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Introduction

For years industrial advisory committees (IACs) have provided valuable assistance to industrial-based programs. IACs provide valuable guidance and input on how industrial-based programs can remain competitive and current with industrial trends. These committees provide information about new technologies, sponsor co-op and internship programs, provide jobs for graduates and have first hand knowledge about hiring trends (Coppula, 1997).

The importance of IACs continue to grow as pressure mounts to establish a curriculum that is responsive to and addresses the needs of both students and the business community. IACs are gaining importance in an environment where support for a program is ultimately derived from employment opportunities that exist for the graduate (Finch and Crunkilton, 1999). Program directors are finding that it is imperative not only to host an industrial committee meeting, but that a methodology be used to collect information that will build a curriculum that aligns graduates with industry needs.

The National Association of Industrial Technology (NAIT) recognizes the importance of the IAC and requires accredited programs to maintain this type of connection with industry advisors. The primary purpose of the NAIT accreditation is to provide recognition of the attainment of certain standards for industrial technology programs. Standard number 6.14 requires that each institution host an IAC meeting at least once a year, and that appropriate minutes be kept showing agenda items, action taken, and recommendations made (National Association of Industrial Technology, 1997). Dr. Everett Isreal (Chair of the NAIT Board of Accreditation, 1999) asserts that an appropriate response to this standard might include a list of action items based on industry counsel and evidence as to what actions were taken in response to the recommendations.

Standard 6.14 was developed by the NAIT accreditation governing board, and allows each program the flexibility to select a methodology for facilitating an industrial based meeting that best suits their program. An industrial advisory meeting that meets the requirements of the accreditation committee can take may different forms and it is the responsibility of each program faculty to select an appropriate meeting strategy for their particular program of study.

To meet NAIT standard 6.4 educators often organize an obligatory industrial advisory committee meeting once a year and ask for approval of existing curriculum content and program direction. Driven by time constraints and their desire for accomplishment, industry members often understand the compulsory nature of these meetings and may have the attitude of, "let us tell you what you want to hear so we can all be done with this meeting" (Peterson and Nelson, 1988, p.4). The result is an IAC meeting that fails to generate curriculum recommendations and action items for the future growth and improvement of the program. What is needed is a methodology for moving the industrial advisory committee toward an industrial "action" committee, satisfying the NAIT accreditation requirements and more importantly creating an agenda for program improvement.

Purpose

An IAC meeting should be organized and designed to review and generate new curriculum. In addition, meeting recommendations and action items for improving the program should be documented. Accomplishing these tasks will invariably require an established methodology. An example of a systematic methodology for hosting an IAC meeting that would generate such action items would be useful for the I.T. professional. The following case study provides a description of the steps used by faculty within the Industrial Technology Management (ITM) Program at Colorado State University (CSU) to redirect the focus of their IAC from that of reviewing the program content to one of content determination, identifying critical obstacles to success and converting these obstacles into an action agenda. To facilitate this effort CSU's faculty used the Theory of Constraints (TOC), a systematic thinking process revolving around three questions (Goldratt, 1998):

- What should be changed?
- What should it be changed to?
- How should the changes be implemented (Goldratt, 1998)?

The implications of undertaking this process are also discussed.

Methodology: A case study of an IAC using the Theory of Constraints (TOC) Procedure.

Depending of the nature of the program and the objectives of the meeting (including type of information desired), there are many ways to prepare for, organize, and facilitate an IAC meeting. The following case study shows the background, preparation, and the process of facilitating an IAC meeting hosted by Colorado State University.

Before you begin

The decision to create or redesign a course or curriculum should not be taken lightly, since it will require committing a great deal of time and effort (Diamond, 1989). Furthermore, entering into this activity can have a direct impact on the professional careers of the faculty involved. These time-consuming projects take faculty members away from those activities that have traditionally been most highly recognized in tenure, promotion, and merit-pay decisions. The message on many campuses is clear: if you want to advance your career, this is not an activity on which you should spend your time (Diamond, 1998).

Establishing a program philosophy

One of the first steps that should be taken is to develop a program philosophy that will guide curriculum decisions. It must be remembered that a person or group's philosophy is a basic belief or value. A philosophy is composed of several belief statements, each of which contributes to its overall content. As is typical with any value-laden statement, the philosophy will vary from person to person and from group to group. It is for this reason that groups often have a difficult time reaching consensus regarding belief statements.

The establishment of belief statements is a rather straightforward activity (Finch and Crunkilton, 1999). To begin, various sources should be examined to identify existing statements that might or could align with one's philosophy. Universities, colleges, professional associations as well as departments all provide a wealth of potential belief statements. Your program should have an established mission and definition statement, and your philosophy should reflect these statements. In addition, a literature search can be a useful tool for clarifying the characteristics of a program's philosophy.

This philosophy determination process can be done in conjunction with or separate from your IAC. Typically IAC members understand the significance of the program philosophy but are less interested in the process of developing this set of statements. Furthermore, this process can be time consuming, consisting of long academic debates in which IAC members have little knowledge, expertise and/or interest. Experience suggests that these statements be established before the IAC meeting and then presented to the advisory group along with a history of how they were derived. However, it is

Figure 1. Comparison of Curriculum Content Determination Strategies (adapted from Finch and Crunkilton, 1999).

				Applicability to Technical Education		
Strategy	Ease of Data Collection	Objectivity	Validity	Awareness of Work	Exploration of Work	Preparation for Work
Introspection	+	-	?	?	?	?
DACUM (Design a Curriculum)	?	+	+	-	-	+
Task Analysis	-	+	+	-	?	+
Critical Incident Technique	-	?	+	-	+	+
Delphi Approach	-	?	?	+	+	?
TOC Approach	+	?	+	+	+	?

important that each member be given the opportunity to respond to each belief statement.

Selecting a content determination strategy

After establishing your program philosophy a content determination strategy should be selected. There are a number of curriculum content determination strategies that run along a continuum from more subjective at one end to more objective at the other (Finch and Crunkilton, 1999). In addition, the data collected using the various strategies range from that of specific vocational skill sets to identifying new and emerging occupations or programs. A comparison of various curriculum content determination strategies shows the range of possible data, ease of data collection, and applicability to technical education (see figure 1). It is evident that there is great diversity among curriculum content determination strategies. The key is to select the strategy that best suits your program, taking into consideration program philosophy, background and desired results.

When selecting a strategy it is important to consider your audience. Typically IACs consist of both industry and academic members. Each group has its own frame of reference related to actions and accomplishments. Often academics are content to discuss, debate, and analyze a topic at length without reaching a conclusion or taking action; while industry members will strive for setting an agenda and working on tasks to accomplish a set course of action. This is not a condemnation of academic discourse only a reminder that each group has its own unique paradigm, and until the strengths of each group are understood and used to complement and reinforce each other, the resources of the advisory board will never be fully utilized (Peterson and Nelson, 1988).

A discussion dealing with each of the content determination strategies is beyond the scope of this paper. However, focusing on a case study as an example of the selection process is appropriate. Faculty at Colorado State University selected the Theory of Constraints (TOC) approach to content determination because it aligned with the program philosophy and provided a mechanism for collecting information related to the future direction of the program. In addition, the TOC approach focused on the creation of a project map and an action agenda. Furthermore, the goal was to develop a strategy that forced our industry members to look, not at the current curriculum, but to generate data/information directly related to the problems (or obstacles) that they face within their businesses. As discussed below, this "ambitious target," if reached, would provide great value to all involved, including the institution, students, and industry members. The TOC approach allowed the IAC to accomplish this by focusing on and beginning to solve their problems.

In addition, an approach that went beyond simply developing a list of actions for faculty members was desired. The industry partners needed to commit themselves to tasks that they were best suited to accomplish. For example, if the ambitious target of establishing a needed state-of-the-art CAD lab is to be achieved then the industry partners should be involved in selecting lab equipment and soliciting vendor contributions. These are tasks that are best accomplished with the influence and "potential customer" powers that only the industry partners possess.

The importance of selecting the appropriate curriculum determination strategy cannot be overstated. This

Figure 2. References for curriculum development strategies.

Strategy	Reference	Description
Overview (Introspection)	Finch, Curtis R., and Crunkilton, John R. (1999). Curriculum development in vocational and technical education: Planning, content, and implementation. (5th ed.). Boston, MA: Allyn and Bacon.	Provides an overview of each curriculum determination strategy.
Critical incident technique	Flanagan, John C. (July, 1954). The critical incident technique. Psychological Bulletin 51, no. 4.	Provides detailed description of the critical incident technique.
DACUM	http://www.interlynx.net/archway/ohio/DACUM.htm	Provides detailed description of the DACUM approach.
Delphi	Harold, Sackman. (1975). Delphi critique: expert opinion, forecasting, and group process. Lexington, MA: D.C. Heath.	Provides detailed description of the Delphi process.
Task analysis	Swanson, Richard A. (1994). Analysis for improving performance: tools for diagnosing organizations and documenting workplace expertise. San Francisco, CA: Berrett-Koehler, c1994.	Provides detailed description of the task analysis process.
Theory of Constraints (TOC)	http://www.goldratt.com/	Provides details on the Theory of Constraints (TCO) approach to problem solving.

case study illustrates the TOC approach in researching and selecting the strategy that meets your programs needs. Figure 2 provides a list of references that can be used to further investigate the other strategies.

The TOC Strategy

The TOC approach is a variant of introspection and combines elements of the Delphi approach. The technique has been used to develop team unity in a variety of industrial, government and education settings. This "team spirit" helps develop cohesive units, breaking down barriers that typically have halted the implementation and success of lofty changes, efforts and projects. The team-oriented TOC process culminates in the development of action items, which are then placed within a project PERT chart. There are five steps to the TOC approach as it is related to curriculum determination. These steps including:

1) establishing an agreed upon ambitious target,
2) soliciting objectives,
3) deriving intermediate objectives,
4) building an intermediate objective (IO) map,
5) converting the IO map into a project map and making content decisions.

Each of these steps is detailed below.

Step 1: Establishing an agreed upon ambitious target

The first step in the process was to establish an agreed upon ambitious target. An ambitious target is a goal that if achieved is certain to be good for everyone. Furthermore, it must be a target that nobody believes can be achieved thus the title "ambitious target". Although not necessary, it is often a good idea to use a professional facilitator to develop an ambitious target. If a faculty member facilitates this activity they must remain neutral and listen to all industry members, which is often difficult for someone who is self-invested in a program. Again, take time to determine this statement. It may take several hours to generate a single sentence.

The faculty was looking for a methodology that would fundamentally change the way in which they interacted with the advisory board. No longer would the advisory board be presented with the current ITM curriculum and asked to provide a stamp of approval. What was needed was a strategy of ongoing improvement that would place demands on faculty and IAC members to think outside the current curriculum, identifying an ambitious goal (target), and then turn that goal into both curriculum content and a process for implementing that content.

Step 2: Solicit obstacles

The second step may appear to be counterproductive, however, one of the perennial problems with teams is that they often don't listen to all the concerns before they begin to solve the problem. In this step, it is necessary to listen to each industry member's concerns or obstacles as to why the ambitious target can't be reached. It is important to realize that these are obstacles and will be stated in negative terms. The TOC theory states that, in general, people like to complain and that before a solution to a problem can be reach – amongst a group – the group must listen and addresses all concerns. This step is designed to solicit those concerns.

Facilitate this step by going around the room and asking each industry member to state an obstacle. If they do not have an obstacle they can pass, but give them an opportunity to contribute the next time around. Keep going until all the obstacles have been stated or until the obstacles become so ridiculous that everyone agrees the activity has gone too far.

When facilitating the solicitation of obstacles several rules should be followed.

- First, an obstacle must be no more than one sentence in length.
- Second, no one can say that the obstacle is wrong - protect open communications.
- Third, an individual can always pass but should be given an opportunity to participate the next time around.
- And fourth, end the activity only after everyone has stated all obstacles or until they are obviously ridiculous. Typically this will generate no more than 40 to 50 obstacles no matter how complex or difficult the stated ambitious target.

Step 3: Deriving intermediate objectives

In the third step, use the obstacles generated in step two to derive intermediate objectives (IOs). Instruct the IAC committee members to ask the following question related to each obstacle. "What must be achieved so that the obstacle is overcome?" The answer to this question will be the IO needed to overcome that obstacle. If the IAC members have difficulty getting started redirect the question to the individual who identified the obstacle. For example, say, "who contributed obstacle number one?" After they have identified themselves respond with, "please be the first one to contribute an IO to overcome it."

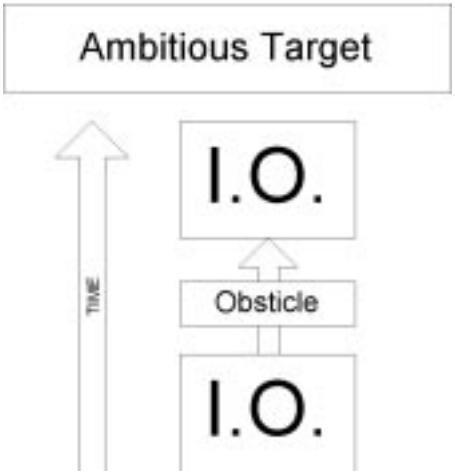
The key to developing accurate and worthwhile IOs is to avoid accepting poorly defined or ambiguous statements. For example, if the obstacle is "our customer will never accept the product," don't accept, "our customer accepts the product." This does very little to define the true problem. Furthermore, after the IO has been written all IAC members should agree that the IO can be accomplished. It is at this point that a working definition of the IO has been reached. If the IAC committee has difficulty reaching this definition, either the obstacle does not exist or the obstacle itself is not well defined and may contain several imbedded roadblocks. At this point it is best to redefine the obstacle or consider its elimination.

Again, the key to this process is to allow people to willingly express themselves. It is important that each IAC member be given the chance to contribute to the discussion. Ownership in the process is key to getting individuals invested in seeing the team and your program through to a solution.

Step 4: Build the intermediate objective map

After the IO definitions have been established create an intermediate objective map. The IO map is an obstacle-based sequence of all intermediate objectives. The map is arranged based on time and indicates an IO sequencing including obstacles that are overcome by completing each intermediate objective (see figure 3). At the top of the map is the IAC's ambitious target.

Figure 3. Intermediate objective map.



Although it is best to build this map with IAC members, we suggest that this step can be accomplished separate from the IAC meeting. The IO map sequencing can usually be accomplished with few members as the simple sequencing relies less on group decision making. The Colorado State University IAC decided to leave this task to the faculty and it was accomplished outside of the group.

Step 5: Convert the IO map into a project map and making content decisions

The last step in the process is to convert the IO map into a project map. From this point it is easy to convert to a PERT or Gantt chart and begin to assign resources to each project task. Similar to the IO map this work can be established outside of the formal IAC meeting. However, it is critical that the group agree on the final project plan and required resources and responsibilities. The faculty at CSU involved in this case study are working on this step.

Findings

The TOC strategy allowed CSU's faculty to collect more than 26 obstacles, 68 intermediate objectives, and generate a detailed plan of action. The five steps to the TOC process culminate in step five (project map and content decisions) with the development of a project plan. The project plan consists of a networked scheme of tasks providing direction for program development, ties IAC members to this plan as resources, and in so doing directly responds to the NAIT standard 6.14 by providing programmatic action items. Furthermore, if the project plan is used to track progress it provides evidence as to what has been accomplished related to these action items.

The following data was generated by CSU's Industrial Advisory Committee (IAC) using industrial based problems, and centered on a common goal or ambitious target. A sample of these findings is provided below for illustrative purposes only. Each college, university, or program should generate its own data using the detailed process.

Ambitious target

Action taken: A professional facilitator was used to help the IAC determine an ambitious target. The goal was to generate a statement which all IAC members agreed would be good for all if accomplished and that the target was almost impossible to accomplish.

Time required: One hour.
Outcome obtained: The following is the established ambitious target. Students from your program would be able to identify or develop best practices and apply them "overnight " resulting in an immediate increase in profit and delight all stakeholders.

Obstacles

Action taken: A faculty member led IAC members in a session to generate obstacles to reaching the ambitious target stated in step one. Each obstacle was written on a white 8.5" x 11" card and posted on the conference room wall. Displaying the obstacles allowed IAC members to review what had already been presented and prepared the group for the third step of generating the intermediate objectives. A list of 26 obstacles was included in the total, a cross-section of which is provided below (see figure 4).
Time required: Three hours.
Outcome obtained: The following provides a sample of the 26 obstacles that were generated by the IAC.

Intermediate objectives.

Action taken: IAC members worked to establish intermediate objectives for each of the posted objectives. For each obstacle on the wall the question was asked, "What must be achieved so that the obstacle is overcome?" Each intermediate objective was written on a white 8.5" x 11" card and posted on the conference room wall next to its corresponding obstacle. Time was

Figure 4. Sample obstacles.

Obstacle
• We don't have a way to define needed resources.
• We don't have a way to obtain needed resources.
• The technology needed to respond does not exist to our knowledge.
• We don't know what "best practices" are.
• Critical people in the organization are not trained in existing best practices.

taken to clarify each intermediate objective thus avoiding ambiguous statements and identifying the action that would help overcome the obstacle.
Time required: Eight hours.
Outcomes obtained: The IAC committee established a list of 68 intermediate objectives. Figure 5 provides a sample of two obstacles and the corresponding intermediate objectives.

Intermediate objective map

Action taken: An intermediate objective map was developed outside of the IAC meeting. After spending one and a half days working to establish obstacles and intermediate objectives the IAC agreed that a smaller group could establish the intermediate objective map. Faculty arranged the intermediate objectives based on time and indicating which obstacles were overcome by completing each intermediate objective.
Time required: Eight hours.
Outcomes obtained: An intermediate objective map was created. Figure 6 provides a sample of this map.

Project map and content decisions

Action taken: The IAC also agreed that the project map could be created outside the larger advisory group. Faculty worked to convert the intermediate objective map to a project map.
Time required: Eight hours.
Outcomes obtained: Figure 7 provides an example project map that was established using the TOC approach. The project map is the terminal document that is created using the TOC approach and is the record that provides direction for curriculum development and revisions. This document connects IAC members to curriculum improvement by assigning each industry member to tasks, assigning them responsibility for remaining involved. Furthermore, it assigns then to tasks that are more appropriate or more easily accomplished by industry members. For example, the acquisition or donation of equipment or software can often only be achieved with industry backing.

Figure 5. Sample of obstacles and corresponding intermediate objectives

Obstacle	Intermediate objective
We don't have a way to define needed resources	We have a way to clearly define tasks.
	We have a way to clearly define resource requirements by tasks.
	We have a way to accurately determine the time to complete a given task.
We don't have a way to obtain needed resources.	We have a way to identify competing needs for resources.
	We have a way to determine the relative priority of tasks within and between projects.
	We have a way to access availability of existing resources and resource capacity.
	The appropriate individuals are authorized/ empowered to assign and/ or acquire the needed resources.

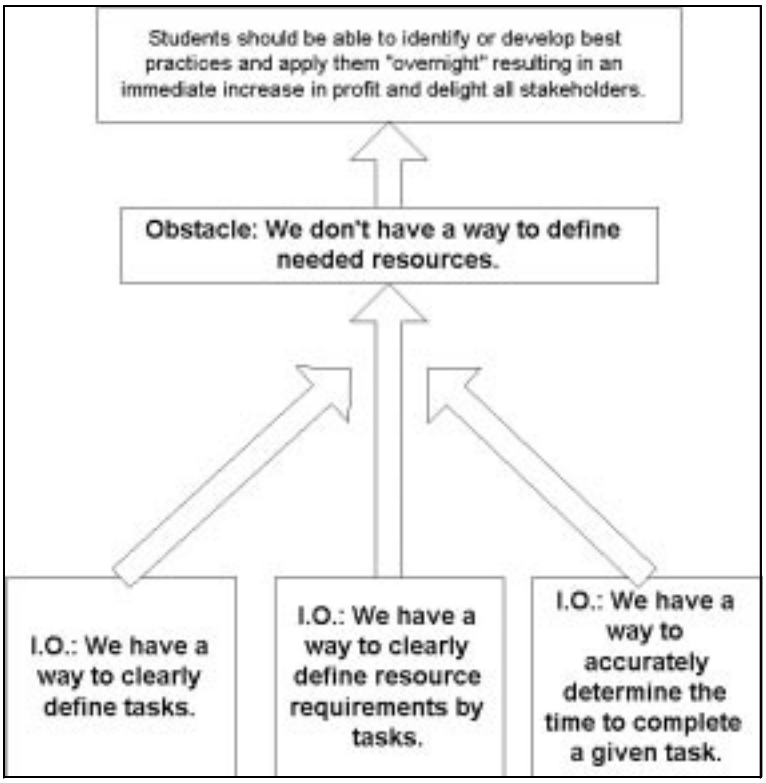


Figure 6. Sample IO map.

In addition, the project map provides a direct response to NIAT standard 6.14 by establishing industry directed action items. The map provides an illustration of how industry members are involved not just at one IAC meeting but also throughout, to improve and support the program. If the project map is used to track project progress it also provides evidence as to how a faculty is responding to the industry established action items. The TOC project map provides a response to NAIT – but most importantly – it provides a strong tool for program improvement that fully utilizes the power of the IAC.

Implications

From this case study, it is apparent that the TOC approach can be used to facilitate an IAC meeting to generate action items and a project map for curriculum revision and development. Experience has shown us that our industry members appreciate this action-oriented approach and that this process has generated significant enthusiasm and commitment. We found this to be true even though the process require a significant commitment of time and resources.

It is the authors' belief that the implications for the application of the TOC approach to IAC meetings are significant. After reviewing the literature on other curriculum determination strategies this methodology

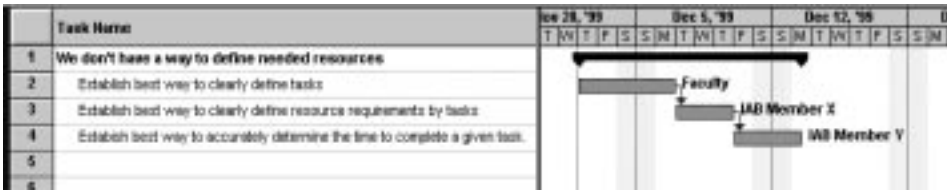


Figure 7. Sample Project plan (Gantt chart).

provided a straightforward approach to creating an action plan. Furthermore, after reviewing NAIT standards and information on appropriate responses to these standards the importance of an action oriented agenda is evident. The information generated from the TOC approach will allow our faculty to respond directly to these requirements, presenting not only action items but also a well-established project map, to their NAIT accreditation visiting team.

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