermediate entities or used existing activities and proposed injections. These injections became Tactical Objectives for developing the next step, a Prerequisite Tree. The tree we obtained with injections and intermediate entities is called a Future Reality Tree (FRT). After we obtained, the FRT we worked on several Negative Branch Reservations. This work convinced us that the modified FRT would bear no negative consequences. We also looked for different sustaining loops which could be reinforced as in Figure 3.7. The FRT is difficult to read, but an interested reader can obtain the full FRT from the first author.
Chapter 3—What to Change To

Figure 3.6 Legend: DE’s are in Magenta; Injections, called “Tactical Objectives,” are in Green; and additional or existing entities are in Yellow (Grayscale in Preprint)
Students do well on tests.

Students learn all expected and necessary material.

Students have opportunity for test taking/prepare for tests.

Department makes prelude/practice tests available with feedback and asistance.

Students have good test-taking/preparation skills.

Students get a brush up on math needed for courses.

Students feel math is relevant for their careers

Students get good grades in math dependent courses.

Students do mathematics well.

Students do well on tests.

Students are satisfied with instructor's style
3.5 Summary of the steps to answer the second basic question: What to change to?
The answer is the Strategy for a TOC solution.
2. What to Change to? Constructing the Solution Strategy

3. Evaporating Cloud: What assumption(s) are we going to challenge?

4. List DEs

5. Future Reality Tree: Ensures that the starting injection will lead to all the DEs without creating negative branches.

Exercises -
Take any UDE to represent an issue for the day. Develop a list of negative consequences arising out of the UDE. This is a Negative branch. Trim the negative branch by one or more injections.

1. Form a DE from your UDE. Develop a list of positive consequences from the DE. This is a Positive Branch. Describe one or more injections to sustain the positive branch.

2. For the following set of UDEs form a set of DEs.
   1. Students do not keep the area clean.
   2. Administrators do not respect me.
   3. The non-academic challenges of students are often not addressed.
   4. The difference between an academic advisor and a counselor is not known.
   5. More and more students have mental health challenges.
   6. There are many turf wars.
   7. Students don’t see connections.
   8. The student services department experiences many disruptions.
   9. Students come to school hungry (no food, transportation, etc.)
   10. College faculty are dismissive of students’ personal issues.
   11. Students who identify as LGBT are victimized.
   12. Part-time faculty often do not attend to students’ needs.
   13. Some students fall between the cracks (Freshman seminar is not required of all students.)
14. There is a large dropout rate in science classes.
15. There is inconsistency of outcomes from Freshman classes.
16. Staff morale is low.

4. Try to connect as many UDEs as possible and develop a CRT. Try to connect as many DEs as possible and develop a FRT.
CHAPTER 4 – HOW TO CHANGE?

4.1 Overview
This chapter answers the third basic question: How to change? or How to cause the change? The answer is the Tactics of the TOC solution of a personal or institutional problem. The Thinking Process (TP) tools required here are Prerequisite Tree (PrT) and Transition Tree (TrT). In the second section we develop the concept of a Prerequisite Tree. A Prerequisite Tree is based on necessity condition logic. In order to achieve goals that at first glance seem unreachable, one needs to use The Ambitiously Target Tree (ATT), also known as the Prerequisite Tree (PrT). We describe several simple examples of a PrT. Constructing a syllabus is an example of a PrT. A PrT is a standalone tool. In the third section, how we can plan a project after developing a PrT. Using a project you will see how to do well in a course, with a given day-to-day syllabus. In the third section you will also see a game of multitasking. In the fourth section we will describe the concept of “Critical Chain Project Management” (CCPM) for managing a course successfully. In the fifth section, we consider the institutional example to describe the PrT in a complex case derived from institutional FRT. This leads to the sixth section of a Transition Tree (TrT). Section seven summarizes the answer to the third question, and Section eight gives the complete TOC roadmap to resolve conflicts, make decisions and solve problems whether the problem is personal or institutional. The Appendix to this chapter describes a TOC course titled, “Creative Thinkers’ Toolkit.”

4.2 Simple Examples
To develop this tree, start with a statement of your goal (Ambitious Target). Then make a list of all the obstacles to reaching that goal. Prepare a list of intermediate objectives (IOs), usually the logical opposite of the obstacle, but not always. Logically connect the IO’s using a “necessary condition” logic: “Before I have this ..., I must first have...”

Step 1: State the Ambitious Target and prepare a list of obstacles:

<table>
<thead>
<tr>
<th>Obstacle to reaching target</th>
<th>Intermediate Objective (IO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>
There could be any number of obstacles not just 9.

We have observed in our teaching ATT that the hardest thing for our students is doing the IO’s. We want to make it clear that each obstacle needs one IO and that the IO is not a SPECIFIC action but it is a state. A state does not take time. IO is attained by performing action which takes time. The actions performed successively according the logically listed IO attains the ambitious target. To arrive at an IO, make a logically opposite statement of the corresponding obstacle.

**Step 2:** Connect IOs logically, from bottom to top, using arrows to show the flow of the necessary condition logic. Beginning students always get the direction wrong and forget the arrows. We can use an IO Map.

**Step 3:** Plan activities to achieve each IO.
We have several examples of The Ambitious Target Tree starting with a very simple one.

**Example 4.2.1: We will fry an egg.**
This simple example was developed to help teach the PrT to Introductory Psychology Students by Nancy Oley.

<table>
<thead>
<tr>
<th>Obstacles</th>
<th>Intermediate Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. We do not have eggs.</td>
<td>1. We have eggs.</td>
</tr>
<tr>
<td>2. We do not have oil.</td>
<td>2. We have oil.</td>
</tr>
<tr>
<td>3. Eggs are not cooked.</td>
<td>3. Eggs are cooked.</td>
</tr>
</tbody>
</table>

Sample Prerequisite Tree
We develop an IO Map lining up the activities above as follows in Figure 4.1:

**Figure 4.1a:**

We read the tree top-to-bottom: Before I have 3, I must have 1 and 2. Thus 1 and 2 are necessary conditions for 3. In other words, before we cook an egg, we must have/buy eggs and we must have oil. Usually in an Ambitious Target Tree, and or “banana” is not used. In order to develop a complete Ambitious Target Tree, however, we need to add in missing steps. They are
numbered without the IO label. This also serves as a general time line for a project plan if rotated 90 degrees to the right and read from left to right with first IO at time 0. This results into a project plan which is logical series of actions. Each IO corresponds to one or more actions. For the sake of simplicity, we call the action/s IOs.

The numbers in the above ATT do not have any logical meaning except that they relate to IO 4. The numbers 4.1, 4.2, 4.3, 4.4, 4.5 are added actions to achieve 4, but some actions could be done before others, such as 4.5 before 4.4. Many people in fact do that.

The project plan can also be laid horizontally on a time line as follows:

Figure 4.1 b: Project Plan: Fry an Egg.

A.T. = WE HAVE A FRIED EGG

IO 3. Cook until firm

4.5 Light fire under the pan

4.2 Pour oil in the pan

4.4 Break egg into the pan

4.1 Take out frying pan

4.3 Get an egg

IO 1: Buy oil

IO 2: Buy eggs

2.1: Go shopping

Figure 4.1 b: Project Plan: Fry an Egg.

A.T. = WE HAVE A FRIED EGG

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IO 1: Buy oil

IO 2: Buy eggs

2.1: Go shopping

The numbers in the above ATT do not have any logical meaning except that they relate to IO 4. The numbers 4.1, 4.2, 4.3, 4.4, 4.5 are added actions to achieve 4, but some actions could be done before others, such as 4.5 before 4.4. Many people in fact do that.

The project plan can also be laid horizontally on a time line as follows:
On the Time axis, note that when IO 3 is attained, we have no more steps to do to reach the ambitious target.

Example 4.2.2: We will do Long Division of Numbers.
The following is a simple example regarding division. Suppose Pat does not know how to perform the long division of whole numbers. The teacher, Jana, and Pat worked together to come up with the following ambitious target tree and action plan.

Ambitious Target: We can do long division.

<table>
<thead>
<tr>
<th>Step 1: List the obstacles</th>
<th>Step 2: Intermediate Objectives (IOs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I don’t know where to start.</td>
<td>1. I know the arrangement.</td>
</tr>
<tr>
<td>2. I don’t know where to place the quotient at every step.</td>
<td>2. I know where to place the quotient at every step.</td>
</tr>
<tr>
<td>3. I don’t know multiplication tables and when to use them.</td>
<td>3. I know multiplication tables.</td>
</tr>
<tr>
<td>4. I have difficulty with subtraction and when to use it.</td>
<td>4. I know how to use the multiplication tables</td>
</tr>
<tr>
<td>5. I don’t know where to place the different numbers.</td>
<td>5. I know subtraction.</td>
</tr>
<tr>
<td>6. I don’t know the terminology.</td>
<td>6. I know where to subtract.</td>
</tr>
<tr>
<td></td>
<td>7. I know the arrangement in the division process.</td>
</tr>
<tr>
<td></td>
<td>8. I know the terminology.</td>
</tr>
</tbody>
</table>

One IO for each Obstacle is a must; but sometimes several more IO’s are necessary.

Rearrange the Intermediate Objectives (IOs) in a logical order.

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15 This example evolved in a break out session of the 8th Annual International Conference of the TOCforEducation, Seattle, WA, August, 2005.
Division of whole numbers is defined as repeated subtraction. Repetition involves multiplication. Thus the process of division involves multiplication and subtraction.

The project plan to perform division of long division is as follows. (Renumbered.)
1 – 3 (old) Practice multiplication tables – using recitation, video, songs, flash cards.
2 - 5 (old) Learn subtraction – single digits and by borrowing.
3 - 8 (old) Learn terminology: divisor, dividend, quotient, remainder, and relationship: remainder < divisor.
4 - 1 (old) Learn arrangement:
5 - 4 (old) Learn where and how to use multiplication tables.
6 – 6 (old) Place the subtraction result and get the new dividend.
7 - 2 (old) We have a new dividend and old divisor. At every step, repeat 5, 6.
We write a long division in the following traditional arrangement.

\[
\begin{array}{c|ccc}
\text{Divisor} & \text{quotient} & \text{dividend} \\
\hline
\end{array}
\]

Example:

\[
\begin{array}{c|c|c}
\text{divisor} & \text{quotient} & \text{dividend} \\
3 & 4 & 122 \\
- 12 & & - 12 \\
\hline
02 & 0 & - 00 \\
- 00 & & \\
\hline
\text{remainder} & 2 & \\
\end{array}
\]
Example 4.2.3: Ambitious Target Tree for a student to improve her learning

The student is capable of doing mathematics. In particular, she learns the course material. This is a student’s answer to How to cause the change? To answer this question requires considering all the obstacles in attaining the objective.

Ambitious Target: The student learns course material.
She lists all the obstacles. Recall: The logic used for Ambitious Target Tree is “necessity logic.”

Obstacles
1. I have forgotten/not taken prerequisite course
2. I cannot get help outside of my classes.
3. I have not formed logical connection between topics.
4. I do not have good study habits.
5. I do not know how to manage time.
6. I do not know how to study for a test.
7. I have test anxiety.

This list is rearranged as follows and renumbered.

<table>
<thead>
<tr>
<th>Obstacles</th>
<th>Intermediate Objectives (IOs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I do not have good study habits.</td>
<td>1. Take charge of directing my studies.</td>
</tr>
<tr>
<td>2. I do not know how to manage time.</td>
<td>2. Learn to use my time effectively.</td>
</tr>
<tr>
<td>3. I have forgotten/not taken prerequisite</td>
<td>3 a. Learn the prerequisite material for each topic from the</td>
</tr>
<tr>
<td>course.</td>
<td>text or consulting with instructor</td>
</tr>
<tr>
<td></td>
<td>3 b. Connect the prerequisite material logically to present</td>
</tr>
<tr>
<td></td>
<td>material.</td>
</tr>
<tr>
<td>4. I have not formed logical connection</td>
<td>4 a. Form logical connections between current topics.</td>
</tr>
<tr>
<td>between topics.</td>
<td>4 b. Summarize important points.</td>
</tr>
<tr>
<td></td>
<td>4 c. Read the material and note difficulties.</td>
</tr>
<tr>
<td>5. I cannot get help outside of my classes.</td>
<td>5 a. Talk to instructor/better students in class</td>
</tr>
<tr>
<td></td>
<td>5 b. Use internet to solve difficulties.</td>
</tr>
<tr>
<td>6. I do not know how to study for a test.</td>
<td>6 a. Complete my assignments on time.</td>
</tr>
<tr>
<td></td>
<td>6 b. Review day before the test, not cram.</td>
</tr>
<tr>
<td>7. I have test anxiety.</td>
<td>7 a. Learn to relieve test anxiety</td>
</tr>
<tr>
<td></td>
<td>7 b. Take mock tests at home.</td>
</tr>
</tbody>
</table>

Read aloud: Because of Obstacle 1, before we can have IO 2 we must first IO 1, and so on.

Example: In the above table IO 3 requires both IO 1 and IO 2. "Because I have forgotten/ not taken prerequisites I must first take charge of directing my studies and also learn to use my time effectively, before I can learn the prerequisite material ..."
We show this in the following figure. Obstacles go in “STOP” signs.
Each of these intermediate objectives may involve several activities depending on the student and situation. But it is clear that the Ambitious Target Tree focuses on learning material logically and on time, and performing well on the tests, a measure of learning the course material. This Ambitious Target Tree also gives a roadmap to a sequence of activities to get better grades in any course. Just put a time-line -- dates/hours-- for achieving the intermediate objectives.

In order for the student to sequence her detailed activities without logical gaps attaining the intermediate objectives of the Ambitious Target Tree, she can use a Transition Tree as in Example 4.6.1 for each intermediate objective.

**Example 4.2.4: Use of PrT and Its Implementation in Academic Content**

PrTs are also currently being used in Psychology courses by Dr. Oley. An example is given in the following paragraphs.

**PREREQUISITE TREE ANALYSIS**

**Dr. Oley**

**AMBITIONST Target (AT)**

1. AMBITIOUS TARGET—This is your goal, and should appear at the top of your diagram. State it clearly so that there is no ambiguity.

**OBSTACLES (OB)**

2. OBSTACLE—This is something that is standing in the way of your accomplishing your goal.

3. OBSTACLE NUMBERS--Number the obstacles; the order makes no difference.
4. CLARITY--The meaning of your AT, OB or IO is unclear.

**INTERMEDIATE OBJECTIVES (IO)**

5. INTERMEDIATE OBJECTIVE—This is a general statement of what the situation would look like if the specific obstacle were overcome, e.g., if the obstacle is that “I don’t have the money,” an appropriate IO might be “I will have the money” or “I will not need money.” Do not assume that the IO is always just the opposite of the OB. Be creative in envisioning the IO.

6. OB-IOPARALLELS—For each obstacle, there should be an IO; for each IO there should be an OB.

7. IO NUMBERS-- Each IO should be numbered according to the Obstacle it overcomes; the order of the numbers makes no difference. You should include these numbers in the PrT.

8. COMPLETE SENTENCES--Use a complete sentence to state the AT, OB, or IO.

9. IO CONTENT--The intermediate object should NOT explain HOW to overcome the obstacle in specific terms. It should be more general. A specific solution comes later when you turn your PrT into an action plan.

**PREREQUISITE TREE (PrT)**

10. TREE STRUCTURE--The tree should start at the bottom of the page and work towards the top.

11. LOGIC—To check the logic connecting these two IO’s, use the test “In order to have the upper item, I MUST first have the lower item.”

12. BRANCHES—Do you need another branch here? You can have many branches leading up to the AT.

13. ARROWS--You need to use arrows to connect the items.

**Example 4.2.5:** We will implement thinking process tools of TOC in FYP to promote student success.  

<table>
<thead>
<tr>
<th>Obstacles</th>
<th>Intermediate Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The faculty has a workload that prevents any additional activities.</td>
<td>1. The faculty workload will allow for additional activities of any magnitude.</td>
</tr>
<tr>
<td>2. The faculty are not trained.</td>
<td>2. The faculty will be sufficiently trained.</td>
</tr>
<tr>
<td>3. There is no time to learn new ideas.</td>
<td>3. There is enough time to be receptive to new ideas.</td>
</tr>
<tr>
<td>4. The faculty are not open to the discussion</td>
<td>4. The faculty will be open to the discussion of TOC.</td>
</tr>
</tbody>
</table>

16 Acknowledgment: This work was done by a group of faculty from the Freshman Year Program and Department of Mathematics of Medgar Evers College of CUNY at AGI, New Haven, CT in January 2007 under the funding of WEEA grant of the U.S. Department of Education. Howard Meeks of AGI, retired Professor of University of Iowa, served as a facilitator.
5. Leadership at various levels has chronic conflicts that block collaboration. | 5. Leadership at all levels of the college will resolve chronic conflicts that block collaboration
6. TOC is not included in the college budget. | 6. TOC is included in the college budget.
7. There is no faculty training in TOC. | 7. The faculty will receive TOC training.
8. The curriculum is not coordinated between FYP and academic departments. | 8. The curriculum will be coordinated between FYP and the academic departments.
9. The faculty do not receive support or want to participate in TOC training. | 9a. The faculty will be reassured they will have adequate support.
9b. The faculty will be willing to participate.
10. Part-time faculty do not get compensated for extra time spent (policy) | 10. Part-time faculty will be compensated for extra time spent
11. Students are not excited about TOC. | 11. Students will be excited about TOC.
12. Leadership at some levels does not value problem solving. | 12. Leadership at all levels will value problem solving.
13. TOC has not yet been proven to be an effective tool in education. | 13. TOC has been proven to be an effective tool in education.
14. There is not enough time to teach TOC. | 14. There will sufficient time to teach TOC.
15. Faculty morale in the College is low. | 15. Faculty morale in the College is high.
16. Some staff development programs are not meaningful. | 16. All staff development programs will be meaningful.
17. FYP policies and practices are not strictly enforced. | 17. Adherence to FYP policies and practices is strictly enforced.
18. There are no training programs available. | 18. There are training programs available.
19. No trained help is available. | 19. There is trained help available.
20. TP tools are not regarded as important in all programs. | 20. TP tools are important in all programs.
21. We do not have a formal process of implementing new initiatives system wide. | 21. We will develop a formal process for implementing new initiatives system wide
22. Faculty/staff at some levels do not support FYP. | 22. Faculty/staff at all levels will support FYP.
23. Workbooks are not available. | 23. Workbooks are available.

An IO map was not developed, but a PrT was used directly using sticky notes. Before writing the final draft of PrT, we, as mentioned before, write each IO using a notepad with sticky notes so that they are easy to move around for placing in a logical order and also they stick on a paper. The final draft turned out to be as follows.
We will prepare a Project Plan for this PrT on the next page.
For a project plan the activities are sequenced on a flexible time axis. A syllabus for such a course is in the Appendix of Chapter 4.

Example 4.2.6: “Faculty Satisfaction in 90 minutes”
In a 90 minute discussion on improving faculty satisfaction during a Faculty Development Workshop in January, 2007, at Medgar Evers College facilitated by Nancy Oley this ATT was developed. Here we discuss the steps involved.

Discussion of Faculty Satisfaction: The table shows the apprehension the facilitator felt before holding the discussion. She built the following ATT as a set of rules to have a meaningful discussion.

<table>
<thead>
<tr>
<th>Obstacles</th>
<th>Intermediate Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely limited amount of time to complete task</td>
<td>Time will be used efficiently</td>
</tr>
<tr>
<td>Faculty and Administration have hostile relations</td>
<td>Faculty and Administration will not have hostile relations</td>
</tr>
<tr>
<td>Faculty want to assign blame</td>
<td>Blame will not occur</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Faculty do not feel they and their opinions are valued</td>
<td>Faculty will feel valued</td>
</tr>
</tbody>
</table>

**STEPS**
Get agreement to use index cards to express issues (obstacles) and desired outcomes (intermediate objectives)
1. Insure that each person can contribute as many ideas verbally and/or on index cards as desired.
2. Do not permit criticism of ideas; administration is not allowed to comment, but can ask for clarification.

3. Issues on index cards:

```
Academic Issues

1. Release time and support for faculty research
2. Collegiality of faculty & less politics
3. Increase library holdings & e-resources
4. Updated governance plan, college catalog & phone directories

Academic Issues

1. Respect shown to faculty
2. Faculty on college policies
3. Access to information about the budget
```
Comment

- Everyone quickly understood how to formulate obstacles, although they tended to list them on a single card.
- Not everyone understood how to formulate intermediate objectives versus actions.
- The discussion was respectful and low key.
- Administration took a lot of notes.
- Faculty expressed satisfaction with the discussion afterward.

4. After the Meeting…

- Transcribe the ideas from index cards
  - Many items were listed on the index cards (in RED) but not mentioned publicly.
- Refine and combine IO’s in order to—
  - Create first draft of logical tree (Prerequisite tree)
Figure 4.6

AT: Faculty will be very satisfied with their working environment

IO1. The institutional climate will be satisfactory

IO3. The academic climate will be satisfactory

IO2. Administrative and staff support for faculty teaching and research will be satisfactory

IO4. The physical plant will be appropriate and well maintained.

OVERVIEW

INSTITUTIONAL CLIMATE

IO1. The institutional climate for faculty will be satisfactory

Faculty feel safe on campus.

- Offices with windows have shades
- Students are respectful to faculty.
- It is safe to cross streets near campus

Sexual harassment and hostile work environment issues are dealt with appropriately.

Faculty bathrooms are not shared with students.
There is a transparent budget process.

Faculty are shown respect by administration.
Faculty understand how and why decisions are made.
Faculty have significant influence over the policies that affect them.
Faculty affairs are managed by faculty, not administration.
Faculty influence the allocation of resources that affect their teaching and professional lives.

There is careful long range planning.
There is college wide coordination of activities.
Meetings result in documentable actions.
There are sufficient "non class hours" for meetings.

There is a place for faculty to congregate.
The College Council is controlled by the membership, not the President.
Information about College business is available inside the College before it is available outside the College.
Key College documents are continuously updated.

Innovative ideas are brought forth.
There is adequate input from all levels.
Faculty are engaged in college issues.
Faculty participate in activities that feed into college governance.

People appointed to governance roles report back to their constituencies.
People appointed to governance roles are recalled for non-performance of duties.

Pleasant dining service is provided for faculty.

Faculty are collegial within and across departments.
5. **Follow up**
- Meet with Faculty Senate Executive Committee to review/revise PrT
- Meet with Administration to present PrT
• February 2006– Administration takes corrective action

6. **Corrective Actions**
   - Elevators are fixed.
   - Bathrooms are locked and cleaned regularly.
   - Administration expresses the wish to meet regularly with the Faculty Senate Executive Committee to continue discussion of remaining issues.

**Conclusions**
- The “index card” approach is a very efficient and effective way to air issues, establish desirable outcomes and promote teamwork in a university setting.
- Development of a PrT based on the index cards, even by one person, can help faculty/administration prioritize and focus on problem solving instead of complaining.

**Example 4.2.7: Curriculum and Syllabus Development**
In the Spring 2011 semester, the Department of Mathematics decided to develop a seamless curriculum from Prealgebra to College Algebra (inclusive). The purpose of this was not to miss any subtopics with which students have difficulty, avoid unnecessary repetition of topics, spiral approach to certain topics, logical development of topics so that students do not have gaps in their understanding as they proceed in the course. The following partial PrT is a preliminary version on the topic of Lines. Note: Here we have included a third column called Actions. The list of obstacles was developed using our experience of working with students and difficulties they usually have.

<table>
<thead>
<tr>
<th>PrT on Lines - Student’s AT: I can answer all questions on equations of lines.</th>
<th>Obstacles</th>
<th>Intermediate Objectives</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>I do not know what a linear equation is.</td>
<td>I know what a linear equation is.</td>
<td>I learn what a linear equation is.</td>
<td></td>
</tr>
<tr>
<td>I do not know how to plot a point</td>
<td>I know how to plot a point</td>
<td>I learn how to plot a point</td>
<td></td>
</tr>
<tr>
<td>I do not know how to plot a linear equation.</td>
<td>I know how to plot a linear equation.</td>
<td>I learn how to plot a linear equation</td>
<td></td>
</tr>
<tr>
<td>I do not know what the intercepts of a line are.</td>
<td>I know what the intercepts of a line are.</td>
<td>I learn what x- and y-intercepts of a line are</td>
<td></td>
</tr>
<tr>
<td>Given a graph of a line, I do not know how to find its intercepts.</td>
<td>Given a graph of a line, I know how to find its intercepts.</td>
<td>I learn how to find x- and y-intercepts of a graph of a line</td>
<td></td>
</tr>
<tr>
<td>I do not know what a slope of a line is.</td>
<td>I know what a slope of a line is</td>
<td>I learn what a slope of a line is</td>
<td></td>
</tr>
<tr>
<td>Given a graph of a line, I do not know how to find its slope.</td>
<td>Given a graph of a line, I know how to find its slope.</td>
<td>I learn how to find the slope of the line from the graph</td>
<td></td>
</tr>
<tr>
<td>I do not know the significance of the slope of a line.</td>
<td>I know the significance of the slope of a line.</td>
<td>I learn the significance of the slope of a line</td>
<td></td>
</tr>
<tr>
<td>I do not know how to find the point-slope form of a line</td>
<td>I know how to find the point-slope form of a line</td>
<td>I learn how to find the point – slope form of a line</td>
<td></td>
</tr>
</tbody>
</table>

---

17 Team members – Joshua Berenbom, Tatyana Flesher, Umesh Nagarkatte, Department of Mathematics, MEC
### Theory of Constraints and Thinking Processes in Academia

| I do not know how to find the slope of a line from its equation. | I know how to find the slope of a line from its equation. | I learn how to find the slope of a line from its equation. |
| I do not know what the standard form is. | I know what the standard form is. | I learn what the standard form is. |
| Given a graph, I do not know how to find its equation. | Given a graph, I know how to find its equation. | I learn how to find the equation of the line given its graph |
| I do not know the relationships of slopes of parallel lines. | I know the relationships of slopes of parallel lines. | I learn the relationships of slopes of parallel lines. |
| I do not know the relationships of slopes of perpendicular lines. | I know the relationships of slopes of perpendicular lines. | I learn the relationships of slopes of perpendicular lines. |
| I do not know how to find an equation of a line that is parallel or perpendicular to a given line. | I know how to find an equation of a line that is parallel or perpendicular to a given line. | I learn how to find an equation of a line that is parallel or perpendicular to a given line |

A syllabus on a course can be developed using a similar project plan discussed in the earlier examples. A syllabus on a TOC course COR 100 is given in the Appendix of this chapter.

Example 4.2.8: A PrT and Its Implementation in the Department of Mathematics

The Department of Mathematics studied student attrition in mathematics courses using TOC in January, 2002. The Future Reality Tree requires various “injections”. Injections in FRT are called Tactical Objectives. In order to achieve a tactical objective one must prepare a prerequisite tree for attaining the objective. As mentioned before, the “Stop signs” are the obstacles. The way we read this tree is also described in the following figure. The tree presented is only a part of a huge tree covering all aspects of students’ success. A tactical Objective (TO) is the goal (Ambitious Target) of the intermediate objectives (IOs)

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18 This study was presented to the Annual International TOCICO Conference at Las Vegas, NV 2007.
Figure 4.7

Prerequisite Tree (PRT) Example #1
Concerns that there are obstacles that will block us from achieving the solutions' tactical objectives...

1. Because Math Dept does not have enough tutors available.

2. We must first

3. Before we can have

- Tutor Center doesn't make allowances or provisions for last minute contingencies.
- Math Department has enough qualified tutors available.
- Tutors understand their role and contribution to peers.
- Tutors don't follow established policy for absenteeism.
- (Alternate) Tutors show up and are on time.
- Tutors aren't disciplined about showing up on time or being present.
In this manner, stop signs are used to list the various obstacles in some PRTs, and the logic to overcome the obstacle is described as shown in Figure 4.8. A copy of the Departmental Guidelines prepared in 2003 and approved by the President of the College is available from the first author. The following paragraph indicates the significance of the document.

As part of our goal of continually improving the instruction that the Mathematics Department provides, we have found it sensible to provide a written statement of departmental goals and the guidelines for implementing these goals. The purpose in doing this is to implement policies that will lead to improved student performance which in turn will lead to a higher rate of students passing mathematics courses and an overall improvement in student retention. Many of the guidelines in this document are longstanding informal policies, but they may have been carried out haphazardly or inconsistently from instructor to instructor. This set of departmental guidelines attempts to clarify and reiterate these policies so that the department can speak with a uniform voice. These guidelines are especially important for adjuncts that are often unaware of accepted procedures and do not have extensive contacts with full-time department members.

A TOC analysis of students’ academic and non-academic UDEs leads to the synchronization of instructional activities, support activities, instructional support and college support to attain the goal: To offer instruction and programs tailored to the needs of the student.
4.2.8.1 If you are working with children, go to the section of TOC For Education.
4.2.8.2 If you are want to know how to manage a project, read on.
4.2.8.3 If not go to section 4.6 on Transition Tree (TrT).

4.3 Managing a Project

4.3.1 How to pass a course with a high grade

Recall that a Project is an application of the sufficient condition, “If...then...”, logic.

Project Plan:

A project plan looks at the whole sequence of tasks. For instance, if it is to get a degree, look at the whole series of courses that we need to take. But at the same time we should not be overwhelmed by any project. We should not think, “Oh, when am I going to finish all this?” No one has asked us to do everything in one day or this moment and by our own effort alone. We must relax and enjoy what we are doing; we must concentrate fully on what has to be done at this moment; we must relate to people surrounding us in a friendly manner. That will make our time on task meaningful. We have to know that people such as our teachers, our friends and relatives want us to succeed in whatever we are doing and are ready to help in whatever way they can. Even strangers come to help a person in need.

First of all, to be proactive also means we have to remain in charge of our own project. In a huge institutional, or a company project, we play different roles. Our role and the tasks we need to do is our project.

Academic Success:
We need to take many courses. We should aspire to get an A in each course. We should be in charge by taking the responsibility on ourselves to finish the course syllabus. For each course, there are several lessons. If the lesson-wise syllabus is not available, work with the instructor to find the emphasis on topics in terms of time to be allocated for each project. Lessons can be bunched as weekly tasks. The following picture describes a course as a project. Usually there four tests and they are announced a week or two before.

For each project there are various resources. Our family, employers, mentors, teachers, tutors and classmates, and colleagues - people are our resources to help us carry out our project. Our

20 We must consider also the fact that in some families and friends there are conflicts and conditions not conducive to study. If we are equipped with Thinking Process tools, they can be used to resolve conflicts, solve any problems,
family, our job, our scholarships and student loans are our financial and comfort resources which help us keep working towards our goals without worry and in a protected environment.

For a course, the instructor is the primary source; the tutors are supplementary resources. There are print materials and web materials that help us which we also should consider as our secondary resources. To the best of our ability and time we should make timely use of these resources. We must respect all our resources and acknowledge from time to time where we get the help. An acknowledgment and recognition helps everyone to improve in their efforts. It brings satisfaction and happiness to all parties involved.

In any project we must consider changes or setbacks due to unseen factors. We must know Murphy’s law: “Anything that can go wrong, will go wrong.” When we plan a project we should take into account Murphy’s Law and plan some flexibility to change the course of action. Taking care of all these factors lets us see how to take a systematic approach to finish a project.

Taking a course as a project that has a definite duration and a laid out path and program, finishing it successfully will give you a practice in finishing your academic course of study as a series of projects. It will also give you the practice of completing more complicated projects in your career and life and help you to live a meaningful life.

You will learn how to manage a project using what is called Critical Chain in Section 4.4. In order to use our time meaningfully we must not multi-task; we must carry out a single project in a focused manner. To get educated, we must take a number of courses and carry out each course as a project.

4.3.2 A game of Multi-tasking
Let us play a game of multi-tasking. I owe this game to Alan Barnard, a TOC teacher from South Africa. Let us assume you have a portfolio of three projects to finish. Play this game and experience the feeling you have. It teaches us that multitasking takes each project longer to finish. While being “proactive” you will have to make sure that you are not multi-tasking.

Starting Conditions
There are 3 Projects each with 20 tasks, a different Customer for each project. All customers want their project to be done ASAP.
Each Task Time = ½ sec (1 sec with 100% Safety)
Promised Project time (called Lead Time) = 20 sec
Promised portfolio of three projects Lead Time = 60 sec
A model is given for each project with time taken in three columns.

Execution Rule

and make wise decisions based on various possible consequences that might lead us into. These are discussed in the last chapter of this guide. There are also professional counselors and agencies that provide us with alternative choices to keep us focused on our goal.

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Chapter 4 – How to Change

1. Without multi-tasking – Do each project by itself in the column next to the model project and go on to the next project. Note your time in the last box in the column.
2. Multi-task - Do each project in the next (third) blank column.

What is to be done?

1. No-multitasking:  Project 1: Write 1 – 20 below one another.
   Project 2: Write A through T below one another.
   Project 3: Draw a triangle △ circle ○ diamond ◊ below one another.
2. Multi-tasking:  Start with Task 1 Project 1, i.e., write 1
   Task 1 Project 2  i.e. write A
   Task 1 Project 3, i.e., draw △
   Then go on to the next task of each project and so on.

Assumption behind Multi-tasking
The sooner we start a project the sooner we finish.
The point of the game is to convince the player that constant shifting from one task to another takes away speed and concentration. If we move from the first project of numbers to writing letters, we must think which letter to write, and after that if we move to the third project, we must decide which figure needs to be drawn – a triangle, circle or a diamond. These decisions take some time. If you do the three projects without multi-tasking, it would take you at most three minutes. But in multi-tasking we move constantly from one task of one project to a task of

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**Expected Project Finish Time when each project is done one after another is 58 seconds, 59 seconds and 1 minute respectively.**

The next bottom box is Actual Finish Time you need when each project is done one after another. The final bottom box for each project is Actual Finish Time with multi-tasking.
another which takes considerably longer to finish all three tasks. Bad multitasking takes each project longer and should never be done.

Then how do we carry out multiple tasks that we need to accomplish during the day? Besides, it will be so boring to do just one project all day. The key is to “Divide and Conquer.” Divide the project into small parts or tasks and make a flexible mental marker called a “milestone” at the end of a set of tasks. We should reward ourselves in some way-- take a break for exercising, eat or entertain ourselves for some time. We do this intuitively in many projects we do. We must plan how to execute our project/s.

Exercise: If you are an instructor, ask your students to read the two topics of this section and write a summary of each topic.

4.3.3 If you are satisfied with this discussion of project management, go to the section 4.5, TrT.

4.3.4 If you want to know how to manage a complex project, read on.

4.4 Critical Chain Project Management (CCPM) of a course
Student’s “Critical Chain”

Definition: “A critical chain” is the set of tasks which determine when a project can finish. They are critical because improvement anywhere in the Critical Chain means the project can get done earlier or better. It requires taking resource\(^{21}\) capacity into account. Resource capacity is typically regarded as the constraint or leverage point of the project. A leverage point is an area where a small change can have a big positive impact on student’s performance. For CCPM of the course, the constraint is the student, since a proactive student can make a rapid individual improvement using all resources. Students’ study habits and academic preparation, which determine the grade of difficulty in a syllabus topic, play an important role. The most difficult topic in the course is a constraint for the student, which will take longer to grasp and will use more resources. So once the syllabus is given, it is better for you, the proactive student, to follow the CCPM and be vigilant in mastering the course topics with or before the instructor covers them.

If you finish a project in time or early, you will build confidence for and credibility for others who wanted you to carry out the project. For a course, finishing early provides time for revisiting the ideas and getting a deeper understanding. Sometimes, a mechanism is in place to study the next course and you might get a waiver or credit for that course.

The following example presents some ideas concerning the improvement of student services within the Department of Mathematics, as well as increased accountability and effectiveness of faculty and staff that resulted in fostering better communication among the students, the

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\(^{21}\) Discussed in detail after the syllabus for a course. But basically resources are those people, including student, or items that support student’s study or in short “student’s support team and supplemental software.”
instructors and the tutors. Throughout the discussion, italics are used to describe roles as well as communication and performance measures.

**Even though the course syllabus discussion is related to mathematics, it is not limited to any other subject. Wherever a lesson-wise syllabus is available, this discussion is transferable.**

**Basic Goal:** The Department of Mathematics offers academic programs that are tailored to the needs of the students of the College.

**Assumptions:** The working assumptions on which this discussion is based are as follows:
1. All persons with the Department (students, faculty and staff) want to improve themselves;
2. External recognition of a person’s efforts at self-improvement can frequently lead individual to make greater and more sustained efforts toward improved performance;
3. Leading students to regard each of their course syllabi as a 14-week long project, putting responsibility on them to finish, and helping them to finish, will develop confidence in them and give them in training how to finish projects. Then they will also be able to complete other more complicated projects in life.
4. Students regard their teachers as a primary resource, the tutors as a supplementary resource, and computer web-based materials as secondary resources which they can use to finish the project at hand.
5. In any course syllabus, there is plenty of “buffer” allocated which doesn’t necessarily have to be used on all topics. But the students should try to finish as many lessons as they can and use the usual one week buffer before a test only for mastering the difficult topics.

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
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</thead>
<tbody>
<tr>
<td>Test</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
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<td>Buffer</td>
<td>1 week</td>
<td>2-week</td>
<td>1 week</td>
<td>2-week</td>
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<td></td>
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</tr>
</tbody>
</table>

- Each student coming for tutoring is given the list of tasks or topics using the syllabus for the appropriate course (example on a later page of the appendix.)
- Copies of all syllabi from Intermediate Algebra to Calculus I are available in the Department. The last three columns of the syllabus are for the signatures of the student, tutor and instructor after completion of a set of topics. Students and tutors must also have the scores of various class tests at the end of completion of an appropriate set of topics.

After a student finishes a topic, s/he makes a point in the green area if s/he has finished it before the instructor does, in the yellow area if s/he finishes it with the instructor or within one week after the instructor’s, and in the red area if s/he finishes more than one week after the instructor does. Connect the points as you go. If the curve is completely in

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22 A buffer is a time put into the schedule systematically in order to protect against unanticipated delays, and in order to allow early starts. Buffers are essential parts of the schedule. These ideas are also discussed after the syllabus.
the green area then you are running your course effectively. Otherwise, you need to come to the green area as early as possible. This graph shows student's visual progress curve during the semester.

The instructor is provided with these copies as well, so as to get an idea of what service the tutors are offering to their students. The instructor knows that s/he is the primary facilitator for the course and the tutors are supplementary facilitators. The instructor makes an effort to contact several tutors for his/her course, to acknowledge that the tutor’s service in individualizing help to students is valuable. This will help to maintain communication between the student, the tutor(s) and the instructor. The instructor communicates the assumptions stated at the beginning to students.

The Department measures i) the pass rate of class ii) the class average score on each test iii) ratio of passing rates to tutorial expenses for a course and keeps track of these numbers using a computer database along with the number and list of students in courses taking tutoring, all tutors and instructors.

- It usually happens that a student comes for the first time right before a test to get a sample test solved by the tutor. The tutor should not solve the problem but help the student solve the problem by asking questions – to see the steps where the student has the difficulty. This pinpoints the student’s difficulty. The tutor then should take out the problem set for the course, if the student has not been given one, and along with helping the student on a particular problem, get several problems on the given topic from the problem set. This should continue until all problems related to the sample test are solved. The Department has more tutors available during the week before, after the midterm and two weeks before the final.

The instructor and tutor emphasize to the students that sample tests are given for the students to develop their test taking skill, so instead of solving that sample test first, they should use the problem set to do a lot of problems, get ready for the test and then take the sample test as a mock test at home while timing themselves without looking at any text or notes. To finish more or all questions on any test in a given time period, the student should look at the entire test first, do the easy problems and then go on to difficult problems, even going out of the sequence in which problems on the test are given.

- Along with the scores on a test, the instructor indicates to the student topics where the student has difficulty. If an error is made, it is so indicated to the student and also whether the error is due to not understanding the topic, carelessness or lack of time. If students come to tutoring the first time after a test bringing their tests with them, the tutor should ask them to mark the topics from their list of topics (syllabus form) where they made their mistakes. The tutor should require them to do that problem again, and check where they have difficulty. The tutor should then help students do more problems on the topic in question.
from the problem set. As far as possible the effort should be more of the student than of the tutor.

- About 10% of the students do well in a course and are bored by the pace of the course. They must be given a choice: 1) Work with students who are not doing well in their class, even outside of class time, because while helping others they will improve their own understanding, or 2) If some students want to finish all topics early, the students are encouraged to work with a tutor on a regular basis, studying the topics from the book by themselves, showing the tutor his/her work on the problem sets. They must attend the classes, since an instructor gives an insight into or easy methods of working on a topic which they might not get by studying themselves. They take their tests along with other students in the class. In addition, if the students are basically finished with all lessons from a course, arrangements should be made for the students to get in touch with an instructor of the next course, complete the set of lessons from that course and also take tests in the tutorial area from the instructor. They should take their finals with the appropriate instructors. Students who do this should be given an exemption (not credit for the course not taken) from the next course by the Chair and should be placed in a more advanced class. We have examples of students in the past finishing two courses in one semester.

- In each of the above cases, a lesson-by-lesson course syllabus is carried by a student attending tutoring. The student initials in front of the topics and gets the initials of the tutor on the topic(s) and shows it to his/her instructor who initials the form at the appropriate places and give it back to the student. This classification can give rise to numbers ahead, on time, or falling behind for the student database, and focuses on students who need intervention from tutors, instructor and counselors. For a record of progress of all students coming for tutoring, the tutorial coordinator, with the help of an assistant, enters once a week in the database number of students according lagging behind, absent/about to fall behind, and going ahead of the course schedule. 23

An Example of a syllabus is provided on the next page. A sample progress curve for a student is given at the end of the document.

23 Thanks to Jim Cox, University of Georgia and James Holt, Washington State University for stimulating discussions in 2007-2008 for designing a CCPM of a course syllabus as a project.
## SYLLABUS FOR College Algebra and Trigonometry - MTH 138 Section ______
### NAME: ___________________ Name of Instructor: __________________________

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Topic</th>
<th>Section/s</th>
<th>Student/Date</th>
<th>Tutor</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Linear inequalities, compound inequalities</td>
<td>1.7, 1.8</td>
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<td></td>
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</tr>
<tr>
<td>2</td>
<td>Functions</td>
<td>2.2, 2.4</td>
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<tr>
<td>3</td>
<td>Absolute value equations and inequalities</td>
<td>2.6</td>
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</tr>
<tr>
<td>4</td>
<td>Slope, distance, and linear functions</td>
<td>2.7, 2.8</td>
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</tr>
<tr>
<td>5</td>
<td>Systems of equations in two variables</td>
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</tr>
<tr>
<td>6</td>
<td>Systems of equations in three variables</td>
<td>3.2</td>
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<tr>
<td>7</td>
<td>Introduction to trigonometry</td>
<td>4.1</td>
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<tr>
<td>8</td>
<td>Right angle trigonometry</td>
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<tr>
<td>9</td>
<td>Trigonometric functions of any angle</td>
<td>4.3</td>
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<td>10</td>
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<td>Review of factoring</td>
<td>5.1, 5.2</td>
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<tr>
<td>13</td>
<td>Solving polynomial equations</td>
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<td>14</td>
<td>Review of arithmetic with rational functions</td>
<td>5.4, 5.5</td>
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<td>Rational exponents</td>
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<tr>
<td>20</td>
<td>Computations with radicals</td>
<td>6.3</td>
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<td>Further computations with radicals</td>
<td>6.4</td>
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<td>22</td>
<td><strong>DEPARTMENTAL MIDTERM</strong></td>
<td>Score</td>
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<tr>
<td>23</td>
<td>Complex numbers</td>
<td>6.5</td>
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<tr>
<td>24</td>
<td>Completion of the square</td>
<td>7.1</td>
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<tr>
<td>25</td>
<td>Quadratic formula</td>
<td>7.2</td>
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<tr>
<td>26</td>
<td>Discriminant, word problems</td>
<td>7.2</td>
<td></td>
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<tr>
<td>27</td>
<td>Equations that lead to quadratic equations</td>
<td>7.3</td>
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<tr>
<td>28</td>
<td>Parabolas</td>
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<td>7.6</td>
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<td>30</td>
<td>Ellipses and hyperbolas</td>
<td>7.7</td>
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<td>31</td>
<td>Nonlinear systems of equations</td>
<td>7.8</td>
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<tr>
<td>32</td>
<td><strong>Test 3</strong></td>
<td>Score</td>
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<td>33</td>
<td>Exponential functions</td>
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<td>34</td>
<td>Inverse functions</td>
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<td>35</td>
<td>Logarithms</td>
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<tr>
<td>36</td>
<td>Properties of logarithms</td>
<td>8.4</td>
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<tr>
<td>37</td>
<td>Logarithmic and exponential equations</td>
<td>8.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Applications of ( e )</td>
<td>8.6</td>
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<tr>
<td>39</td>
<td>Sequences</td>
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<td>Series</td>
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<td><strong>Test 4</strong></td>
<td>Score</td>
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</tr>
</tbody>
</table>

### DEPARTMENTAL FINAL EXAM Score
Details of technical terms in CCPM of a course.

1. Student receives a syllabus for the course - the topics s/he is responsible for. This is the set of tasks. The student should know the goal of the course, how it is relevant for his/her career/specialization. (The student should seek clarification from instructor/tutor, since it is not possible to list all relevancies in the syllabus.)

   The Goal of every mathematics course is to master the concepts and skills listed in the syllabus so as to use the knowledge immediately in the next courses for which a particular course is a prerequisite. The goal while learning a course is to link the ideas logically so as to form a mental picture of the course and not a set of isolated facts or rules. The long-term goal of mastering mathematics is to develop logical way of thinking to be able to use in studying any subject and in life.

   This is the critical chain for each student. The student has to know his role, instructor’s role and tutor’s role. The student has to also know if there are supplementary materials available on the web. The instructor and tutor must know their roles as facilitators.

2. Resources: Instructor is the primary resource and tutor is a supplemental resource to facilitate achieving the knowledge of the course. Every tutor and instructor must make it clear to the student that they are only facilitators and it is the student’s responsibility to acquire this knowledge and it is to his/her benefit to make use on a regular basis of their availability and follow up on their directions. We are also in the process of providing computer resources for courses up to Precalculus by making the web courses available so that the student can access the materials 24/7.

3. There is a project tracking involved: STATUS - What is being covered, how much is yet to be covered. EVALUATION of STATUS: What are the difficulties on current and past topics? How much is the score on the class exam/s and the midterm? What exactly are the mistakes made on a sample test, actual test, etc.?

4. Importance of Tutor: The tutor can help the individual student manage the project, whereas the instructor does not have sufficient time to individualize the process of learning as s/he has the responsibility of instruction of mainly the course content. The tutor can help student track the project - focus on the student’s exact mistakes on the test and correct student’s understanding.

5. Scheduling high-risk tasks: Topics such as Trigonometry and Exponential Functions and logarithms are important in College Algebra/Trigonometry and Precalculus and if the instructor puts them to the end of the syllabus they get done in a hurried manner with no deep understanding on students’ part. They have to be covered early in the syllabus. Some instructors, including myself, make sure that they cover these topics as early as possible. By doing this if a student has not understood the concepts there is time to help him/her. In any other course, looking at the syllabus the instructor can decide the high-risk tasks and place them early.
6. **Buffer Management**: Definition of buffer: It is time put into the schedule systematically in order to protect against unanticipated delays, and in order to allow for early starts. They are usually parts of the schedule. Buffers are not slack. Slack is a free time available to move a task later. There are four types of buffers – Project buffers, feeding buffers, resource buffers, and strategic resource buffers. Buffers are an extremely valuable tool for monitoring the status of projects and determining whether drastic actions are required.

Every course syllabus arranged day-to-day has built-in buffers – not arranged systematically – but the average time to complete a topic. For instance, there is flexibility on the part of the instructor to cover a certain topic in more or less than the indicated day or duration in the syllabus. Experience shows that the instructor finishes topics for a test about a week earlier. If an instructor is absent on a certain day, there is a time buffer, not mentioned, but to cover the topic and the rest in the remaining periods. Similarly, the student if absent for a particular class can cover the missed topic on his/her own or with the help of the resources available in a reasonable time.

If the buffers are arranged in a more systematic manner as project buffer, etc. instead of spreading it out throughout the syllabus, the student can complete the topics on his/her own or with the help of the resources. From this point of view, place the **project buffers** of one week or usually half the time allocated the tasks before the test. The student should finish all tasks – studying the prescribed topics - one week before a class test, ideally in half the time allocated for the topics in the syllabus. In the week/s leading to the test, the student should take various sample tests, old tests and work on the areas that are perceived as difficult. For the final exam, the student should have a two week buffer. In this manner, avoid the stock phrase of “student syndrome’, where a student starts studying a day or two before a test. If a student does not have difficulties and is finished, the student should be given reinforcement/enhancement material to study which an instructor can make available to student. (In the past, for at least ten students at different times, some instructors have given the topics of the next course in the course sequence and most of them finished and ended up taking the final exam for the next course also. The Department gave them a waiver, but no credit, for the next course. Most of them did A level work in both courses! Thus a student was not restricted by a policy constraint of taking only one course per semester.) This requires constant communication between student, tutor and instructor.

The project buffer needs to be checked, and if it is being used up doing certain tasks, extra help in terms of instructor and tutor intervention has to be taken so that the tasks are finished before the project buffers are used up.

**Feeding buffers**: These buffers make sure that supplemental work is available if a student needs. Thus giving the students departmental selection of test preparation problems is adequate. If a larger variety of problems is available the course becomes richer and student has more practice materials. From that point of view faculty should keep enhancing the set of problems.
**Resource buffers:** If a student needs extra help/time to finish the task before the project buffer begins, the instructor/tutor should make more help/time available as the need arises. The resource buffer is like a wake-up call.

7. **Information Flow:** The information flow to manage buffers is as in the following. It is nothing new. We do this check even now. What is different here is the introduction of the three buffers and making student aware of his/her responsibility.

![Diagram of information flow]

**Multiple Courses:** Develop a “realistic schedule.” Approach counselors and advisors to help you. Take a balanced set of courses – some technical and some not, but not all hard or all easy. Manage the project and resource buffers, use the days when the course does not meet and weekends to complete the various tasks of each course.

If you practice the principles discussed here, you will enjoy every course. You might be able to complete more courses and finish your required courses earlier.
4.5 Developing a Prerequisite Tree (PrT) and Project Plan from a Future Reality Tree (FRT) – Institutional Example

We use each of the injections or Tactical Objectives (TOs) is an ambitious target (AT) and develop a PrT for each. We put all these individual PrTs together to make a humongous PrT. Here the top of the tree is the Strategic Injection or Bright Idea from the FRT. Once the development of various PrTs for the TOs start, we discovered that TOC reaches to all stakeholders in student success. PrT is not limited only to instruction, but to tutoring, advisement, counseling and financial support of the student, thus a “holistic” approach to the student. We had to reach out to tutors, counselors, advisors, etc., and get their support to implement our reforms.

In many colleges/universities, because of the “silos” of departments, it is hard to communicate with other colleagues in the specialized areas, and improvements are done only in terms of students’ academic needs, while overlooking the non-academic needs. TOC study of student attrition in mathematics courses made us aware how important the other stakeholders roles are for student success and retention. We had to make special efforts go to the administration and get their buy-in to reach out to the other stakeholders. In that sense, Theory of Constraints (TOC) is Theory of Communication. We give an example of sub-PrT for instruction and the project plan.
Figure 4.9

Legend

[Student DE's]

Existing/Interm. steps

Injections

*1*
Students feel the instructor moves at a comfortable pace.

*11*
Instructors help students to keep up with the work.

215
Students have good test-taking preparation skills.

190
Instructors take an active role in developing study, homework, and test-taking skills.

191
Instructors are actively involved getting students to make use of Supplementary Instruction and Tutorial centers.

141
Late registrants are required to do adequate supplemental instruction to be current with the class.

140
Faculty hold appropriate office hours.

145A
Tutors show up on time.

100
SI Department offers programs tailored to the needs of students.

110
Department provides guidelines for instruction.

*4*
Students have all the prerequisites for the courses.

*7*
Students are punctual and attend all classes.

*12*
Students get the supplemental instruction they need when needed.

121
Students receive comprehensive academic services to deal with any math-related difficulties.

130
Class time prepares students well for doing homework/assignments.

125
Assignment is closely related to material covered in class.

134
We communicate with students the importance of passing their classes first time/finishing degree on time showing the negatives of fail and in-completes.

135
Entire syllabus is covered.

120
Lecture is closely related to syllabus.

145
Students finish all homework on time.

187
Students are ready to understand the lecture.

140
Faculty hold appropriate office hours.

180
College provides adequate help in terms of tutorial and drop in centers.

134
We communicate with students the importance of passing their classes first time/finishing degree on time showing the negatives of fail and in-completes.

121
Math instructors are involved in informing/training tutors in how to do their work.

115
Assignment is closely related to material covered in class.

134
Entire syllabus is covered.

120
Lecture is closely related to syllabus.

145
Students finish all homework on time.

187
Students are ready to understand the lecture.

140
Faculty hold appropriate office hours.

121
Math instructors are involved in informing/training tutors in how to do their work.

115
Assignment is closely related to material covered in class.

*5*
Students finish all homework on time.

*11*
Instructors help students to keep up with the work.

*12*
Students get the supplemental instruction they need when needed.

121
Students receive comprehensive academic services to deal with any math-related difficulties.

130
Class time prepares students well for doing homework/assignments.

125
Assignment is closely related to material covered in class.

134
We communicate with students the importance of passing their classes first time/finishing degree on time showing the negatives of fail and in-completes.

120
Lecture is closely related to syllabus.

145
Students finish all homework on time.

187
Students are ready to understand the lecture.

140
Faculty hold appropriate office hours.

180
College provides adequate help in terms of tutorial and drop in centers.

134
We communicate with students the importance of passing their classes first time/finishing degree on time showing the negatives of fail and in-completes.

121
Math instructors are involved in informing/training tutors in how to do their work.

115
Assignment is closely related to material covered in class.

*5*
Students finish all homework on time.

*11*
Instructors help students to keep up with the work.

*12*
Students get the supplemental instruction they need when needed.

121
Students receive comprehensive academic services to deal with any math-related difficulties.

130
Class time prepares students well for doing homework/assignments.

125
Assignment is closely related to material covered in class.

134
We communicate with students the importance of passing their classes first time/finishing degree on time showing the negatives of fail and in-completes.

120
Lecture is closely related to syllabus.

145
Students finish all homework on time.

187
Students are ready to understand the lecture.

140
Faculty hold appropriate office hours.

180
College provides adequate help in terms of tutorial and drop in centers.
A complete PrT and a project plan are given in Figure 4.11 and Figure 4.12. It is heartening to know that the project plan developed in 2002 is robust and still viable and being implemented thanks to the many stakeholders. The project plan is, of course, not static but is the Process of OnGoing Improvement (POOGI) discussed in Chapter 5.
Students the importance of proper time showing. The negatives of failing and passing their classes increased enrollment in instructors of need to accommodate students. We communicate with the college and affect Department surveys the availability of services. We explain to faculty that accommodating classes are scheduled to run it. Facilities are set up to conduct workshops. Students who have not taken seqential math courses in consecutive semesters are provided refresher. Departments seek money and a pool of substitutes is established. Tutors show up on time. Faculty committee writes guidelines. Students receive timely completion of syllabus. Departments establish guidelines and disseminated in a library and drop-in center. Students spend time on selected topics in the department's personal advisement and academic, supplemental instruction on the needs of students. The mechanism for getting students involved when needed. Substitutes are readily available when needed. Math instructors are pressured to use drop-in center and supplementary instruction on the needs of students. The math dept creates a pool of students. There is a mechanism for attendance and discussion, etc. on the role and participation of counselors of absences or problems of suspected student incompletes. The math dept creates and disseminates in a library and drop-in center. Math instructors are pressured to use drop-in centers. Math instructors are pressured to use drop-in center and dissemination in a library and drop-in center.
4.6 Transition Tree (TrT) --A Standalone Tool

4.6.1 General Discussion of a Transition Tree

In any presentation, lecture or procedure, one has to lay down various steps in a logical manner. How do you make sure there is no logical gap? TOC provides a tool called the “Transition Tree” (TrT or TT). This is a powerful empowerment tool. It uses sufficient condition logic.

Every transition tree starts with a goal or objective to be attained and a clear set of actions. An Ambitious Target Tree (ATT) or Prerequisite Tree (PrT) discussed in the previous sections is the starting point if the objective to be attained is known while a clear set of logical actions is not known. At each step the effect of an action is evaluated and any negative effects are trimmed. This tree is also extremely useful for turning an Ambitious Target Tree into an action plan and the various activities needed to satisfy each action in the plan.

Tracy Burton-Houle, the TOC facilitator at AGI, New Haven, CT, for the team of the first author, explained the importance of this tree in January, 2002. In South Africa, there were two hospitals that performed heart transplant surgery. In one hospital the success rate was 90% and in the other it was 10%, even though both teams were following the same textbook procedure. It was decided to apply the Transition Tree to the procedure in the hospital with a lower success rate. While developing the TrT, it was discovered that there was a logical gap in the steps of the
textbook procedure. They asked the successful surgeon in the other hospital about how he filled in this gap. The surgeon told what he did, which was not published anywhere in literature, and the logical gap was filled. From that time forward, the success rate in the other hospital also came up to the rate of the more successful hospital. Thus the TrT or TT is useful filling in any logical gaps.

Transition trees are used to give a clear set of directions. The constructed TrT is a good tool to use for training new hires. This would be a clear way for people to learn duties and WHY. To add clarity: The only thing needed for the new hires to do is to learn how to read the TrT. Another way to accomplish the new hire training is to list the set of actions and the entities that explain why the actions must occur. It is not as concise but may be satisfactory.

4.6.2 Structure of a Transition Tree
This tree has a repeated entity structure as shown in Figure 4.13. Each action is supported by three entities to make it logically sound. Sometimes the five entities are listed differently, but we will follow the procedure outlined here. First narrate the storyline that needs actions to achieve an objective or overcome an obstacle. Then list all actions according to their logical order of execution. Fill in the steps numbered 2, 3 and 4 as necessary for each action.

Figure 4.13

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24 This TrT structure is based on a course (EM526) given by Dr. James Holt, Professor, Washington State University.
Sometimes, the order of actions is modified while developing the TrT.

**General Steps to developing a TrT:** List all actions according to their logical order.

Example: Storyline- An instructor is troubled by the fact that the students do not listen to him and talk among themselves. He has important new ideas to introduce in the class and he wants students to participate in the discussion.

1. **Verbalize the objective:** (This may be the top entity in the TrT block in Figure 4.13 or the final goal of the series of actions planned.)
   - For example: In classroom instruction the objective is: “Students participate in the discussion.”

2. **Verbalize the “Action” entity #1 in the TrT.** Answer questions like:
   - “What should I do in order to achieve the objective?”
   - “What should I do in order to satisfy the Need (or overcome the Obstacle?)”
   - Example continued: Action: Make the material relevant to their life.

3. **Write the obstacle or need in the need entity #3 in the TrT.**
   - If it is an obstacle, write the words “need to overcome the obstacle.”
   - To continue the above example: The instructor’s need is “Students listen to me during class,” or “I need to overcome the obstacle that students do not listen to me.”

   Ask the following questions to get the need fleshed out:
   - What is the need to take this action?
   - Why is this action important? In order to …
   - Why take this action? In order to …

4. **Verbalize the “Fact” entity #4 in the TrT.** Ask questions
   - “Why will taking this Action achieve the Objective?”
   - “Why will taking this Action satisfy the need/overcome the obstacle?”
   - “What do you assume, when you claim that this action satisfies this need?”
   - Fact for the above example: “People are engaged when something relates to them.”

5. **Verbalize the “New Reality” #2 needed for the execution of the current Action.**
   - Answer questions like:
     - What negative effects will be caused by the next action unless this action is taken?
       Verbalize that they will not be created.
     - What new ability do you have after taking this action that enables you to take the next action? Verbalize the new ability/reality.
   - New Reality: Students start listening to me.
   - Example continued: Start with the information that students have already learned or know. Relate the new topic to the known facts. A prolonged discussion of a totally unknown topic will bore students and they will not participate.
6. **Verbalize the “Fact” #5 needed for the place/time/details to execute the current Action.**
   Answer questions like:
   - When/where/how should the execution of the action take place?
   - Verbalize the new ability/reality.

   The goal is attained. Otherwise, keep repeating the TrT block structure.

The transition tree for the example is as follows:

**Figure 4.14**

Transition Tree – Goal: Students participate in the discussion.

There might be more actions necessary for the instructor, which will be clear once the instructor starts to look at entities #1 and #2. The entities #3 and #4 help the presenter to ascertain that there are no negative effects and no logical gaps. This short tree can be used to prepare a presentation with small changes.

**Example 4.6.2.1 – Transition Tree (TrT) to Help a Student Modify Behavior**

To cause a change in a troubled freshman’s behavior.\(^{25}\)

- **The overall objective is:** “The freshman changes his/her behavior.”
- **Storyline:**

\(^{25}\) The example is based on a TrT developed by Dr. Howard Meeks, AGI, New Haven, CT, and Professor, Iowa State University, Ames, IA, January, 2006. Some ‘facts’ in the TrT are based on his TrT.
Kim is a seventeen year old freshman who behaves in a way that leads to meaningful negative effects. You, the authority, want Kim to change his behavior. The problem is that you have had the prior bad experience that Kim is aware of the negative consequences of his behavior, but will continue to behave in a negative way, even if he will be sanctioned. This happens for two reasons:
1. In order to maintain and show his independence.
2. In order to satisfy the original need that led him to act this way to begin with.

- **List Your actions:**

  **Action #1:** I initiate a discussion with Kim in a relaxed atmosphere, without company that might provoke him to show his independence.

  **Action #2:** I mention to Kim his behavior (or bring him to mention it), and ask him about its outcomes:
  “What will happen then?” … “And then what might happen?”

  I continue to ask Kim these kinds of questions about every outcome he mentions, until we form a Negative Branch, that starts with Kim’s behavior and ends up with a meaningful outcome for Kim. I ask Kim to write out the Negative Branch by himself.

  **Action #3:** I ask Kim to examine the negative branch and think it over. I don’t tell Kim to change his behavior.

  **Action #4:** I ask Kim to consider the logical opposites of statements in the negative branch and to construct a positive branch by himself without any further comment about his behavior. (These might be needed later to provide “injections” for correction of behavior.)

  **Action #5:** I examine Kim’s future behavior for signs that will tell me whether Kim has changed or has not changed his behavior.

  **Action #6:** I figure out what Kim’s original need is, using questions like:
  1. Why are you behaving in this way? For what?
  2. What are you trying to achieve in this way?
  3. What prevents you from changing this behavior?

  **Action #7:** I direct Kim to find an alternative way to satisfy his need, using questions like:
  4. Can you achieve this in another way?
  5. Can we do something else to achieve this?
  
  I work on injections to continue to work on his needs. (This part may not be needed.)
We will construct the TrT using the repeated structure. The "facts" are quite complex in the following TrT. They are based on "Treatment – 12 Principles from the Muktangan Rehabilitation Center, Pune, India (www.muktangan.org)."
1. **Act:** I greet Kim and assure him that I accept him unconditionally as a person, as a ‘friend’, in a relaxed atmosphere, without company that might provoke him to show his independence.

2. **New Reality:** Kim is ready to discuss his behavior.

3. **Need:** Kim needs to feel accepted before he is ready to discuss his behavior that leads to negative consequences.

4. **Fact:** Unconditional acceptance of a ‘friend’ as a human being differentiates his behavior and personality.

5. **Fact:** People reveal their feelings in an appropriate atmosphere.

11. **Act:** I mention to Kim his behavior (or bring him to mention it), and ask him write out each outcome. I ask “What will happen then?”...“And then what might happen?” I continue to ask Kim these kind of questions about every outcome he mentions, until we form a Negative Branch, that starts with Kim’s behavior and ends up with adverse consequences for Kim.

12. **New Reality:** Kim completes a negative branch.

13. **Need:** Kim should discuss his own negative behavior.

14. **Fact:** Every human being is rational, constructive, positive, trustworthy and full of potential, even though he/she may for some time act, think and behave irrationally.

**Figure 4.15 A**

Page 1 TrT
33. Need: Enable Kim to see the consequences of the positive thoughts, acts, and behavior. I want to make sure his original need will not motivate him to behave the same negative way.

25. Fact: Every human being has an innate capacity of correcting his/her thoughts, feelings and actions.

22. New Reality: Kim detects his distorted cognitions causing hindrances in his life.

24. Fact: Let Kim reach the conclusions by himself.

23. Need: Kim must be ready to correct his negative behavior.

21. Act: I ask Kim to examine the negative branch and think over it. I don’t tell Kim to change his behavior.

15. Fact: Kim realizes that the thoughts, acts and behavior are causing hindrances in life.

43. **Need:** Kim must understand to make the choice of positive thoughts, acts and behavior, instead of negative ones.

35. **Fact:** Kim himself comes up with the effects of negative behavior and the impact of positive behavior.

32. **New Reality:** Kim develops the ‘positive branch’ and examines both the ‘negative and positive branches’.

34. **Fact:** A ‘friend’ should help a ‘friend’ replace the negative behavior by appropriate positive thoughts, acts, and behavior.

33. **Need:** Enable Kim to see the consequences of the positive thoughts, acts, and behavior. I want to make sure his original need will not motivate him to behave the same negative way.

31. **Act:** I ask Kim to consider the logical opposites of statements in the negative branch. I ask him to arrange the positive statements logically and develop a positive branch. (I think about ‘injections’ I might need later to make the corrected thoughts, acts and behavior possible.)
41. Act: I assure Kim to be there for him in the future. I will observe his future behavior for signs that will tell me whether he needs help or not.

42. New Reality: Kim feels secure and loved and starts making the choice of positive thoughts, acts, and behavior.

43. Need: Kim must understand to make the choice of positive thoughts, acts and behavior, instead of negative ones.

44. Fact: Security and love are very important needs of the person suffering and must know that help is available when needed.

45. Fact: Restoring faith in oneself is necessary for improvement. Honesty, openness and willingness are considered the values and signs of improvement.

46. Fact: Kim’s original need to commit negative actions is stronger.

53. Need: He needs extra support not to commit negative actions.

Injection: Human beings are happiest when they establish their life goals and actively strive to achieve them. Getting “there” is as exciting as being “there.” Help Kim establish short term, mid-term and long term goals and stay on path.

Result: Observing Kim I see that he will not commit negative actions.

Injection: Human beings are happiest when they establish their life goals and actively strive to achieve them. Getting “there” is as exciting as being “there.” Help Kim establish short term, mid-term and long term goals and stay on path.

Injection: Human beings are happiest when they establish their life goals and actively strive to achieve them. Getting “there” is as exciting as being “there.” Help Kim establish short term, mid-term and long term goals and stay on path.

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Injection: Human beings are happiest when they establish their life goals and actively strive to achieve them. Getting “there” is as exciting as being “there.” Help Kim establish short term, mid-term and long term goals and stay on path.
Injection: Human beings are happiest when they establish their life goals and actively strive to achieve them. Getting “there” is as exiting as being “there.” I help Kim establish short term, midterm and long term goals and stay on path.

Result: Kim does not repeat his negative behavior.

61. Act: I direct him to find alternate ways to satisfy his original need by asking: “Can you achieve it in some other positive way?” “Can we do something else to achieve this?” I introduce some injections to connect his needs to the ‘positive branch.’

54. Fact: I provide a watchful support system such as family, friends, peer mentors to implement the ‘positive branch.’

63. Need: Kim needs to know alternative ways to fulfill his need, and connect with injections to the ‘positive branch.’
**Injection:**
Human beings are happiest when they establish their life goals and actively strive to achieve them. The satisfaction obtained in process is as relevant as the satisfaction of reaching the goal. I help Kim establish short term, midterm and long term goals and stay on path.

**Result:** Kim does not repeat his negative behavior.

**54. Fact:** I provide a watchful support system such as family, friends, peer mentors to implement the ‘positive branch.’

**61. Act:** I direct him to find alternate ways to satisfy his original need by asking: “Can you achieve it in some other positive way?”
“Can we do something else to achieve this?” I introduce some injections to connect his needs to the positive branch.

**63. Need:** Kim needs to know alternative ways to fulfill his need, and connect with injections to the ‘positive branch.’

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**4.6.2.1.1 The TrT as a standalone tool**
If this satisfies your need and if you are working with children, go to TOC for Education. If you are interested in applying TrT to word problems in mathematics, read on.
If not, review the different standalone tools given in terms of TOC for education. The website www.tocforeducation.com and www.Tocia.com (under construction) has examples of several applications as examples of the standalone tools of TOC to community work.

Example 4.6.2.2 TrT to solve a word problem in Math.
4.6.2.1 Example of a simple word problem
Solving a word problem is a developing a TrT and executing each step.
The following example was discussed in 1.7.3 and presents a simplified version of the TrT.

Example: A woman had $10,000 that she invested in two funds, a fund that earned 9% and in one that earned 7%. If she earned $880 in interest from the two funds, how much was invested in each fund?
Solution: Usually a figure or a chart helps to analyze the problem. We usually do not draw entities and arrows, but in this example we will. First we will solve the problem without using entities.

Given (Assumptions): The woman invested $10,000, some of which is at 9% and the rest, at 7%.
If x be the amount invested at 9%, then the rest of the amount is 10000 – x at 7%, because, both investments must add up to 10000. (x + (10000 – x) = 10000)
The interest of each investment is given by: .09x and .07(10000 – x). The total interest in algebraic terms is .09x + .07(10000 – x), and total given interest is $880. We equate them.
.09x + .07(10000 – x) = 880
To solve this equation we get rid of decimals by multiplying every term by 100 to get
9x + 7(10000 – x) = 88000
9x + 70000 – 7x = 88000 removing parentheses
2x = 18000 simplifying
x = 9000
The woman invested $9000@9% and 1000@7%
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Fact: We know addition and subtraction of algebraic terms. Given: Total investment: 10000 invested two ways.

Fact: We must subtract this x from 10000: 10000 - x

Need: Find x in: .02x + 700 = 880

Fact: Given: total interest = 880. We know how to equate the total interest found.

Act: Assume one part x @ 9%

Need: Find amount invested @ 7%

Act: Multiply each term by 100.

Fact: The two investments add up to 10000.

Need: Find both investments:

Act: Solve for x: 2x = 18000 ; x = 9000

9000 @9%
1000 @7%

Fact: We know multiplication of algebraic terms. We know how to convert percent into decimal.

Fact: We know how to solve an equation.

Fact: The two investments add up to 10000.

Fact: we know how to get rid of decimals.

Need: Find interest for each investment

Act: Multiply each investment by respective rate and add to get the total interest.

Fact: We know addition and subtraction of algebraic terms. We know how to convert percent into decimal.

Need: Find interest for each investment

Interests:.09x and .07(10000-x) or .09x and 700 - .07x

Total interest = .02x + 700

Need: Find amount invested @ 7%

Act: Assume one part x @ 9%

Need: Find both investments:

Act: Solve for x: 2x = 18000 ; x = 9000

9000 @9%
1000 @7%
4.6.2.2.2 TrT to solve on systems of three equations in three unknowns
Suppose the student wants to solve word problems using systems of three linear or non-linear equations in three unknowns.

Here is a set of actions obtained by constructing a “Transition Tree” (Figure 4.15).
1. I read the word problem identifying the unknown quantities as: x, y, z.
2. I translate sentences into equations. I must have three equations.
3. Rearranging if necessary I use the first equation and one of the methods – substitution or addition/subtraction - to eliminate one variable (x, y or z) from the remaining equations. I get two equations in two variables. This is the second step. I now proceed to eliminate the second variable from the two equations at the second step repeating the procedure and I reach the last step which reduces to
   1) an equation of one variable, or
   2) has all zeroes or
   3) has a zero on the left side and non-zero number on the right side.
4. If I have 1) an equation of one variable, I solve it and use the value of that variable to find the value of the second variable from one of the equations at the second step. I use the two values of the two variables to find the value of the third variable. I have a unique solution(s) for each variable. Once I find the values of all variables, I interpret the meaning in the given context.
   If, in the third step, I have 2) the last equation has all zeroes, then the system has infinitely many solutions.
   In the third step an equation has zero on the left side and a nonzero number on the right side. Then there is no solution and the system is called inconsistent.
Figure 4.16

Transition Tree – To solve a word problem with three equations in three unknowns. The problem is done in three steps.

1. Act: I read the problem and determine the variables: $x, y, z,$ and with what math operations they are related in the problem.

2. I have a system of three equations in three unknowns.

3. Need: I need to translate the storyline into three equations with three unknowns.

4. Fact: I know how to translate unknowns into variables and sentences into equations.

5. Fact: I know the method of elimination of a variable from two equations.

30. Need: I need to eliminate one variable from two sets of equations of two equations.
20. I have a system of two equations in two unknowns.

30. Need: I need to eliminate one variable from two sets of two equations.

40. Fact: To eliminate x from two equations, the coefficients of x in the two equations must be opposite. One equation of two variables is obtained for each set.

50. Fact: I know the method of elimination of a variable from two equations.

10. Act: I number the equations 1, 2, 3. I eliminate one of the variables, say x, from equations 1 and 2, 2 and 3.

300. Need: I need to eliminate one variable from two equations of two equations.
Chapter 4 – How to Change

Step 3

300. Need: I need to find the values of all variables

500. Fact: I know how to solve one equation in one variable, z.

200. I have one equation in one unknown, z.

400. Fact: To eliminate y from two equations, the coefficients of y in the two equations must be opposite. One equation of one variables is obtained for the set.

300. Need: I need to eliminate one variable from two equations with two unknowns, y, z.

100. Act: I number the equations 10, 20. I eliminate one of the variables, say y, from equations 10 and 20.

4.7 Summary - Answering the Third Question of TOC- How To Cause the Change?
The PrT, the project plan and various transition trees answer the third question of TOC: How to cause the change? The steps are summarized in the following figure. The Tactics of a TOC solution of a problem is the answer to the third question “How to cause the change?” to make the future reality into actual reality.

Figure 4.17

3. How to Cause a Change?
Designing the Implementation Tactics

5. Future Reality Tree: Ensures that the starting injection will lead to all the DEs without creating negative branches.

6. PreRequisite Tree: In what order do we implement the T.O.s and what blocks their implementation?

7. Project Plan

8. Transition Trees: What actions must we take to implement the PreRequisite Tree?
The actions described as the last entity in the above figure in Transition Trees is now written in the middle and the working assumptions are to the right.

4.8. TOC Roadmap – Summary of All Steps of TOC

Key terms

We employ the following logical steps.

**Define the Problem.** List the issues, UDE’s, on the problem. Select 3 important UDEs. “Define a problem precisely and you are half way to a solution.” --Dr. Eli Goldratt

1. Consider 3 clouds to develop the generic cloud root cause.
2. Current Reality Tree (Branch).
3. Negative loops in CRT
4. Future Reality Tree (FRT) (Branch)
5. Positive Loops in FRT
6. Negative Branch Reservations (NBRs). This topic answers, “What could possibly go wrong with the proposed solution?”

These steps were discussed in Chapters 2 and 3.
Chapter 4 – How to Change

7. Prerequisite Tree (PrT) - Ambitious Target Tree (ATT)
8. Project Plan
   **These steps were discussed in Chapter 4.**
9. Transition Tree (TrT) to execute the activities of the project plan.
   **This step was discussed in Chapter 3.**

We also observed that the cloud tool (Chapter 2) and Ambitious Target Tree (ATT) Chapter 4 require necessary condition logic while the branch tool Chapter 3 require sufficient condition logic.

**Figure 4.18** Source: AGI, New Haven, CT.

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**Exercises**

1. Using a problem in an assignment of a course as an ambitious target list all the obstacles you have to overcome to attain the ambitious target as a PrT.

2. For a course in your chosen major, a day-to-day syllabus given by an instructor is a project plan s/he will be using for the semester. Based on that plan, decide what obstacles you
personally feel you have and devise a PrT and project plan for the course. Discuss the project plan with your instructor or counselor.

3. Using the goal of your graduating from college as an ambitious target, develop an Ambitious Target Tree and a project plan based on the Example 4.7.1.
Appendix Chapter 4: Creative Thinker’s Toolkit – a Freshman Year Course

**COR 100: Creative Thinker’s Toolkit: Thinking and Acting**

*(General Education Program Foundation Cluster)*

**Fall, /Spring,**

1. **Course:** COR 100, Creative Thinker’s Toolkit: Thinking and Acting, 3 Cr. 3 Hr.

2. **Textbook (initial):** Theory of Constraints and Thinking Processes for Academics – Umesh Nagarkatte and Nancy Oley

3. **Objectives:** This course serves as "Thinking Across the Curriculum." The course empowers students to think effectively, solve problems, make responsible decisions and reach their academic and personal goals.

   The course has been developed to bring students in contact with the academic faculty of their chosen major in their freshman year or as early as possible in their academic career. This is an interdisciplinary course taught by various instructors in students’ chosen major – Science/Mathematics, Business, Social and Behavioral Sciences, Liberal Arts/Undecided.

**Learning Competencies:**

Students will be able to:

1. Solve complex problems
2. Resolve conflicts at home and at work: Work out daily conflicts
3. Articulate personal, academic and vocational goals
4. Learn virtually anything
5. Think creatively
6. Make win/win decisions
7. "Read between the lines" and "connect the dots"
8. Manage their time
9. Approach tasks confidently
10. Clarify values
11. Identify wants and needs
12. Think about consequences
13. Communicate effectively
14. Argue persuasively
Topics/Content Areas:

- Conceptualization: how to state and shape a problem
- Problem solving: hypotheses, algorithms, heuristics
- Creativity: brainstorming with convergent/divergent thinking
- Decision-making
- Argumentation and evidence
- Argument mapping and reconstruction
- Making logical inferences: normative patterns for deduction and induction
- Basic research methods

4. Learning Activities

- Developing a plan
- Articulating obstacles
- Visualizing and graphically rendering problems/issues
- Collaborating on team-based community projects (students of a particular major will be divided in several groups of 4 or 5 students for semester-long collaborative work.
- Writing intensively – using journals, blogs, and wikis to develop storylines, surface assumptions, summarize topics and describe ongoing projects.
- Faculty workshops several times each semester to share findings and discuss instructional issues. Examples will be provided from appropriate disciplines that use the above tools.
- As assessment, the student will prepare several small and large PowerPoint projects and 50 examples to resolve their own daily conflicts during the semester, and a final project plan for their career as a final exam of the course. In addition, the faculty in various disciplines will assign other projects in their disciplines.

5. Instructor/s: Various from different Disciplines

Office: , Telephone: , Hours: and appointment.

Email: @mec.cuny.edu

6. Prerequisites – None
7. Software: Students will use Microsoft Word, PowerPoint and TLT software to construct various diagrams involved in the course. No previous knowledge of software is assumed. Students will get a copy of TLT for their use.

8. Resources: Resources:

   Faculty: In addition to the instructor being the important resource, students will work concurrently with other academic instructors of the course. All faculty will first receive workshop from Drs. Nancy Oley of Department of Psychology and Umesh Nagarkatte of Department of Mathematics assisted by Dr. Michael Fitzgerald of Department of Philosophy in addition to their professional expertise.

   Students: Fellow students are another important resource. Studying with two or three students together, discussing the ideas with them on a regular basis twice a week helps to motivate study and improve performance. Students are expected to attend all classes. Any absences from the class form a gap in the understanding, since there is no substitute for firsthand knowledge obtained in the interaction with the class instructor and fellow students.

Other resources:

Reading Materials:

- The authors have developed a Motivational Guide introducing various effective tools and strategies for students’ understanding life and achieving success in personal and academic life, various course and time management.

There are additional help materials on the following websites:

- www.autosocratic.com,
- www.TOCforEducation.com

Other useful TOC websites will be notified as the instructor becomes aware of them.

9. Strategies for the Learning Outcomes

   1. Faculty in various disciplines teaching the course will communicate with each other frequently and meet formally prior to teaching the course and every four weeks
during the semester. They will also work with counselors of SASS as the need arises, but formally before the course starts.

2. Use all available resources. Each class will be equipped with a smart cart.

3. Topics will be presented with concepts and algorithms in a logical fashion informally and formally using examples from various sources such as newspapers, websites. The course schedule is attached at the end of the document.

4. Confidence will be instilled in students by their active participation in instruction in order to accomplish consistent individual and group work that will lead to success.

5. Students will prepare a (word processed) summary in their own words from each section using the examples from their discipline in a structured format: Goal of the sections, concept or concepts covered in the section each with example/s linking them in a logical order. This will help them with practice in writing, reflection, to review for tests and will form a portfolio of the course at the end of the semester.

6. Students will be assigned homework to turn in and receive feedback within a week.

7. Students will complete several projects and the instructor will select some for class presentation.

8. Instructors will always available through office hours and also by appointment and by e-mail.

10. Assessment Methodology

The grade will be determined as follows:

1. Assignments: All assignments must be completed and handed in by the date announced. The deadlines for turning in the projects are assigned in the syllabus. Students who do not hand in all their assignments will not receive a passing grade.

2. The summaries of each chapter will constitute 25% of the course grade.

3. Exams: Student presentations and various trees developed by the student -

   50 Conflict Resolution Clouds (25%), Ambitious Target Tree to attain student’s academic goal (25%) Collaborative Community Project (25%)

11. Expected Results

1. The strategies will guarantee that students perform A or B grade level work.

2. Students will be able to use computers and use software to do their homework.
3. Students will learn how to apply the concepts and skills of the course to practical applications.

4. Students will develop communication skills.

5. With the cooperation of students it is expected that 100% students will pass the course.

6. Most students will develop an ability to handle systematically credit courses in their disciplines.

Detailed syllabus next page.
### 12. Syllabus for Creative Thinker’s Toolkit

#### Detailed Syllabus for:

**COR 100 - Creative Thinker’s Toolkit: Thinking and Acting**

**Fall /Spring**

14 weeks, 27-28 meetings, 1.5 class hrs./meeting

*Italicized* phrases list 15 Learning Competencies.

<table>
<thead>
<tr>
<th>Lecture Day</th>
<th>Topic</th>
<th>Chapter/Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What are thinking processes? Logic underlying – Logic twigs.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Making groups of students in the class for collaborative work.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Discussion of Examples of logic – from Academic Disciplines</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Argumentation and Evidence</strong> - Graphical method of resolving conflicts - Evaporating Cloud – creating a simple personal cloud; <em>Identify wants and needs</em>, <em>Clarify values</em>; Identify and resolve day-to-day conflicts, Multitasking game Numbers Game – Finding order in chaos slides # 7,8</td>
<td>2 – 1,2</td>
</tr>
<tr>
<td></td>
<td>Examples from Academic disciplines – Academic Class project – List of UDEs</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>8 personal clouds, Chapter 1 summary</strong></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Addressing Chronic Conflicts; <em>Resolve conflicts at home and at work</em>: Working out daily conflicts</td>
<td>2 – 3</td>
</tr>
<tr>
<td></td>
<td>Examples in Disciplines - Writing about your experiences in mathematics/disciplines – Listing UDEs and making clouds from 3 chosen UDEs</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><strong>Approach tasks confidently</strong>; Empowerment Clouds</td>
<td>2 – 4</td>
</tr>
</tbody>
</table>
Examples from Academic Discipline

3-Cloud Process, summary of clouds 2 – 5

Making the CORE Conflict Cloud and surfacing assumptions, suggesting injections. **Construct persuasive arguments**; Examples from Academic Discipline

**Assignments due**

10 personal clouds, Chapter 2 summary, academic project Core Conflict Cloud

Communicating effectively; how to debate; Student individual/group Presentations on core conflicts;

**Assignments due**

Argument mapping and logical connections - The Branch - Checking “if ..then” logic

Examples of the Branch from Academic Discipline

**Assignments due**

Learning how to read between the lines; 3 – 2

Reaching Decisions

Examples from Academic Disciplines

Negative Branch Reservations and Positive 3 – 3 Branches

**Assignments due**

Solve complex problems; Examples from Academic Disciplines

Half-Baked Solutions; **Think about consequences**

Examples from Academic Disciplines

18 personal clouds, Chapter 3-1 thru 6 summary, academic project Current Reality Tree

**Assignments due**

Inferential patterns: deduction and induction - Current Reality Tree (CRT)

Discussion of Students’ Academic CRTs

Student individual/group Presentations on CRTs

Student individual/group Presentations on CRTs

Future Reality Tree

Student’s Academic Future Reality Tree

Examples from Academic Disciplines

“Connecting the dots”, Transition Tree

Solving a System of Equations – Science, Business Example

**Assignment due**

6 personal clouds, Chapter 3 summary, academic project list of DEs and Future Reality Tree
19 Ambitious Target Tree (ATT) 4 -1, 2
Examples from Academic Disciplines

20 **Envision their goals:** Students prepare their ATTs 4 – 3, 7

21 Examples to solve problems in Academic Disciplines using ATTs 4 - 8

22 **Time management:** How to develop a project plan and use Transition Tree to bring it into action.

Assignment due 6 personal clouds, Chapter 4 summary

23 **Become more creative thinkers:** Student individual/group Presentations on ATTs

24 Student individual/group Presentations on ATTs

25 Job shop game

26 Summary of Thinking Processes 4-11

27 **Learn virtually anything:** Examples in Academic Disciplines

==== Final Project ==== 
CHAPTER 5 – FIVE FOCUSING STEPS IN THE PROCESS OF ONGOING IMPROVEMENT - INSTITUTIONAL PROBLEM SOLVING

5.1. Overview
The purpose of this chapter is to bring together TOC concepts introduced in previous chapters to show how they can be used to solve institutional systemic problems. Institutional problem solving or systemic problem solving requires us to traverse the entire TOC Roadmap. To insure the Process of Ongoing Improvement (POOGI), institutions use five focusing steps.

At the outset, we recall from Chapter 1 some technical terms: A “constraint” is something which hinders attaining a goal and which should be removed. A “system” in academia consists of students, faculty, services, staff, administration, and their interactions that are related to a constraint. A system for an institution is all departments and personnel related to the constraint. A “system” for a person is all people related to an interpersonal and personal issue. “Performance” is measured in learning, passing rates, graduation rates, being more successful in achieving goals, etc. “Performance” improves due to a “paradigm shift” in how we view the underlying issues, and results in changing various behaviors, measures and policies that are restricting or constraining that improvement.

In the second section we define the five focusing steps of the Process of OnGoing Improvement and explain them related to constraints in academia. In the third section we discuss in detail these steps as they applied to the institutional study at Medgar Evers College.

In the fourth section we discuss numeric measures of the Throughput in terms of graduating students and students progressing towards a degree.

5.2 Five Focusing Steps of the Process of Ongoing Improvement
Step 1: IDENTIFY the System Constraint (the Weakest Link in a system)
Step 2: Decide how to EXPLOIT (Make maximum use of - not Waste) the System Constraint
Step 3: SUBORDINATE everything to the above decision
Step 4: ELEVATE the Constraint.
Step 5: WARNING!!! If the constraint was resolved in previous steps, do not let INERTIA become the constraint. GO BACK to Step 1 to identify the new weakest link.

(FC Dictionary)
Before beginning to solve a problem, it is necessary to define the problem. Depending on the educational institution, improvement can only be made in the area of one’s responsibility and the area under one’s control. Occasionally some individuals are themselves involved in external constraint analysis such as interdepartmental concerns: recruitment or placement in internships, jobs, or cooperative work with industries; or college wide committees whose mission is to promote the welfare and interests of people in all areas of concern.
An institution such as shown in Figure 5.1A below does not exist in Nature. To improve the institution A, each entity in the figure needs to exert an independent effort. But, thanks to Nature, there exist only institutions such as shown in Figure 5.1 B. The institution B can be improved by improving just the two bottom entities. This is because no entities in the institution are isolated. They are always logically connected to one another by cause-and-effect relationships. By addressing the issues related to a constraint in a way that no party has to compromise will lead to a harmonious resolution and improve that institution. Improving every entity individually does not lead to overall improvement of the institution.

**Figure 5.1** Institution A consists of isolated entities. Institution B has interrelated entities. Arrows indicate cause-and-effect relationships between entities.

**Figure 5.1 Systems/Institutions**

An educational institution is a service organization. Its customers are students and industries that employ its students, or other higher education institutions, such as graduate or professional schools, that will develop further the academic knowledge of the students. It has to be sensitive to students’ needs and other customers’ needs. If students’ needs are not met, they will look to other institutions to meet their needs. Similarly, employers and colleges, universities, business
and professional schools look for quality graduates from educational institutions. Thus the survival and reputation of an educational institution depends upon recognizing and meeting its students’ needs and maintaining quality education.

With the single goal of helping students to meet their needs and graduate them, the staff and faculty of an institution can come together and resolve any issues that arise. They should not get emotionally trapped in any one point of view. For a few administrators, used to making “ad hoc” decisions, such a systemic analysis might seem tedious, since it does take time to flesh out the assumptions underlying the various issues which can be addressed in a way that has a long lasting effect.

Most initiatives start as a reaction to pressure or adverse effects on the entity such as a confining written or unwritten policy, measurement or behavior. People behave according to the way they are measured. Measurements come as a result of a policy. Actions may depend on funding, which is also a policy of some kind. For example, for recruiting personnel, the pressure is to enroll as many students as possible, since in some cases, funding of the college or university may depend on enrollment. For the admissions department, the pressure is to select students who have minimum academic preparation. For program and curriculum developers in the institution, the pressure is to do the development work in the shortest possible time. For advisement, the pressure is to place the students correctly. For academic departments there is a pressure to maintain the quality of instruction and assessment and at the same time to accommodate students with different deficiencies. For career advisement personnel there is pressure to place as many graduates as possible. For counseling, library and other services, there is pressure to abide by various State or university regulations and funding, and to meet student and faculty demands. Mostly the various entities tend to react to the pressure, treat the symptoms, and not to address the causes. If instead, people involved introduce initiatives based on an objective analysis of issues that addresses the three questions of TOC, a long lasting resolution of the issues will result.

Sometimes decisions have to be made.

- How many instructors are needed in a department?
- How many administrators are to be recruited?
- What are the best strategies for personnel retention?
- What are the best strategies for student retention?
- What can we do for students to help them keep up with the course syllabus?
- How can we convince others that our strategies are beneficial to all?
- How can we develop an optimal tutoring program that meets the needs of students?
- How should we implement the proposed changes?

TOC analysis gives definitive answers to such questions, and methods to consider all likely consequences of these decisions.
Figure 5.2 shows an overview of how to solve problems and make decisions, the theme of this book. See Chapters 2, 3 and 4 for a review of the main elements of problem solving. Good decisions rest on the three elements of making improvements. According to Figure 5.2, one should know 1. What to change, 2. What to change to, and 3. How to cause the change. Improvements made on the basis of symptoms without the systematic analysis of the three questions lead to temporary solutions and conflicts between different entities, as the following examples will show. Ignoring any one of these questions in the given order leads to adverse consequences.

**Figure 5.2**

![Diagram of making good decisions](image)

_The power of the “AND”:_

_IF any ONE of the entry elements is missing - desired outcomes don’t get achieved…_

Examples of making changes while ignoring the first of the three questions abound. We will consider three examples.

1. Because of the policy issued by a college/university administrator, every degree granting department in a college had to present a five year plan of course offerings. No academic department was consulted in making this policy. By the department’s strictly adhering to this policy, many students had to wait until a given course was offered and delay their graduation.

2. Most departments do not communicate with other departments on a regular basis. If two courses are scheduled at the same time in two related departments which are taken by

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26 Many of the figures and diagrams in the fifth chapter are adaptations of slides from a TOC workshop for counselors and faculty at Medgar Evers College, CUNY, facilitated by Dr. Janice Cerveny of Florida Atlantic University, Port St. Lucie, FL, in April, 2007, and are being used with her permission.
students as co-requisites and if the affected students cannot take the two courses when required, their graduation is delayed.

3. A university administrator made a rule without input from faculty that a student would need 120 credits to graduate regardless of whether the course is remedial or carries credit towards the student’s degree. The consequence of this action was that the higher level courses the student was supposed to have in a recognized degree program could not be accommodated in the student’s course sequence, thus potentially lowering the standard of the university degree.

Many people in power like to make changes without analyzing “what to change” discussed in the second and third chapters, and do it so quickly that they ignore the possible undesirable effects (UDEs). Many do not involve all the stakeholders and their issues. Decisions made then might not address the needs of some stakeholders.

In the second chapter we studied how to describe issues as UDE’s by removing the emotion from them.

An UDE should: be serious, be a condition not a lack of an activity, not blame anyone, happen frequently, have a serious negative outcome, not incorporate the solution within the statement. - Theory of Constraints International Certificating Organization (TOCICO) Thinking Process Committee, Nov, 2007.

The UDE should state what bothers you in a simple, clear, complete sentence, not a compound sentence using “but,” “and” or “because.” It is not a negative effect or a symptom. It should be a “benign” statement, that is, it should not hurt anyone. It should have no emotion. It should focus on a current fact. The UDE should focus on the “action/activity” or “want.”

The third chapter especially deals with the Current Reality Tree and negative branches to analyze the harmful consequences that a policy decision might cause. TOC analysis of “What to change” begins with listing all issues, expressing them as UDEs, and logically linking them to form a Current Reality Tree (CRT), discussed in the second chapter. You can develop the root or the core conflict later, as discussed in the later sections of Chapter 2.

As an example of implementing the second chapter alone as a quick method of resolution, we will consider the following incident reported by a colleague.

The Lab has been moving toward collapse on a number of levels for some time, and things reached a crisis point this week. The two lab techs were not cooperating, and they were unable to solve some serious technical problems that, if unresolved, would render the lab useless. I called a meeting of the parties involved. Everyone was upset. But instead of the usual, I decided to try the TOC approach of developing, collectively, a Current Reality Tree. First we agreed upon a common goal: to have the lab running smoothly and effectively. We put “Post-it’s on the wall, one for each UDE standing in the way of that goal. The rules did not permit criticism of any idea, and we continued.
until we ran out of ideas. Then we arranged the UDE's in "if-then" order. This revealed four clusters of problems, each cluster emerging from a more generic UDE. This took 3 hours, and took into account everything from resentment over being paid too little and late, to not knowing enough to solve the problem. We were able to work as a team without rancor, and many ideas for solutions popped out right away (interventions to cut the negative branches). Both lab techs are now working together, and discovered a workaround for the technical problem in less than a day. I also recognize that I have to take care of some issues at my end as well. Anyhow, we haven't gotten to the "CORE" conflict formally yet. It was amazing! Now I have to put it down on paper and present it to the administrators with the power to solve some of the problems. That won't be as easy.

TOC observes that frequently we don't improve because we're stuck in a chronic conflict that causes most of the problems we struggle with on a day-to-day basis.

Definition: Chronic Conflict - A conflict for an individual is a chronic conflict if the person feels trapped, does not see any other choice and feels powerless to remove the conflict. The individual submits to the reality unwillingly. The issue is long term, highly emotional, with little effort being given to addressing the issue. The issue may be personal or interpersonal. – (AGI 27 in a booklet on conflict resolution)

Any conflict not addressed directly has a tendency to become a chronic conflict, unless, because of time or change of situation or maturity, the issue no longer exists. Chronic conflicts have been discussed in Chapter 2. How can we find a chronic conflict or constraint? Review how to identify the constraint from a set of issues that we want to resolve.

In the TOC approach there is no blaming any party since we have active participation of all stakeholders and analyze the current situation in terms of policy, measurement and behavior, and not in terms of the particular people sitting there or reacting to them. No changes for change sake are to be made. If we want to improve some system, improving every entity in the system does not improve the system; rather, it is addressing the weakest link in the chain of entities that make up the system that brings about rapid systemic improvement.

An institution is able to identify the weakest link, bottleneck or constraint in a systematic fashion. To do this, list all the issues. Define UDEs, each of which is an objective, simple statement that describes a current negative situation and does not blame anyone. Select three important UDE’s from the set. Form an Evaporating Cloud for each of the three UDE’s, as in Chapter 2, and a Core Cloud (Conflict) that represents the three Evaporating Clouds. Just three important UDEs are sufficient to identify the constraint. In order to convince ourselves that the Core Conflict is indeed so, we have to show that most of the UDEs are logically linked to the Core Conflict. In other words, a Current Reality Tree (CRT) with the Core Conflict as the root

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27 AGI – Avraham Goldratt Institute, New Haven, CT. The authors had their Jonah training in TOC at AGI in 2001-2002 and 2005 with funding from two US Department of Education grants.
must be formed. If a CRT does not include all important UDEs then one must analyze the three statements selected, and also check whether the UDEs can be connected using intermediate logical statements. This is discussed in detail in Chapter 2. This answers the question “What to Change?” The dilemma or opposing “wants” in the boxes D-D” in a Core Cloud is the “conflict,” “constraint” or problem. **This IDENTIFIES the bottleneck or constraint of the system.**

By analyzing the assumptions underlying the Core Cloud, we obtain a resolution to break or resolve the conflict that considers the needs of both involved parties and transcends opposing “wants” that cause the conflict. That resolution is popularly called the “Great Idea” in TOC. All stakeholders must be in consensus that it is the bright idea that would resolve the conflict. That is the first step of “What to change?”

The detailed answer to the question “What to Change to?” lies in considering the logical opposites of UDE’s. These are called Desirable Effects (DE’s). When these are logically connected, one gets the skeleton of a Future Reality Tree (FRT). The effort or intervention that has to be taken up as an “injection” to bring each DE into reality must be added along with the DE to develop a complete FRT. The bottom of the FRT is the “bright idea.” This answers the question “What to Change to?” This is explained in detail in the third chapter. It shows logically how by addressing the “Great Idea” or “Starting Injection’, we can make the Desirable Effects (DE’s) a reality. **This indicates how to EXPLOIT the constraint, or how to make maximum use of the constraint.**

The listed injections of the FRT are called Tactical objectives (TOs), when we want to answer the question, “How to change?” For each Tactical Objective (TO) an ambitious target tree (ATT), also called a Prerequisite Tree (PrT), is developed using Intermediate Objectives (IOs) as discussed in Chapter 4. The top of all the PrTs is the Great Idea discussed earlier. **One should SUBORDINATE everything else to the decisions about how to handle the constraint in order to realize the Bright Idea or main objective.** All resources should be directed toward resolving the core conflict—the weakest link—using the Great Idea. In this way the resources do not get wasted on improvement of each individual entity in the system, but are used to improve the “system.” This is done using the ideas discussed in the fourth chapter to answer the third question, “How to cause the change?,” using the Prerequisite Tree.

In order to implement changes, Chapter 4 gives a step by step plan so that the hurdles and obstacles that might arise have already been considered. **This indicates how to ELEVATE the constraint.** The word “Elevate” involves action to implement the Great Idea, using all resources in a synchronized manner as shown by the Project Plan. In this step are expenditures, actual services, tangible results, and the tangible part of the answer to the question “How to cause the change?” You will see long term improvements and paradigm change. In that sense, the weakest point in the logical chain of the system has been elevated in strength and is no longer a constraint.
For the Process Of OnGoing Improvement (POOGI) this step automatically leads to the next step. If the constraint was resolved in the previous steps, do not let INERTIA become the constraint. GO BACK to Step 1 to identify the new weakest link. These steps will be further explained by a case study.

Figure 5.2, given earlier, summarizes the importance of the three questions of TOC. Just as in business, “throughput” is defined in terms of the product reaching the hands of the consumer and the income received as a result; the “throughput” is the ultimate product or outcome of the institutional processes, such as the number of students graduating from an educational institution. An educational institution does not have an inert product that is sold or monetary values that play an important role in running an industry, but has the intangible product -- education or knowledge.

The Partial Organizational Chart for an educational institution in Figure 5.3 shows selected departments. This figure summarizes the “silo” mentality of most institutions. Each department or functional area is working in isolation. Each department also operates within its own silo and with its own issues. The problems that arise from this silo mentality are further illustrated in Figure 5.4, which shows the institution from the larger perspective of input/output relationships and processes associated with the departments in Figure 5.3. Each area in Figure 5.4 represented by a silo has a particular function to perform or “job” to do, criteria for success or agenda (goal), undesirable actions it takes (UDE’s) and actions it would prefer to take (DE’s). For example, the faculty needs to educate students. They do this typically by enforcing strict academic standards. But in order for the program to continue, the faculty are under pressure to let a sufficient number of students pass, thus accommodating students with a lower standard. This results in a dilemma.

Figure 5.3 Part of Organizational Chart
Figure 5.4 Institutional flow chart detailing the functions of each silo.

The entities in the lower two rows are conflicts. In the first silo, note that establishing and running programs takes considerable time and resources. But there is also a push from the faculty or administrators to launch them as quickly as possible. This causes conflict. Similarly, other silos can cause conflicts. TOC resolves these and other such conflicts by looking at the educational institution as a system.

Figure 5.5 Colleges and Universities from a systems point of view
In Figure 5.5 the throughput is the number of graduating students. The processing of students forms the throughput chain.

TOC emphasizes that we should concentrate on the “weakest” link or constraint in the chain leading to the goal. There can be only one weakest link at any given time. We have discussed how to identify the constraint in a chain in earlier paragraphs. This discussion is summarized in Figure 5.6.

**Figure 5.6 Summary of the “chart” versus “chain” view of an organization.**

T” stands for throughput or the number of graduating students.

Since the student is the most important customer for an educational institution, the system has to be geared towards meeting the needs of the student and graduating her/him with a quality education in the shortest possible time. A typical incoming student moves through the system in the following sequence. A student desirous of graduating with a degree enters the college enrolled in a Freshman Year Program (FYP). Meeting the Basic Skills requirement is his/her first concern. Or, as a transfer student, the student might need some or none of the FYP and Basic Skills courses. See figure 5.7. The student might also be able to take some credit-bearing courses while fulfilling the Basic Skills requirements. Then the student needs to go through college level English and Mathematics requirements, which can be taken concurrently or as prerequisites to a degree program in a specific discipline. The student finishes the course track of years 1, 2, 3 and 4 in a sequence and graduates. There are students who drop out, or cannot be placed in a specific year because of failure, absenteeism, personal and family problems, courses not being offered when the students are ready, and many other problems. If a college wants to improve its throughput, these students’ concerns must be addressed, so as to expedite their passage through the system.
The Departments of Mathematics and English play a dual role. They are service departments to other departments (the client disciplines) and also provider departments. They draw resources (most importantly students) from the clients (other departments) and the providers (the Math and English departments). Their resources are the students other than mathematics and English majors who require a service such as pre- or co-requisite courses in mathematics or English, and the students who are majoring in mathematics or English, respectively. Some service departments which do not have degree programs of their own, such as the Freshman Year Program (FYP), basic skills instruction, counseling, library and computing services, are purely service departments and draw their resources from clients only.

Sometimes, conflicts may arise between the resources and resource constraints of two departments. For example, suppose a student with a biology major requires a calculus and a physics course, and the physics course has the calculus course as a pre or co-requisite. If the mathematics department schedules the calculus course at the same time that the physics course is offered, it can delay the student’s graduation. Service projects (e.g., Scheduling courses) thus need communication methods to coordinate constrained resources across the two departments (i.e., need to coordinate the two courses for clients and providers.) They need quality assurance methods that identify conflicts without unduly interfering with curricula/disciplines and that are trouble-free (do not generate ill will), diagnose the cause of the trouble, and apply a suitable remedy.

It should be apparent that the impact of problems on a service project (course) can affect the client and the services provider well beyond the duration of the project. For instance, if we
regard a course as a project, as discussed in Chapter 4, a student taking prerequisite courses in a certain service provider areas (e.g., Mathematics Department) must be equipped with concepts, skills and confidence to succeed in the courses offered by the client departments (e.g., Physical Sciences Department). And if the student is not so equipped, then s/he is not capable of handling the course in the client discipline.

Service providers must simultaneously manage a portfolio of unrelated projects (courses, etc.) for multiple clients, programs of related projects for specific clients, and the service provider’s own internal projects.

In other words, service departments such as Mathematics and English play a very important role in the college, since every college student must take at least one course in each of these departments. Considering the importance of writing and communication and the need for prerequisite mathematics courses in other science, business and social sciences courses, the sooner the student completes the college requirements in Mathematics and English departments, the sooner s/he is on the way to her/his graduation. Therefore, the departments feeding students to Mathematics and English departments have a responsibility to build confidence and prepare students in credit bearing courses in terms of content and process. The Departments of Mathematics and English, in turn, have to be extremely sensitive to the client departments’ (e.g., Psychology, Business, and Biology) needs. In that sense, Mathematics and English departments play the role of “a drum28” or “constraint” in the throughput chain in the language of TOC.

Communication and arrangement of the smooth flow of students into and through the “drums” is an essential condition for steadily increasing the supply of graduates. This means that an adequate number of well prepared students should be supplied to English and Mathematics departments, and these departments should not be overloaded by weakly prepared students, unless the two departments themselves offer further formal preparation for college level courses.

In some Colleges and Universities, Basic Skills service departments are outside the respective disciplines as a “cost saving” measure by underpaying and making some people overwork or for some other reason, where all the consequences are not well thought out. There is a sophisticated side to Elementary Mathematics29, which the administrators overlook by separating Basic Skills from the Department of Mathematics and by employing lesser qualified personnel to teach the courses. Usually graduates from other disciplines know only how to manipulate symbols, and do not take the Advanced Calculus/Mathematical Analysis required of Mathematics majors. These specialty courses discuss how fractions are created, how the decimals are created, and so on. Details are available in the cited document. Thus the students of Basic Skills Departments who are taught by non-mathematicians do not receive a deep, College-level understanding of Basic Mathematics.

28 A Drum is a bottleneck in processing and thus the graduating, capacity of an educational institution.
29 “What is sophisticated about elementary mathematics - ...” H.H.Wu, American Educator, Fall 2009
The only goal for the Basic Skills service department is to ensure that a maximum number of students pass the exit test and to qualify students to take the lowest level of Mathematics or English courses in the respective departments. If, instead, the basic skills courses in English and Mathematics are offered within their respective disciplines, then first time freshman students automatically land in these departments. Preparing students becomes the responsibility and opportunity for the two departments. Students can come into contact early with the faculty of these departments. Students have one less link to pass through to attain their goal of graduation. The Mathematics and English Departments have the higher goal of graduating students with a degree and not just of having students pass some university-mandated exit test. They can exercise flexibility in terms of placing students in higher level courses by direct observation of students’ capabilities, thus possibly lessening the time needed for graduation, and consequently increasing the “throughput.” Freshman students also work towards the higher goal of graduating with a degree rather than just passing the exit tests, which might be demoralizing since the Basic Skills courses are the ones they were supposed to have passed in high school. Students’ morale is raised when they come in daily contact with faculty in credit-bearing courses and tutors in the same department. In conjunction with the Freshman Year Program advisors and resources, the Mathematics and English departments are well-placed to fulfill their responsibility of instilling confidence in students with a focus of graduating students with a major.

The two departments have also responsibility to the students in client disciplines, of course, including their own majors. As shown in Figure 5.6, in general, the advisement and counseling departments play a critical supporting role, and academic departments deliver the courses for the main throughput (T). Considering the only goal of increasing “Throughput,” the various departments in an educational institution can come together and brainstorm, using the systematic TOC approach to resolve any conflicts that may arise from time to time.

In the following we discuss in detail the five focusing steps of TOC for an Educational Institution’s ongoing improvement.

5.3 Process Of OnGoing Improvement (POOGI)

Step 0: Agree on the System GOAL. Define the “Constraint” and the “problem.”

In order to agree on a common goal, a brainstorming session is necessary, where people are free to express their issues and understand their roles in terms of the College’s goal of graduating more and more qualified students. However, if we do not focus on T in Figure 5.7, and instead focus on symptomatic issues, we will end up with the scenario discussed in Figure 5.8.
As a case study discussed in each of the earlier chapters, for the TOC analysis done at Medgar Evers College\textsuperscript{30}, the Department of Mathematics considered the Goal: “To reduce student attrition.” To confine it to the faculty’s area of responsibility, the team restricted itself to the goal “To reduce student attrition in mathematics courses.” As previously mentioned, a team of three mathematics faculty members including the Chair, developed all the steps during the Jonah Program at AGI.\textsuperscript{31} This case study\textsuperscript{32} will be used as our example for the following discussions. After defining the goal of the system and the fact of a constraint, we are ready to consider the five focusing steps as a process to get the most out of the system in terms of the System Goal. Here the system includes the full-time and part-time faculty, students, courses and tutors in the Department of Mathematics, and counselors and advisors working with the Department. In the following we will use TOC terms, assuming that the reader is familiar with the terms from Thinking Process (TP) tools described in the earlier chapters.

### 5.3.1 Levels of Resistance, levels of buy-in and TOC- TP

It is necessary to know the levels of resistance and levels of buy-in before any initiative is introduced by the initiating team. The reason for this is that the perceived resistance can be turned into a positive force using the TOC and TP tools in a systematic fashion, level by level. This is explained in the following chart. The reader can see that the chart is a PrT on how to introduce the initiatives. The following chart is based on discussions with Chuck Gauthier, the facilitator of our January, 2011, TOC workshop in Riverhead, NY.

\textsuperscript{30} As far as the authors know Medgar Evers College of CUNY is the first college to use TOC to address the problem of student attrition.

\textsuperscript{31} Dedicated Jonah Course at Avraham Goldratt Institute (AGI), New Haven, CT. January,. 2002

\textsuperscript{32} Details of this research were presented in International conferences of TOCFE and TOCICO.
<table>
<thead>
<tr>
<th>Levels of Resistance</th>
<th>Levels of buy-in</th>
<th>TOC-TP tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Disagree on the problem.</td>
<td>o Agree on the problem.</td>
<td>1 - UDEs, UDE Clouds, the CCC, CRT, and CCRTs</td>
</tr>
<tr>
<td>2. Disagree on the direction of the solution.</td>
<td>2. Agree on the direction of the solution.</td>
<td>2 - CCC, ECs, and INJs</td>
</tr>
<tr>
<td>3. Disagree that the solution solves the problem.</td>
<td>3. Agree that the solution solves the problem</td>
<td>3 - INJs, FRT, and DEs</td>
</tr>
<tr>
<td>4. Yes, but there are potential negative consequences.</td>
<td>4. Agree that the solution will not lead to any significant negative effects</td>
<td>4 - FRT and trimmed NBRs</td>
</tr>
<tr>
<td>5. Yes, but there are obstacles to implementing the solution.</td>
<td>5. Agree on the way to overcome any obstacles that might block or distort implementation of the solution</td>
<td>5 - INJs, PRT, IO Map, and TrTs</td>
</tr>
<tr>
<td>6. Unverbalized fears.</td>
<td>6. Overcome unverbalized fears</td>
<td>6 - Committed leadership, TrTs, and individual TrT branches</td>
</tr>
</tbody>
</table>

The team presented the buy-in using the following steps. These steps were introduced in Chapter 1 and repeated here for relevance.

### Steps to Winning Acceptance

- **Informally train Grant Team members who did not participate in formal training.** (Spring 2002)
- **Introduce issues (UDEs) & findings (DEs) informally to Department Faculty.** (Spring 2002)
- **Prepare Departmental Guidelines & get Departmental consensus.** (Summer and Fall ’02)
- **Have trainer, Dean Steve Simpliciano of Goldratt Institute, make a presentation to the College President and his cabinet.** (May 2005)
- **Provide Management Skills Workshop (MSW) course for other grant personnel and directors of Freshman Year Program (FYP) and Post Secondary Readiness Center (PSRC).** (Dec. 2005)
Steps to Acceptance (Contd.)

- Give TOC Workshop for tutors, counselors (April 2006)
- Give Refresher TOC Workshop for tutors (March 2007)
- Provide TOC Workshop for new FYP director and academic advisors, FYP counselors, Women’s Center counselors (April 2007)
- Develop a TOC course at Freshman level: Creative Thinkers Toolkit (2010-11).
- Conduct workshops to train advisors and counselors to teach the course and establish communication with academic faculty (July 2011)
- Mount TOC Website for college level audiences. (www.TOCforCollege.com) (July 2011)

For the full-time Department of Mathematics faculty members, who were not on the grant, the cloud tool was not introduced. Only the UDEs and DEs described in Chapters 2 and 3 for the institutional example were presented. The faculty of the Department and various stakeholders of the College agreed with the UDEs, since they were selected from students’ academic and non-academic issues and faculty issues developed by the college-wide faculty senate. The buy-in to participate in the various workshops from various stakeholders, who were long time employees of the College, was gained through power-point presentations of various CRTs, FRTs, PRTs and other presentations made at various TOC conferences.

The Department of Mathematics Faculty easily accepted the logical approach, since the discipline itself is based on logic and it was not necessary to describe to them “necessary” and “sufficient” condition logic. The President insisted that the trainer should present what we learned. Finding a convenient time for both the facilitator and the President played a role in the delay of elevating the solution/problem to College level. Once the facilitator/trainer gave a twenty-minute presentation using the basics of TOC, CRT, UDE-DE chart, and FRT, the President congratulated the team and leadership of the chair, and said, “Conflict Resolution, Problem Solving, Decision Making! I have never seen anything like this. Everyone in the College, starting with the Freshman Year Program advisors, counselors, Academic Foundations, middle management, should implement TOC.” Finding appropriate facilitators for the workshops was a major task, since there are very few TOC experts, who have intuition and experience with a College environment. Funding from several competitive Federal grants provided the muscle and credibility for acceptance, and resources for holding workshops. These
steps go in line with the five focusing steps and the Process of OnGoing Improvement. These five steps are discussed in the following section.

5.3.2 Step 1: IDENTIFY the System Constraint (the Weakest Link)

1) Ensure each problem or issue is stated as an “UDE.”
2) Position the UDE’s (use Post-Its) so that causes are lower and effects are upper ones.
3) Create a cloud for three systemic or key UDE’s (be sure to check the logic).
4) Integrate all three clouds into a more generic cloud or (core) conflict and that it is logically sound. This defines the constraint in terms of a conflict in “D” and “D’”- two opposing actions.
5) Use simple cause and effect relationships to link the core conflict identified to the UDEs.

If it does not, the generic cloud or Core Cloud is not generic enough and we must go back and find other key UDE’s and go through the process again. Even after forming a generic cloud, before connecting the UDE’s it is a good practice to work out some additional clouds to determine for ourselves that we will arrive at the same generic cloud. In our experience, most of the UDE’s get connected to the “D” entity of the generic cloud. See Chapters 2 and 3 sections 2.5 and 3.5 for guidance on steps 1.1 to 1.5.

Thus, this step requires three TOC tools: Evaporating Cloud (ECs), Core Cloud, and Current Reality Tree (CRT). It answers the Question 1 of TOC: “What to change?” While developing the CRT, the team must use the “Categories of Legitimate Reservations (CLR)” to make the logic robust. A discussion on CLR has been given in the Section 3.1. This case study example has been discussed in detail in Chapters 2 and 3.

Figure 5.9 describes the Core Conflict Cloud of the case study.
Comment: When these UDEs and Clouds were presented in Leon, Mexico, at the tenth International Conference of TOC For Education Organization in 2006, a faculty member from a College in Mexico remarked that our team was discussing *their* students’ issues!

Figure 5.10 summarizes the processes involved in identifying and linking the UDE’s to a core cloud.

**Figure 5.10  TOC Thinking Processes**
5.3.2 Step 2: Decide how to EXPLOIT (make maximum use of - not Waste) the System Constraint

Exploiting the system constraint requires getting the most out of the weakest link of the chain. The critical nature of roles played by English and Mathematics Departments in the college has been discussed prior to Step 0. The sooner the students complete the requirements in these departments, the sooner they advance to complete their discipline requirements. For example, the College’s constraint is usually “mathematics,” since a large number of students have difficulty passing mathematics courses. If so, then much work has to take place in the mathematics department itself in terms of instruction, tutoring, interpersonal relationships and the learning environment for faculty and students to remove the constraint.

Even after finishing the core requirements in English and Mathematics, more work is necessary for the College system to bring the “Throughput” to a higher level, such as addressing the concerns of the students who have completed their course track unevenly. As in Figure 5.7, and the discussion following it, it is necessary to assure that college policies maximize use of the “drums” or constraint departments in reaching the goal of graduating many students now and in the future. As discussed in an earlier paragraph, one way to improve throughput is to change the way the students are fed into the “constraints;” the constraints are neither starved for “well-prepared” students nor overloaded with “weakly prepared” students. This is achieved by placing the Basic Skills within the constraint departments so that the preparation of students becomes the responsibility of the “drums,” and resources should be concentrated there instead of scattering them among the Basic Skills, English and Mathematics Departments. Otherwise, the departments will have fewer students finishing their requirements and proceeding to their
graduation in various disciplines. This ideal situation was created by many educational institutions by merging the basic skills courses with the respective departments, even though earlier they had separate basic skills departments.

At this point, we continue with the case study, the TOC work done on the College’s “constraint” by the Department of Mathematics to address the problem of student attrition. How to create a favorable learning environment needs to be summarized. Much TOC application work was accomplished around the College over the course of six years. This shows the long lasting effectiveness of TOC analysis in sustaining continuous progress. With course instruction, tutoring, and the learning environment in the department as areas under their direct control, the department studied Step 2.

This second step, illustrated in Figure 5.11, helps us to “break” the Core Conflict or resolve the dilemma in the Core Cloud. The TOC steps needed for this are: finding the “bright idea” or “starting injection” to break the conflict, developing Desirable Effects (DE’s) and the Future Reality Tree, and eliminating Negative Branch Reservations (NBR). These ideas have been presented in Chapter 3.

In the case study the Bright Idea was: “The department offers programs tailored to the needs of its students.” The CRT, FRT and NBRs were constructed on a poster board and are to be included in a cd in the final version. The injections are part of the FRT. They suggest the measures or initiatives to be implemented.
5.3.3 Step 3: SUBORDINATE everything to the above decision
This is the crucial step in institutional problem solving and is the first step in answering the third question “How to cause a change?” In this step, while doing work on the conflict/constraint, we might discover that there are several system UDEs that might seem to keep us from reaching the goal. However, we should maintain focus on the constraint itself. The work on the “constraint,” that is, the work of the constraint department (e.g., Mathematics or English) is the necessary “work” for student success in credit-bearing mathematics or English courses.

The case study of MEC and the Department of Mathematics continues. When it came to Mathematics, a large number of students needed basic skills or personal counseling, and helping them was important. However, developing areas under the direct control of the department was even more important and allowed the Department of Mathematics to continue to focus on its credit-bearing courses.

5.3.4 Step 4: ELEVATE the Constraint
This is the step where the plan developed using the Prerequisite Tree (PrT) or Ambitious Target Tree (ATT) needs to be implemented in answering the question “How to cause the change?” The experience of the case study at MEC shows that this involves implementing improvement in instruction through curriculum development and pedagogy; support services such as tutoring; online and print test preparation materials, and finally, continuous monitoring of these efforts as suggested by the injections of the FRT or the IOs of the PrT. This is the tangible or action part of how to cause the change.
The following diagram summarizes Steps 3 and 4.

**Figure 5.12** Processes needed in causing a change.

![Diagram](image)

In order to implement these changes the stakeholders must accept that the proposed changes are indeed the ones needed to resolve the issues. In this process there are difficulties. A higher educational institution is a bastion of academic freedom. The following Figures 5.13 A and 5.13 B make the difficulties of implementation clear.³³ Some of these slides were discussed in Chapter 1.

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³³ Detailed discussion in the TOCICO presentation, Las Vegas, NV, November 2007. Credit for these screens goes to Darius Movaseghi, Chair of the Department of Mathematics, till Dec. 2009.
In our case study, the Mathematics Department faculty came to a consensus as to how to implement the plan developed in TOC training. However, this required the Chair’s taking time out in monthly department meetings to discuss the issues faced by all the faculty and the team’s proposed solution. An agreement was reached among all the Mathematics Department faculty members regarding the plan after four months of discussion in Spring, 2002. The entire TOC
Chapter 5 – Five Focusing Steps in the Process of Ongoing Improvement

A roadmap was used for implementation. A project plan was developed from the Prerequisite Tree (PrT) during the winter break, and TOC-inspired activities taking place around the college still follow that plan. The Future Reality Tree (FRT) allowed us to write the Department of Mathematics Faculty Guidelines outlining the roles of instructors, tutors and counselors.

Significant improvements in the functioning of the department over five years are detailed in the document “A TOC Initiative at MEC” [Nagarkatte, 2007]. Within two years of the birth of the Bachelor’s degree program in the department, and because of the learning environment created by the open discussion of student issues, the number of math majors went from 7 to 29. Over the subsequent 6 years the department graduated about 25 math majors and increased the number of majors to 40.

Based on the faculty’s TOC training, a holistically-oriented Motivational Guide [Nagarkatte, 2007-2008] was developed to teach students how to achieve academic success, how to regard a course as a project with Critical Chain Project Management (CCPM), how to study any subject, how and why to study mathematics, how to study using a team approach, and techniques of achieving tranquility along with a brief introduction to TOC.

After working within the Math Department, the team needed to approach the service departments who share resources or feed resources to the Mathematics Department. Those are the Freshman Year Program (FYP); Academic Foundations Division (AFD); and personal counselors from the Student Advocacy and Student Support (SASS) Department and the Center for Women’s Development (CWD). Their cooperation was required in order to improve the quality of students entering credit bearing-courses in the Department of Mathematics. However, the Math Department had little leverage with these departments. Progress was made only after the President of the College, Dr. Edison Jackson, accepted the Faculty Guidelines and the facilitator of the math team, Steve Simpliciano, of the Goldratt Institute (AGI), gave him a private presentation about TOC in May, 2005. As a result of the presentation, the President indicated that everyone in the college should learn this theory for conflict resolution, problem solving and decision making, starting with the Freshman Year Program and Academic Foundations Division. The President acknowledged that the Department of Mathematics had addressed not only the Department’s major issue but the entire College’s issue of student attrition. Thus, he was the one who took responsibility for elevating the constraint to the college level. It is because of his leadership and encouragement that efforts were able to continue vigorously.

From 2005-2007, approximately 250 people around the college were exposed TOC and more students, staff, counselors, faculty and members of administration are learning TOC. Some faculty members have introduced TOC into the content of their courses. In the process, the Department provided funding, through U.S. Department of Education grant funds, for a Management Skills Workshop (MSW) course for the grant personnel and directors of the programs cited earlier. TOC workshops and refresher workshops were arranged for tutors, counselors and academic advisors.
The College’s focus could then be shifted to improvement in the feeder departments as the “constraints” departments. The President took the initiative in Spring, 2008, to hold a “retreat” to resolve all issues of the Freshman Year program and Basic Skills both housed in the College of Freshman Studies (CFS), a constraint department. This process showed all the participants that administrators and faculty could work together. A few months after these workshops, the President decided to merge the Basic Skills courses and faculty into their respective departments of Mathematics and English. By merging the feeder departments, he raised the “ceiling” for students: their goal would not be just to qualify for credit-bearing courses, but to focus on graduating with a degree.

5.3.5 Step 5: WARNING!!! Do not let INERTIA become the constraint.
If the constraint was broken in previous steps, do not let INERTIA become the constraint, GO BACK to Step 1 and find the new constraint.
For the Process Of OnGoing Improvement (POOGI) it is necessary to focus on the current constraint. Once the commitment of all leadership is available, the system’s continuous progress is guaranteed for the working teams.

The Department must focus on improving the quality of instruction and accountability of tutoring. For example, many more instructors than in the past now insist that all students in their classes complete writing assignments in mathematics, because writing forces students to reflect on the material and enhances their understanding. Accountability of tutors has been improved by computerizing certain aspects of tutoring. Critical Chain Project Management (CCPM), discussed in Chapter 3, has been introduced in all math sequence courses in tutoring up to Calculus 2 to help make students responsible for their own progress. The overall process has made constant communication between students, tutors and instructors possible. For example, red, yellow and green areas are drawn in each lesson-by-lesson course syllabus carried by a student. If the student attending tutoring is falling seriously behind in his/her homework s/he falls in the red area; if the student is absent and about to fall behind, s/he falls, around the yellow line; and if the student is current or ahead in the course, s/he falls on or in the green area. This classification can give rise to numbers of students ahead, on time, or falling behind for the student database, and allows us to focus on students who need intervention from tutors, instructor and counselors.

TOC and the five focusing steps constitute an objective, logical procedure that transcends all personalities involved in decision making and allows an educational institution to resolve all institutional and departmental issues. This concludes the discussion on how an educational institution can address a systemic problem using the five focusing steps.
5.4 Numerical Measures of Performance in Educational Institutions

Institutional Problem Solving OR Five Focusing Steps in the Process of Ongoing Improvement - Numerical Measures

We are familiar with the term “Throughput,” the number of graduates, as the performance measure of educational institutions. In business (see Ricketts, 2007), “Throughput” (T) is measured in terms of money made by selling the product; inventory (I) is the money tied up in terms of the number of units finished but not sold and money you spend to finish the product; operating expense (OE) is all of the money you spend to produce the throughput. A successful business runs on focusing the system effort on achieving the goal “Make money now and in the future.” In order to do this, the business keeps on improving T, while reducing I and OE. But just reducing OE or reducing I has a limited effect on making money, whereas increasing T has unbounded potential. The TOC success measures of a business are defined as net profit,

\[ NP = T - OE, \]

Return on investment, \( ROI = \frac{NP}{I}, \)

Productivity: \( P = \frac{T}{OE}, \) and Inventory Turns: \( i = \frac{T}{I}. \)

In applying these measures to a not-for-profit four-year educational institution we have a broader definition of T as not only the number of graduates placed in industry, professional or graduate schools but also the number of students moving up to the next level, i.e., going from Freshman to Sophomore, etc. In other words, we define “Throughput” as the number of students graduating from one year to the next year. After the year 4, they are graduates with a degree in a major. Thus the numbers of students making up T has four components: \( T_1, T_2, T_3 \) and \( T_4. \) \( T = T_1 + T_2 + T_3 + T_4. \) \( T_i \) is the number of students moving up from level \( i \) to the next level. \( T_i \) is the number of graduates with a degree in a major. No dollar amount can be placed on T. We must include in \( T_i \) the number of students placed in industry as interns and who were promoted in the industry due to the quality of their work but did not graduate, since it is also a measure of success for the college.

\( N \) is the number of students who are registered in the college. Thus \( N \) has five components: \( N_0, N_1, N_2, N_3, N_4. \) \( N = N_0 + N_1 + N_2 + N_3 + N_4, \) where \( N_0 \) is the number of students taking courses, but not matriculated or classified, and \( N_i \) is the number in the year \( i = 1, 2, 3, 4. \)

\( I \) is the inventory defined as the number of students who completed their respective year, who continue their studies in the college with grades C or better, but have not yet moved up to the next level, i.e. not yet changed their class standing, possibly because they are lacking some courses in the required course sequence in their discipline. Thus \( I \) has four components \( I_1, I_2, I_3, I_4. \) \( I_i \) is the number who have completed the 120 credits required for graduation, but not graduated. \( I = I_1 + I_2 + I_3 + I_4. \)

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34 Dr. Eva Chan, Director of Office of Institutional Research, MEC has contributed to this section.
35 John Arthur Ricketts in “Reaching the Goal”, 2007, IBM Press, Pearson PLC, p. 56
SAᵢ is the student attrition in the year i which consists of the number of students who did not get a passing grade in the courses they registered for or did not move into the next year’s class due to failure, withdrawal, incomplete, or absence/no show and also those who received a passing grade but did not move; and SA is the number of students attrited or who did not move:

\[ SA = SA₁ + SA₂ + SA₃ + SA₄. \]

If student attrition, SA, increases, then T decreases and eventually fewer numbers are placed in industry, professional or graduate schools.

OE is the operating expense per year, that is, the money spent on the N students.

The net “Throughput” (T) for an undergraduate four year educational institution must be defined as

\[ T = \text{total number of students in each class} - \text{SA} - \text{I} = (N₁ - SA₁ - I₁) + (N₂ - SA₂ - I₂) + (N₃ - SA₃ - I₃) + (N₄ - SA₄ - I₄) = T₁ + T₂ + T₃ + T₄. \]

We define the following terms:

**Productivity** = \( P = \frac{T}{OE} \) (in units of number of students/$)

**Cost per student** = \( CPS = \frac{OE}{N} \)

**Return on investment** = \( ROI = \frac{(T + I)}{OE} = \text{(Number moving up or graduating + continuing in a specific year (pipeline) but lacking appropriate credits to move to the next level in their major)}/OE \)

and **Inventory turns** = \( i = \frac{T}{I} \). This is a pure ratio of the number of students graduating or moving up to those in the pipeline, but not graduating to the next level. This is a (positive) fraction less than or equal to 1. The larger the fraction, the larger the Throughput.

If an educational institution is successful, first of all, it should have high throughput, T. T increases by increasing N, reducing the number of students in inventory, I, (by making them count in T), and loss due to student attrition, SA.

These measures do not take into account the intangible qualities such as knowledge, friendships, mentorship and the values a college education offers a student to succeed in life, or the community work, creative work, research and publications of the college faculty and grants received by them. However, high student attrition (SA) can be easily seen to have a drastic impact on P, ROI and i. In this manner, TOC offers a numerical measure for the impact of attrition, success, return of investment, cost per student and inventory turns as in industry.

The End
APPENDIX – TOC FOR EDUCATION
TOC for Education, Inc (TOCfE), www.TOCforeducation.com, was founded in 1996 by Eli Goldratt who donated his knowledge of TOC for the use of Education. This organization has done a tremendous amount of work in all continents under the leadership of Kathy Suerken. It serves as an umbrella for all activities in Education and arranges international annual conferences around the world. It has influenced Central Boards of Education in many countries and has influenced educational reforms mainly at the kindergarten, elementary, middle and high school levels. It has also provided resources and training to community groups, churches and jail reformers.

We subscribe to its mission statement and ethical code, as described in Chapter 1, for work at the College Level. To simplify teaching the Thinking tools, TOC for Education Inc. has simplified the Thinking Process tools to “Cloud,” “Branch” and “Ambitious Target Tree.” “The Branch” includes “sufficient condition” processes used in the Current Reality Tree and Negative Branch Reservations.

An Evaporating Cloud (EC) or The Cloud is a TOC thinking tool that analyzes the details of a conflict, meaningful action and a decision, in a concise and non-provocative way.

The cloud resolves a conflict. A conflict is well defined when two possible opposing actions (wants) are present to achieve a common goal. Both actions are logically linked to the common goal by two different needs. The two needs are general and do not oppose each other. If the different needs are met, then the conflict is resolved with a “win-win” solution.

The Cloud analyzes the details of the conflict by asking five guiding questions:

What do I WANT?

What does s/he WANT?

What is my NEED?

What is her/his NEED?

What is our Common OBJECTIVE?
The cloud may be internal to an individual. For instance to resolve the conflict: “I must attend to my family responsibilities or I must study.”

The Cloud’s structure is built of five boxes connected by logical arrows. Each box answers one of the five questions to help describe the conflict.

- The broken arrow symbolizes the conflict - the WANTS cannot both exist at the same time.
- The NEED is the real reason why each side insists on getting what s/he wants. In order to satisfy the NEED it is necessary to achieve the WANT.
- The COMMON OBJECTIVE is a situation both sides wish to have, but in order for it to exist each side must satisfy his/her NEEDS.

In order to reveal the assumptions (shown below — add text to empty boxes), we find out why getting the Want is necessary to fulfill the Need. Then we examine each assumption to know if it is really valid, and whether we can do something to make it invalid.

The arrow connecting the Want and the Need is based on many assumptions. If an assumption is invalid, then the Want is not necessary for the Need. If the Want is not necessary for the Need it means there is an alternative way to satisfy the Need.
Finding Win-Win solutions
A Win-Win solution is a solution that enables both sides to satisfy their significant Needs. The problem is that in order to satisfy its Needs, each side usually insists on getting its conflicting Wants. Thinking within a Win-Win framework requires us to shift the focus from getting what we want to obtaining what we need.

The Branch is a TOC tool used to logically analyze and explain a logical structure of cause-effect connections.
The branch is used to understand cause-effect links between actions and consequences, make predictions, and create new and better solutions.

In order to make sure that we have built a sound branch, we should read out loud the diagram using the words: "If...then" which express the causal relationship.
We read every connection: "If...(the cause)..., then...(the effect)..." By drawing cause-effect connections, the Negative Branch describes how an idea could lead to a negative outcome that we do not want.

**To construct a Negative Branch**

We use the Negative Branch to understand and analyze our concerns about implementing an idea.

1. First, define the idea.
2. Then, create a list of negative outcomes.
3. Finally, connect the idea to significant negative outcomes using cause-effect connections.

**As the second step:**

We use the Negative Branch to find a way to implement the idea without suffering the negative implications.

1. Add explanations to the connections.
2. Check to see if the explanations are necessarily valid.
3. Find a way to negate one of the explanations and thus break the connection.

Examples –

1. Discussion with Examples of the Branch— There are six different examples of the Branch in this document.
2. MEC presentation at TOCICO Conference 2007 (Slide 32)

*The Ambitious Target Tree is a TOC tool used to analyze and sequence the steps needed to achieve a goal.*

An Ambitious Target is a positive and desirable objective that at first glance seems unreachable.

The stages in constructing the tool are:

1. **Define the Ambitious Target.**
   - Before we start the discussion about how to achieve the target, we should always make sure that there is agreement among the team members that the target is desirable!
   - Different team members may give a different meaning to the general terms and thus have a different image of the target. When that happens, many arguments are likely to occur about the ways to achieve the target.
   - The third reason for carefully defining the Ambitious Target is focusing. If we do not define the Ambitious Target, the objective may become vague.
   - What is important is to verify that everybody understands the target and agrees that the target should be achieved.

2. **Identify obstacles which block us from achieving the target.**
   - An obstacle is something that prevents or significantly inhibits the successful achievement of a target.
After we define the Ambitious Target, we need to define the obstacles that prevent its achievement.

In order to understand whether a specific action will move us toward the target, we should check to see if this action overcomes an obstacle that we believe prevents us from achieving the target.

3. **Verbalize Intermediate Objectives (IOs) according to the obstacles raised.**
   - An *Intermediate Objective* is a situation reached after overcoming an obstacle. Intermediate Objectives are landmarks or stepping stones between the present situation and the Ambitious Target.
   - For each obstacle that we have identified, we need to verbalize Intermediate Objectives that will overcome it.

4. **Arrange the Intermediate Objectives in a prerequisite order.**
   - A *prerequisite order* indicates which intermediate objectives must be achieved before others, and which can be achieved in parallel.
   - After verbalizing the Intermediate Objectives, we need to arrange them in a prerequisite order.

There are plenty of examples for children, parents, administrators and community groups on the website: [www.tocforeducation.com](http://www.tocforeducation.com)