

**Computer Assisted Group Decision Making For
Educational Program Development**

by

Daniel K. Sheldon

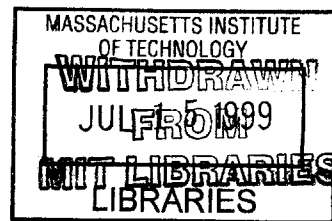
Submitted to the Department of Electrical Engineering and Computer Science
in Partial Fulfillment of the Requirements for the Degrees of
Bachelor of Science in Computer Science and Engineering
and Master of Engineering in Electrical Engineering and Computer Science
at the Massachusetts Institute of Technology

May 26, 1999

[3300 1109]

© Copyright 1999 Daniel K. Sheldon. All rights reserved.

ENG



The author hereby grants to M.I.T. permission to reproduce and
distribute publicly paper and electronic copies of this thesis
and to grant others the right to do so.

Author _____
Department of Electrical Engineering and Computer Science
May 26, 1999

Certified by _____
John Rockart
Thesis Supervisor

Accepted by _____
Arthur C. Smith
Chairman, Department Committee on Graduate Thesis

**Computer Assisted Group Decision Making for
Educational Program Development**

By

Daniel K. Sheldon

Submitted to the
Department of Electrical Engineering and Computer Science

May 26, 1999

In Partial Fulfillment of the Requirements for the Degree of
Bachelor of Science in Computer Science and Engineering
and Master of Engineering in Electrical Engineering and Computer Science

ABSTRACT

Computer assisted development of an educational program can be a powerful tool for avoiding and lessening many of the problems associated with decision making in groups. In this thesis I present a model for describing a group process and discuss briefly a number of alternative models. I will then present a process that utilizing the model in its design so that it effectively reduces group problems. Lastly I will show the implementation of this process as a computer driven facilitator for group decision making in the development of an educational program.

Thesis Supervisor: John Rockart
Title: Senior Lecturer, Director of the CISR

Contents

- 1 Introduction 7**
 - 1.1 Motivation.....8
 - 1.2 Organization of Thesis9

- 2 Problems in Group Decision Making 10**
 - 2.1 Good Decision Making10
 - 2.2 What gets in the way of good decision making12
 - 2.2.1 Problems with getting well informed.....13
 - 2.2.2 Problems with deciding quickly.....14
 - 2.2.3 Problems with negative effects of decision making.....15

- 3 Group Performance Model 17**
 - 3.1 Group Process Framework.....18
 - 3.2 Group Performance Model.....20
 - 3.2.1 GPM Management Factors21
 - 3.2.2 GPM Time Stages22
 - 3.3 “Good” and “Bad” Group Processes.....24

- 4 Model and Process Research 26**
 - 4.1 Other Group Process Models26
 - 4.2 Other Group Processes.....28

| | | |
|----------|--|-----------|
| 5 | Education Program Development Process | 30 |
| 5.1 | Processes that adhere to the Group Performance Model | 30 |
| 5.2 | Scope of Educational Program Development | 31 |
| 5.3 | Process for Computer Implementation | 33 |
| 5.3.1 | Step 1: Determine the focus of the education | 33 |
| 5.3.2 | Step 2: Brainstorming | 33 |
| 5.3.3 | Step 3: Categorizing..... | 34 |
| 5.3.4 | Step 4: Creating the Goals | 35 |
| 5.3.5 | Step 5: Starting to Develop a Plan | 36 |
| 5.3.6 | Step 6: Inventing Possible Solutions | 36 |
| 5.3.7 | Step 7: Choosing the Final Plan..... | 36 |
| | | |
| 6 | Process Implementation and Effectiveness | 38 |
| 6.1 | Computer Based Process..... | 38 |
| 6.2 | Data Entry | 40 |
| 6.3 | Data Organization | 41 |
| 6.4 | Deciding the Goals..... | 43 |
| 6.5 | Creating the Solutions..... | 44 |
| 6.6 | Overall Effectiveness | 45 |
| | | |
| 7 | Conclusions | 46 |
| 7.1 | Summary of Contributions..... | 46 |
| 7.2 | Future Avenues of Research | 47 |

List of Figures

| | | |
|-----|---|----|
| 3-1 | Effort Expenditure Graph for “Good” Group Process | 18 |
| 3-2 | Group Performance Model (Good Process)..... | 21 |
| 3-3 | Early Action “Bad” Group Performance | 25 |
| 4-1 | GPM Time Phases..... | 27 |
| 4-2 | Process Flow | 28 |
| 5-1 | Development and Implementation Phases of the GPM | 32 |
| 5-2 | Steps 1-4 From Brainstorming to Goal Agreement | 35 |
| 5-3 | Steps 5-7 From Goal to Plan..... | 37 |
| 6-1 | Introductory Screen..... | 39 |
| 6-2 | Educational Program Topic or Title | 40 |
| 6-3 | Data Entry by Brainstorming | 41 |
| 6-4 | Data categorization and organization screen..... | 42 |
| 6-5 | Focusing in on the Goals..... | 43 |
| 6-6 | Creating the possible solutions | 44 |

Acknowledgements

I would first like to thank my parents, Garret and Carrel. Without them, not only would I not be, I would not be where I am today. Their assistance and encouragement have made my entire endeavor possible, and at times, even enjoyable.

I would like to thank Prof. John Rockart for his willingness to entertain a proposal from a student who he had never met, and his patience in dealing with that student as he worked on his thesis.

My thanks go out to the Potomac Group for employing me during my collegiate years so that I could afford to go to MIT, and for providing me with the knowledge and experience to delve into my own research. My education working for them has been as valuable to me as my academic education.

Finally, I would like to thank Sarah who has stuck with me these last three years as I have plodded along.

Chapter 1

Introduction

Decision making is an aspect of life that is done every single day, and yet many people do not know the processes by which they make their own decisions. Some people might try to use logic, others might have an intuitive feeling, even others might look to a role-model to see what they would decide. When groups have to make decisions as a whole, it is difficult to have all of the members of the group decide in the same fashion. Not only might they not agree on the subject at hand, but they also might be using very different decision making processes. As a result, it is often the case that groups make poor decisions. In this thesis I present a process with which groups can make good decisions while developing educational programs. The work presents a current model of group performance that this process is based upon. An computer software program was developed that facilitates the educational program development process.

1.1 Motivations

I have programmed computers since I was very young. I started out writing the “hello world” programs in BASIC, then worked my way through Pascal, C, and many other languages as I developed more and more complex systems. I learned about design and specifications, worked on teams, developed large-scale applications for business. As the complexity of the problems that I faced grew, I began to realize that algorithms and languages were not the determining factors in whether or not a program would work. Instead, what mattered more, was how well the program development team worked together.

Through my work at The Potomac Group, I came in contact with their philosophy regarding group projects. They developed a way of modeling how groups perform in all circumstances, not just the development of programs. In addition to working for the Potomac Group, I have also been very active in various teaching capacities. It became painfully clear to me that the development of educational programs was an area that could benefit from the application of Potomac’s work. I decided to combine these three areas, software engineering, group performance, and educational development, into my thesis.

The potential benefits that could arise from the work immediately intrigued me. Having been a student for the majority of my life, I know that well designed, and well motivated educational programs are greatly appreciated. While teaching, I also realized how pleasant it was to teach when the program itself was created well. To develop a process that could enable anyone to design and create good educational programs, would

be a tremendous gift to the educational community. This thesis contributes to the possibility of such a process.

1.2 Organization of Thesis

The remainder of this thesis is organized into the following five chapters:

Chapter 2: Problems in Group Decision Making. I begin by looking at the process of group decision making. Common problems are brought up and discussed.

Chapter 3: Group Performance Model. The third chapter outlines the basic strategy used to facilitate group decision making processes used for this thesis.

Chapter 4: Models and Process Research. The fourth chapter is dedicated to present research used to validate and create both the model and the process discussed in this work.

Chapter 5: Educational Program Development Model. In the fifth chapter, I outline a model created and used specifically for the development of educational programs.

Chapter 6: Educational Program Development Model Implementation and Effectiveness. In the fifth chapter, I look at the results of the model discussed in the previous chapter.

Chapter 7: Conclusions. In the final chapter, the major findings of this thesis are summarized and future research ideas are proposed.

Chapter 2

Problems in Group Decision Making

While much research is done on finding and optimizing the solutions to various problems, I have chosen to focus on research that could lead to a better way of finding and deciding on which problems to solve in the first place. This chapter first defines what is good decision making for the purposes of this thesis. We will then go on to examine common problems that exist within groups that specifically relate to their ability to make effective decisions.

2.1 Good Decision Making

Before we can examine the problems that exist in group decision making we should define what it means to have good decision making. From there, we can then be able to clearly see where many groups fall short, and examine some of the reasons that they do so.

Examples of bad decision making are abundant. One of the most striking pieces of evidence that groups are unable to make good decisions in the technical arena is the rate of attrition in software projects. “Fortune 100 companies last year canceled 33 out of every 100 software projects and ran over budget or beyond deadline on another 40 applications. All told, the development fiascoes cost \$145 billion ...” [SGI97]. Good decision making is a little more difficult to identify.

For the purpose of this thesis I will define good decision making as the ability to make well-informed decisions quickly, and with little, or no, negative impact upon the group making the decision during the decision making process. It is difficult to gauge the effectiveness of a decision until after the consequences of that decision have shown themselves. Even then, without proper controls to show the consequences of alternative decisions, it can still be difficult to know how good a decision it was.

For example, I might think that I made a great decision if, while running through a maze, I made a turn and ended up at the finish line a mere minute later. However, it is possible that all of the other paths leading away from that turn, led to finishes much quicker and I would never know. It is this reason that the best that we can hope for in defining the quality of the decision as good, is a well-informed decision.

The speed of the decision is another matter. Again, while we cannot empirically say that good decision making takes only so much time, we can make comparisons to decisions that have resulted from other means given the same group and type of decision. While the computer program developed does not do this, we can also put a loose definition on a “speedy decision” by stating that the decision is made in a time-frame that does not, by its slowness, negatively impact the decision itself. Take for example the

stock market. We would not want a decision-making process that was 100% accurate, but takes 1 year to decide. We would always be a year behind the market and could never invest effectively. The time taken for a decision should be appropriate to the decision at hand.

The last element of my definition for good decision making is that it have little, or no, negative impact upon the group while making the decision. This may not seem to be a large part of what is normally considered to be good decision making, but in order to have effective groups they cannot destroy their relationships while trying to decide issues. Disagreements will occur. A good decision making process will try to eliminate the frustration and aggravation associated with it.

2.2 What gets in the way of good group decision making

The trivial answer to “What gets in the way of good group decision making?” is simply to say that the group is not well informed, has difficulty deciding quickly enough, and does not function well when members disagree. The real question is, “Why do these problems with group decision making occur? What gets in the way of a group being well informed? Of a group deciding quickly? Of a group getting along?”

2.2.1 Problems with getting well informed

There are many factors that contribute to a group not being well informed as a decision making entity. The first and foremost one is that its members are not educated on the topic that the decision is applied to. If there is no expertise in the subject being addressed by the group, then it would be difficult to be a well-informed group. Ideally each of the members of the group would have individual skills that combine to make a well-informed group. It is this combination of knowledge that is a key facet of group decision making that sets it apart from individual decision making. One can always educate ones self more so as to make a more informed individual decision. However, the question of how to gather the expertise from many members and combine it effectively is what brings the group aspect of decision-making to the forefront.

In order to have a well-informed group, all of the key members must be properly involved and informed. The best way is for all key members to be present. This may seem like a trivial point, however, in many groups, this tends to be one of the major obstacles to becoming a well-informed group. Some group members tend not to show up at certain meetings. This can be due to particularly busy schedules, cumbersome traveling, or just a belief that the decision making aspect of the problem is not very important. It is a common desire for many people to want to “jump in” and start working right away, and not spend time with other members of the group. They believe that they have an understanding of the problem and their part in the solution, and that a planning meeting, where information is shared and key decisions are made, is a “waste of time.”

One of the other large problems with a group being well informed is that it is not known exactly who should be involved in making the decision. There are generally many different aspects of every problem. All of the different aspects that are crucial to the decision must eventually be represented within the group that is deciding upon the issue. If, for example, a software project was decided upon without a financial representative in the group, a very-large scale and seriously under-funded endeavor might be undertaken. By not including someone who knows about the financial aspects, the group as a whole cannot be well informed about that side of the project. This can be an exceptionally difficult problem in large companies when it is hard to see the scope of the project at the outset, much less have an understanding of who should be involved.

2.2.2 Problems with deciding quickly

The speed of decision making can be affected by many different factors, some of which are mentioned above as problems in being well informed. For example, trying to have all members present can be a difficult and time consuming activity in and of itself. Waiting for members who do not value the decision making process highly can waste much time. Educating members on the problem at hand can also take considerable time if not handled well. However, there are also other factors that come into play.

Probably the biggest problem that slows down groups when making decisions is the fact that they do not have a common process by which they make decisions. When

every member has a different way of making a decision, the lack of a common process can make every little element a difficult hurdle.

A good process is also needed, not only in how to make a decision, but also in how to relate to one another during the decision making process. The process for relating can affect decision speed when it is either not present, or when it is too cumbersome to deal with. Roberts' rules of order may be a fine choice for a group of fifty people, but may slow down a group of five. Alternatively, a group of five people could enjoy an allotted time for each to speak, while a group of 500 probably could not afford such a means.

This last point brings up another additional factor in the speed of a decision – the size of the group deciding. Larger groups generally take longer to decide upon something, especially if the decision-making process is poor or no common process is in place. Often this increase is worse than linear. A good way of handling decision-making in large groups of people is required to help those groups decide faster.

2.2.3 Problems with negative effects of decision making

Disagreements will occur while a group makes a decision. It is important that these disagreements do no serious, irreparable harm to the group. The first step in handling these issues is understanding some of the reasons why they occur. There are two major areas that can lead to disagreements, and if it is not understood why these disagreements exist, can lead to negative feelings within the group.

The first problem is that differences in unstated assumptions show up as disagreement. If two members have, at the basis of their individual conclusions, different assumptions about the way things work, they can arrive at different decisions. If they do not expose these assumptions, they will not be able to converse effectively about the decision at hand. In fact, it is often the case that people get frustrated over this issue. It can appear that the other person is stupid or irrational, that they either can't see what is really going on, or simply come to illogical conclusions from the same evidence. What is really happening is that there are simply unstated additional elements (assumptions) that cause the discrepancy.

The second cause of disagreement and internal strife for a group is differences in utility functions. What I mean by this, is that given the same set of facts, different members will assign different priorities, or value, or importance to each fact. Two members may, therefore, come to a different decision even though all the base assumptions are exposed. While there is no quick solution to getting the different group members to agree, once it is established that there is a difference in utility function, negative feelings can be avoided. Even though two people might not agree on relative importance, they can at least understand the other point of view. This understanding opens up the possibility of accommodation and compromise.

By being aware of and managing these common sources of disagreement, groups can stop arguing about the byproducts and begin to address the core differences. This allows a group to function well much more of the time, and avoid the negative effects that prolonged disagreements can cause.

Chapter 3

Group Performance Model

Fundamental to the philosophy of the Potomac Group is the idea that group decision-making behavior can be modeled, that is, described in a way that the group dynamic can be measured and tracked. They have found that an appropriately framed model of group process enables a more rigorous way of addressing the group decision-making problems identified in Chapter 2.

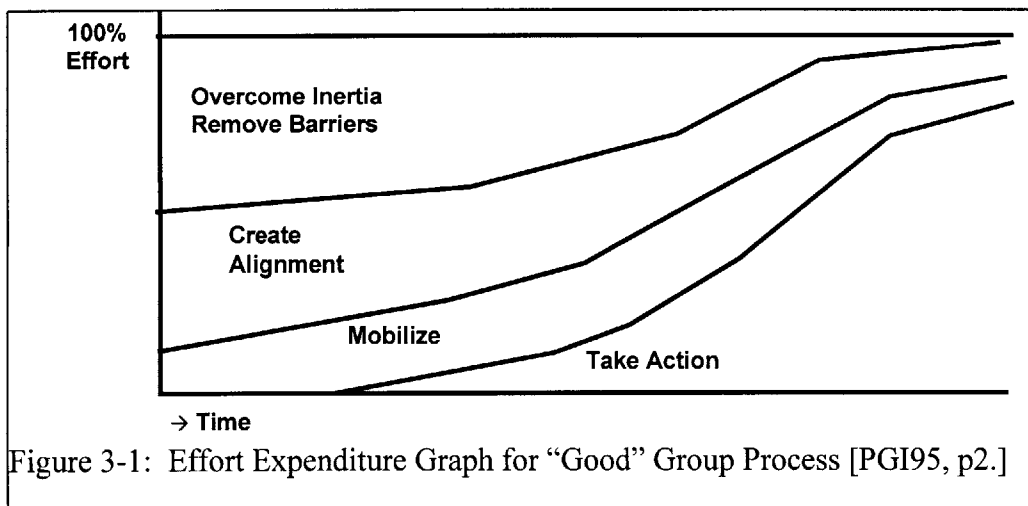
In order for a group to perform well, members need to have a sense of relationship within the group, which includes good communication and an understanding of one another. The group also needs to have a model, or multiple models, that it operates under. These models explicitly determine how members of the group interact, how they relate to the problem at hand, how they solve internal conflicts, and ultimately how they decide and reach the goals that they set for themselves.

This chapter describes the Group Performance Model, the group philosophy used and developed by The Potomac Group, Inc. The Group Performance Model will be

discussed as the basis for the Educational Development Model that will be fully presented in Chapter 4.

3.1 Group Process Framework

Potomac’s philosophy on group process breaks down the factors that groups must address in order to achieve their goals into four categories: overcoming inertia and removing barriers, creating alignment, mobilizing, and taking action. Group process can be characterized by the percentage of effort that the group is expending in each of these four categories, and the percentages can be graphed as a function of time. Figure 3.1 is the effort expenditure chart for a group engaged in effective group process. It shows how the amount of effort spent in each category changes with time. Initially, an effective group spends most of its effort in overcoming inertia and removing barriers, and none at all in taking action. As the group moves towards achieving its goals, the effort spent in action increases dramatically.



Each category of activity describes actions that are appropriate for the group to do at each point in its development. Overcoming inertia and removing barriers entails working through inertia issues and identifying and eliminating barriers of all sorts. There are two different types of barriers: process barriers and subject barriers. The process barriers deal with the processes that the group uses. These could be problems with the group dynamics or problems that the group has making decisions as discussed in Chapter 2. Subject barriers are problems that arise that impede the accomplishment of the goal. For instance, if a goal is to learn the Java programming language, then a barrier might be not knowing where to buy a language reference book. The location of a book on Java is not what the educational goal is, but is essential in obtaining it.

Inertia issues include non-participation and lack of time. Barriers for the group can include: a lack of understanding of the roles and responsibilities that each group member has, interpersonal conflict that can exist previously or get developed during this process, poor communication both within the group and external to the group, and lastly a lack of teamwork skills and processes. [In an electrical system analogue, removing barriers is like removing resistance. Much less energy is wasted, and more can be expended towards productive activity. Reducing inertia means that less energy is required to get the group in motion.]

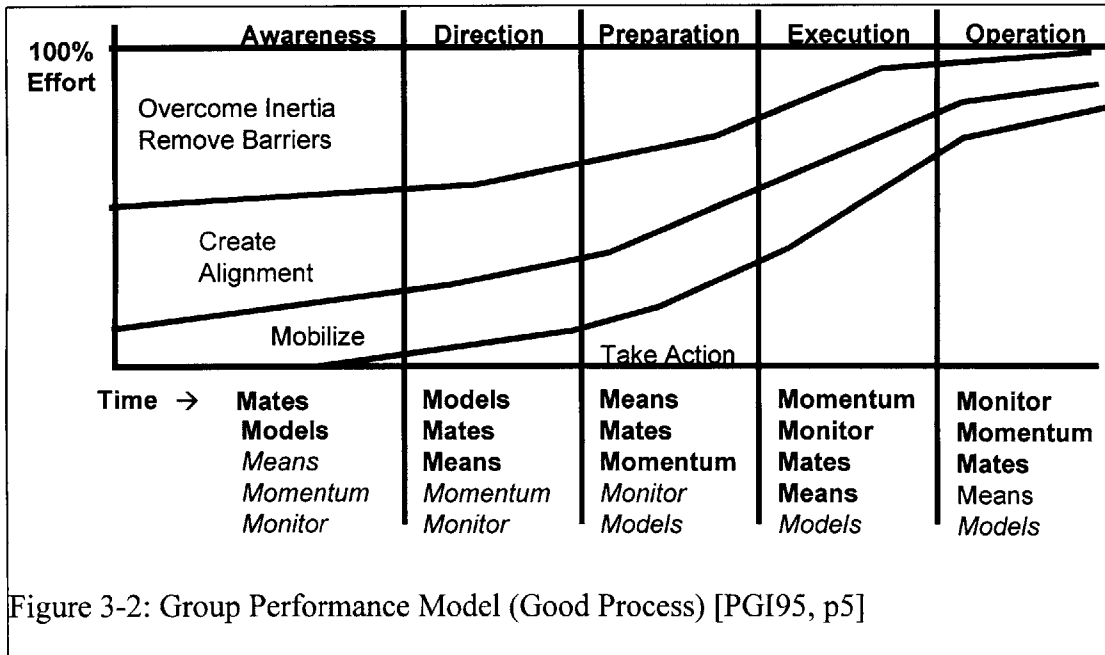
To create alignment, the group must develop agreement on the direction that they are to go, as well as the strategy that will take them there. This includes identifying the group objectives and goals. In addition, the group needs to decide upon procedures for working together.

The mobilize category is primarily devoted to planning, organizing, and preparing. [An appropriate image is of an army mobilizing for war: many interrelated and sometimes dependent activities must be completed.] It is in mobilizing that the group develops or acquires all of the different processes, tools, and capabilities that are necessary to make progress and achieve the goals.

Finally, taking action involves using the tools and capabilities that have been mobilized to execute the plans that were developed.

3.2 Group Performance Model

The Group Performance Model (GPM) breaks down the time scale of a “good” group process into five different segments or phases. The five phases (shown in Figure 3.2) are: *Awareness*, *Direction*, *Preparation*, *Execution*, and *Operation*. Each phase has a different effort expenditure pattern and set of activities that the group should focus on to best move them along the time-line. For example, in the Awareness Phase, the most important activities to focus on are those related to establishing “mates” (interpersonal relationships) and developing commonly-understood “models” describing the situation, problems, cause-effect relationships, solutions, and so on. These five activity focus areas are called management factors.



3.2.1 GPM Management Factors

A useful aspect of the Group Performance Model is that it identifies the management factors (key activity focus areas) that are important at each stage of the group process. These are mates, models, means, momentum, and monitor. They are listed under the time axis in figure 3.2 in the order of importance for that time phase.

Mates refers to the people or members involved in the group process. These members can be both formal and informal members. Depending on the situation, at any particular point in time, some members may be actively involved while others are passive.

Models refers to the conceptual frameworks used in the group process. These conceptual frameworks are essentially the way that the group communicates together and defines its problems and solutions.

Means are the plans, tools, and materials that are needed for the group to move along down the GPM time-line.

Momentum refers to factors that influence action and effective execution, such as enthusiasm, recognition (acknowledgment), progress, and achievement of results and milestones.

Monitor refers to measurement, tracking, and adjustment activities for activities conducted during preparation, execution, and operation. These assure that the group process continues to be focused on achieving the groups' goals.

3.2.2 GPM Time Stages

During the *Awareness* phase the group needs to concentrate on making sure that the group members are prepared and motivated to work as a team. They should all understand what is being discussed and why. Overcoming inertia and removing barriers is the key category that is vital to Awareness. Essentially this is the part of the group process where a team gets created and where the problem faced gets defined. The key management factors that must be addressed in Awareness are primarily Mates and secondarily Models.

During the *Direction* phase the group decides on how to deal with the issue at hand. The group members build on their understanding of the situation and goals desired by the group as a whole, and create and decide on strategies that are going to be adopted

to achieve those goals. In order to accomplish these ends the group needs to be aligned and in agreement.

Alignment occurs when all the group members are able to see the problem in the same way and understand each other's points of view. Agreement occurs when group members express concurrence on a stated goal or activity. Without alignment a common goal or strategy is hard to establish. Without alignment, agreement is often difficult to achieve, and if actions are mandated to those not in agreement, very poor performance results are obtained.

Both alignment and agreement are desirable. Agreement without alignment can result in turmoil down the line as different member's perceptions of the problem and solution alter what they think are appropriate actions. When there is alignment without agreement, no action is undertaken. Expressed agreement is what motivates to group action.

During *Direction* the primary management factor switches to Models, with Mates second. A third Management factor (Means) also becomes important. Consideration of Means ensures the feasibility of various possible directions in terms of being able to prepare, execute, and operate.

Preparation is the stage when the group focuses on action and mobilization. The group has decided on a direction; the plan has been made; and the first steps are taken to really achieve the goal. All the group members understand what is going on and why. Furthermore, they understand their own part in what is to be done. The key management factor in Preparation is Means, secondarily, Mates and Momentum. Note that Models drops to the bottom of the list in importance. There should be no more debate about the

problem definition, or the strategies used to accomplish the goals. If the group continues to debate issues and introduce new models, they stay forever in *Direction*, and make little progress.

During *Execution*, the directional decisions and preparation plans and results are being put into action. Action is the key element. Only near-term planning immediately associated with execution is necessary, and significant progress is made which helps keep members' spirits up. Momentum and Monitoring are key during Execution.

The last phase, *Operation* refers to the ongoing maintenance and other activities that are required to keep the group at the desired goal. In a software project this stage would most likely encompass technical support and the release of "bug" fixes. Monitoring is the key management factor.

3.3 "Good" and "Bad" Group Process

The basic Group Process framework was represented using an effort expenditure pattern associated with generally effective or "good" group process (Figure 3.1). There are many group effort expenditure patterns that are generally ineffective. One of these is shown in Figure 3.3. This is the "Premature Action" effort expenditure pattern.

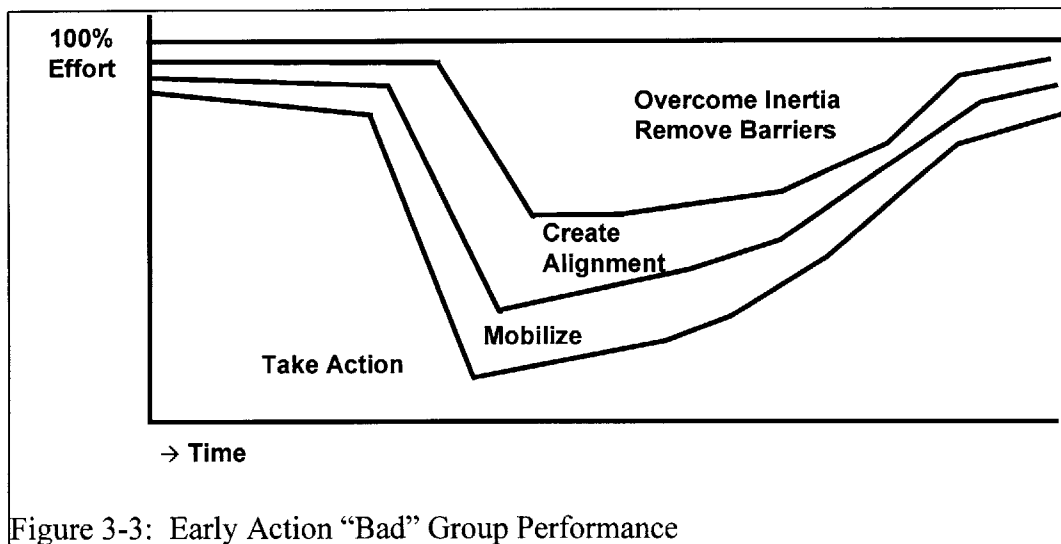


Figure 3-3: Early Action “Bad” Group Performance

In the Premature Action group process, one or more individuals decides that they should start doing something, and they immediately jump into action. However, they haven't created alignment and obtained agreement from others in the group. In some cases, they haven't even identified who else should be involved. When this happens, key participants don't contribute, results aren't obtained, and the action bogs down. At that point, the group must begin again with the process of removing barriers, creating alignment, and mobilizing—this time making sure all the key participants get involved.

The first obvious result is that the group has suffered a significant delay in the whole decision-making and execution activity. A second negative impact is that there is a good chance that a significant portion of the action taken is wasted—or even worse, the action has made the situation worse. (Consider the negative impact of prematurely destroying a necessary wall of a building.)

Chapter 4

Model and Process Research

This chapter examines some of the background research that was done in validating the Group Performance Model, as well as laying the foundation for the process, that will be described in Chapter 4, used for the educational program development.

4.1 Other Group Process Models

The Group Performance Model integrates three different kinds or dimensions of elements into an integrated, coherent operational framework useful for describing and analyzing how groups function. These are: the *four categories* of factors that groups must address in order to achieve their goals; the *five time phases* of activities and effort expenditure patterns; and the *five management factors* that need to be considered. It is the combination of all of these into a single model that makes it particularly useful.

There is also a *process flow* aspect of group performance that will be discussed in the next chapter. For any given group performance situation, there are a multitude of potential process flows and related activities that could be used by the group to go through the group performance model. Some process flows correspond to good group performance, others are bad.

| Author | Focus | Awareness | Direction | Preparation | Execution | Operation |
|--|---------------------------|---|--|---|--|--|
| Drucker [DRU67, p. 92, p. 96-97] | Strategy | Classification & definition of the problem Boundary conditions | Decide what is "right" Build into the decision the action to carry it out | Who has to know? What action? Can they do it? | Action commitment Behavior change Attitudes | Feedback which tests validity & effectiveness of decision versus actual outcomes |
| Nadler, Tushman [NT80] | Organization Dynamics | Inputs environment, resources, history, strategy Identify symptoms | Hypothesis generation and fit analysis | Identify action steps | | |
| Spencer [SPE89, p. 58 p. 105] | Participation (people) | Brainstorm data and ideas Order the data Name the categories Evaluate the work and implications | Map out Practical Vision Set Strategic Direction | Design Systematic Actions Implementa- tion Timeline | | |
| Stoner [SDG95, p. 249-253] | Management | Investigate the situation Define problem Diagnose causes | Identify objectives Develop alternatives Evaluate and select best alternatives | Implement the decision Budgets, roles, responsibility Schedules, plans | Perform tasks & activity Report on progress Manage risk & uncertainty | Monitor the results and the decision |
| Toolkit Document [CQM96, p. 7] | Planning Process | Sense problem Explore and formulate problem Select theme Collect data | Causal analysis Plan solution | Plan solution | Implement solution | Evaluate effects Standardize |

Figure 4-1: GPM Time Phases

There is extensive published literature relative to group performance and group process, and can be mapped to the Group Performance Model. Many of the sources deal with only one of the elements. Other sources address several elements, but treat each

element in isolation. Very few attempt an integrative approach to the problem of group performance, and those focus only on a single dimension. Figure 4-1 presents a representative sampling of the publications relating to the key GPM time phase dimension.

What was discovered was that every aspect found in the models researched could be mapped onto areas of the Group Performance Model. This indicated that the GPM was a comprehensive model. There were no elements that the GPM did not, in some way, address, and thus, it was a good model to base a process on.

4.2 Other Group Processes

Figure 4-2 presents research information related to the *process flow* aspect of group performance.

| Author | Identify Theme | Gather Data | Analyze Categorize | Develop Goal | Rank Categories | Define Solutions |
|--------------------------------|--|--|--|--|---|--|
| Drucker [DRU67, p. 92 p. 95] | Classification & definition of the problem | Complete definitions Check out against all observable data | Boundary conditions | Clearly specify Map out practical vision Set strategic direction | Compromises Right answer vs. wrong answer | Translate decision into effective action: who, what, and how |
| Spencer [SPE89, p. 58, p. 105] | Set the context Define the intent | Brainstorm data and ideas | Order the data Name the categories | Evaluate the work and implications | Set Strategic Directions | Design Systematic Actions |
| BON [BON92] | | Individual brainstorm Group brainstorm Mind Maps | Critical Path Analysis Decision Trees Force Field Analysis | | | |
| Dhebar [DHE93, p. 70-73] | Define the right problem | Representation of problem Ensure quality of data | Representation of analytical model | | | Communicate justified recommendations |
| Toolkit Document [CQM96, p. 7] | Theme selection | Block diagrams, interviews, graphs brainstorm, LP method, flowcharts, benchmark | Pareto diagrams, relationship diagram, scattergram, tree diagram, matrix diagram | Root cause impact reduction, | Pareto diagrams, matrix diagram, affinity diagram, tree diagram | Contingency planning, PERT chart. |

Figure 4-2: Process Flow

Most of the process models found were incomplete. They did not address all areas of planning and activity that are required. In addition many of the suggestions that the process models made were so vague that they were not useful for an implementation. In trying to create a computer facilitated decision making process, I had to have concrete, implementable parts.

In the area of data gathering, the method that was chosen, which will be further addressed in the next chapter, was brainstorming. . Spencer's analysis in *Winning through Participation* shows that brainstorming is a sufficient mechanism for gathering data. Since the acquisition of data can be a difficult task and there are many different ways of having it done, a simple, sufficient solution is extremely useful in creating a computer automated process.

Chapter 5

Educational Program Development Process

This chapter describes construction of a useable group process that adheres to the Group Performance Model discussed in Chapter 3. The steps that are required for the development of an educational program development are explicitly stated, and an in-depth description of the final model is given.

5.1 Processes that adhere to the Group Performance Model

The Group Performance Model provides a blueprint for the amount of effort that should be spent in various stages and areas of activity by a group as they move successfully through a project. A process that adheres to the GPM needs to enforce, or at least encourage, that the proper amount of effort is allotted to the stages and areas of activity in the correct sequence. In this manner, a group can be guided through a project so that they perform as a group to the best of their abilities.

In order to allot the correct amount of effort to each stage and activity area, the group essentially has to use a structured process. Because of this they greatly increase their chance of success. However, success is not guaranteed. It may be the case, for example, that the group as a whole is not able to be well informed because the members themselves did not have enough expertise. Ideally, a process that adheres to the GPM should, in addition to specifying the amount of effort at each stage, also educate the group so that they know about the potential pitfalls that can still occur. The fundamental principle is that, if all the process barriers are resolved, only subject barriers are left, and success is very probable as long as there is a process for handling the subject matter.

For instance, consider the earlier example of a software project that does not have a financial representative in the group. A process for helping a group develop software projects should raise the question to the group of finances. Finances are an integral part of software development, and the group should be reminded or informed of it. In addition to enforcing or encouraging a group to spend their effort in the best places, a process should also bring to the forefront issues that are specific, and vital, to what the process is about.

5.2 Scope of Educational Program Development

When creating a model for educational program development the first thing to realize is that the area of the Group Performance Model that we are dealing with is only the first two time stages: Awareness and Direction. The Group Performance Model in its entirety

would describe the complete Educational Program, not simply its development. A useful way of thinking about this is that the “students” of the education show up around the Preparation and Execution phases. The development of the program should be finished before the students show up.

Since this thesis deals only with the development of an educational program, the model created only has to enforce the effort levels of Awareness and Direction. This means that the only management factors that need to be considered are the Models, Mates, and Means. Means are considered only to the extent necessary to determine the feasibility of a decision and the potential plans. For purposes of educational program development, the GPM splits the entire group process into development and implementation stages. We are only dealing with the development stage.

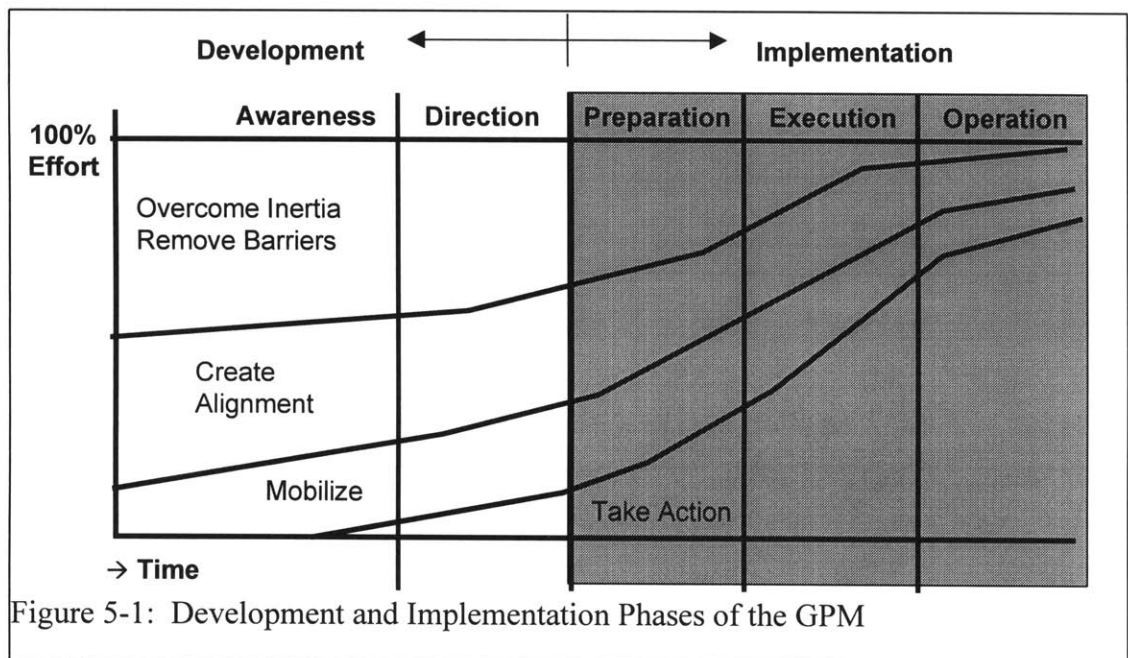


Figure 5-1: Development and Implementation Phases of the GPM

5.3 Process for Computer Implementation

There are numerous different process models that could be created for educational program development, a number of which would adhere to the GPM. However, in order to create a software program which acts as a facilitator for the process, a process model must be chosen that is foremost able to be implemented, and also, reasonable in its tasks, and easy to use as a program. These considerations helped in creating the process model that was implemented.

5.3.1 Step 1: Determine the focus of the education

The first step in developing an educational program is deciding what is to be taught. This does not mean all of the finer points, but merely what is the overall topic. Examples of this would be a class on software engineering, or a new user education for a piece of software, or a new employee education program to familiarize them with the company. In order to create an educational program, it needs to have a basic topic.

5.3.2 Step 2: Brainstorming

The second step involves the identification of as many of the problems that need to be addressed during the program and the potential opportunities that can be seized during the program. In this process model, we adopted group brainstorming where every member of the group comes up with as many different aspects of the educational process that they can think of. During step 2, attention is drawn to specific issues as a means to expose

areas that the group should think about. The emphasis here is to expose as many of the problems as the group can. This goes a long way towards being able to remove barriers and overcome inertia.

Eleven areas of education needs were identified to help groups brainstorm problems, barriers and inertia. These are: skills, theories, processes, facts, models, standards, language (jargon), rules, requirements, attitude changes, and relationships. These are all different aspects of educational programs. Not all programs have elements that go in every single area, and there can be more areas, but these are provided as a way to spark brainstorming.

5.3.3 Step 3: Categorizing

The third step is a process by which all of the items identified during the brainstorming in step 2, are organized in a way that makes sense to the group. All the items are categorized and grouped together under headings. This turns an unmanageable list of issues and observations about the education program into a very manageable set of categories that cover the spectrum of what needs to be considered in the design of the educational program.

The process of categorizing all of the different aspects of the problem helps in creating the alignment that is needed for the group to function to the best of their abilities. By arranging all of the individual parts into a limited number of relevant categories, assumptions made by individual members that were not explicitly stated during the brainstorming, can come to the surface. When members disagree about where items

belong, often times it is due to unstated assumptions. By exposing these assumptions this early in the process, future problems dealing with them can be, if not avoided, at least prepared for.

5.3.4 Step 4: Creating the Goals

Once all of the various categories of issues and opportunities for the educational program are identified, a group goal, or mission statement, for the educational program can be created. Through a series of questions that asks each group member to come up with what is most important in the educational program – the common goals can arise. It is at this point that alignment and agreement are created with the group.

The goal, or goals, that are established here then become the motivating factor for the rest of the program development. In order to achieve good group performance, the groups’ goals must be stated explicitly and known by all of the members.

Figure 5-2 show the four process steps included in the Educational Program Development Process.

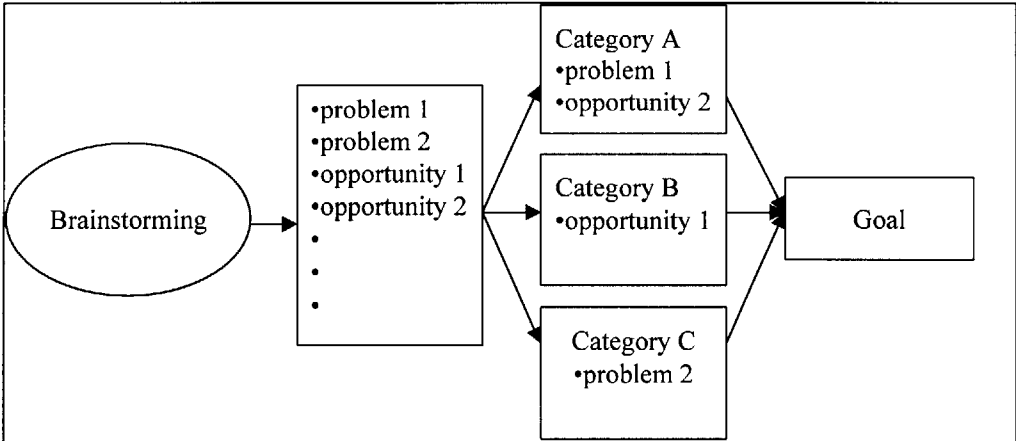


Figure 5-2: Steps 1-4 From Brainstorming to Goal Agreement

5.3.5 Stage 5: Starting to develop a plan

After the group arrives at its goals, it then has to develop a plan to achieve them. The categories that were identified in step 3 to help segment the various aspects of the problem are useful again. These categories become a first pass at the curriculum of the educational program, and serve to define those areas where implementation activities are required. They are arranged in an order that makes the most chronological sense for the educational program. Generally certain categories need to be dealt with first in order to educate about ones that are possibly more advanced.

5.3.6 Stage 6: Inventing Possible Solutions

Once the categories are arranged, possible solutions can be added. Each category has a set of problems and opportunities associated with it. The possible solutions are ways that the educational program can impart the vital information associated with that category to the participants going through the program. At this point, the groups' goals are known and they can be used to ensure that appropriate plans are made to deal with all of the various categories. Thus, the selected solutions will stay focused on the goals.

5.3.7 Stage 7: Choosing the Final Plan

At this point we are clearly within the Direction phase of the GPM. All that is left to do before entering in the Preparation phase is to decide upon which set of possible solutions

the group is going to use. Further examination into them might be required as the Means might not be known at this point, and they should be researched.

The final decision about which possible solution to take, should be made in a manner appropriate for the group membership. There are many different ways of making a decision like this. Since all of the issues that are present have been exposed, and all members are in alignment and agreement, the actual mechanics for this decision do not greatly impact the process. Basically, at this point in the process, it doesn't make any difference whether the group votes democratically, or if there is one leader who makes the decision.

Figure 5-3 shows steps 5 to 7 of the Educational Development Program Model.

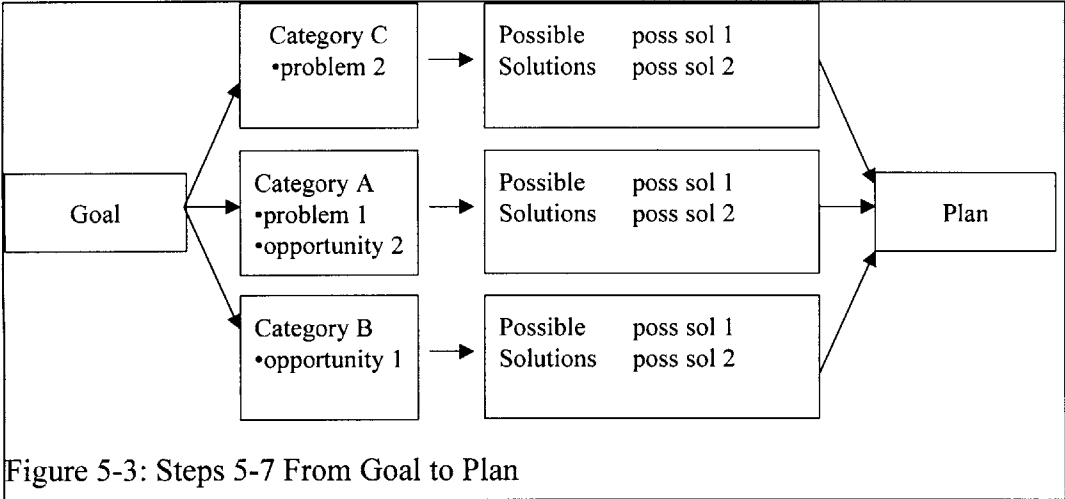


Figure 5-3: Steps 5-7 From Goal to Plan

Chapter 6

Educational Program Development Model Implementation and Effectiveness

This chapter describes the actual computer program that takes the group through the stages of the educational program development model. The problems that were discussed in Chapter 2 are considered to determine the effectiveness of the computer based assistance.

The program was implemented using FoxPro for Windows. This was mostly due to the easy nature of database management that is inherent in that language.

6.1 Computer Based Process

The very first aspect of the implementation of the educational program development model is that it is a computer based solution. This has a number of immediate

consequences. The first is that there is a unified process that must be adhered to. This seems like stating the obvious, but as discussed in Chapter 2, one of the major problems that groups face is that there is no standard process by which they make decisions. Enforcing the structure of a computer program upon a group has the tremendously beneficial effect of enforcing a process of decision making on the group – not matter what that process is.

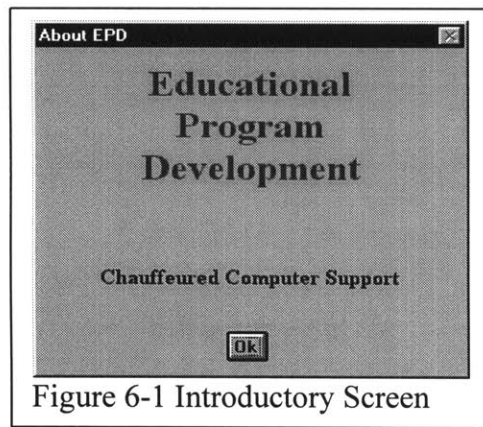


Figure 6-1 Introductory Screen

The second benefit of a computer based solution is in motivating the members of the group to be present in the early stages. As was mentioned earlier, one of the common problems in getting all members to be present at decision meetings is that some members feel that those meetings are a “waste of time.” By having a hands-on process that they can go through with the group, those members can feel like some work is actually getting done. As the group moves through the process there is a feeling of accomplishment, and the “useless meeting” feeling disappears.

6.2 Data Entry

The beginning of the program starts with a data entry field for the group to enter what the educational program is about. This is Step 1 from Chapter 4. This is mostly used to keep track of different development endeavors at the same time.

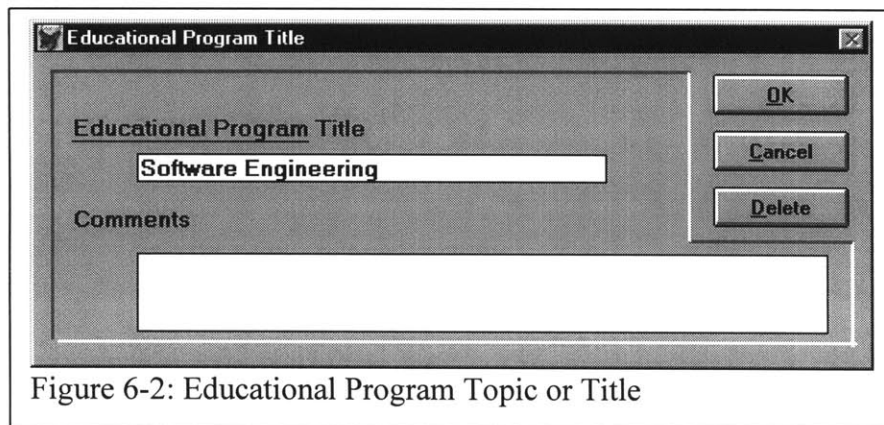


Figure 6-2: Educational Program Topic or Title

The data entry then continues as the group is prompted to enter the brainstorming ideas. As the group enters in their ideas, the program takes them through the series of issues that are specific to educational program development that they should think about. In this manner a large group of ideas, problems, and opportunities gets collected. The prompting of the key issues that should be considered helps the group recognize if key members are not present. If the group does not know about the issues involved, then they need to find additional people to fill in the gaps in their collective expertise.

The benefit of having the data collection done by a computer is that it makes a difficult task – that of collecting and organizing a large amount of data, a trivial task. In fact, the computerized data entry helps with some of the additional problems faced by

large groups. Where small groups can get away with the amount of data that they can generate, large groups often cannot without assistance.

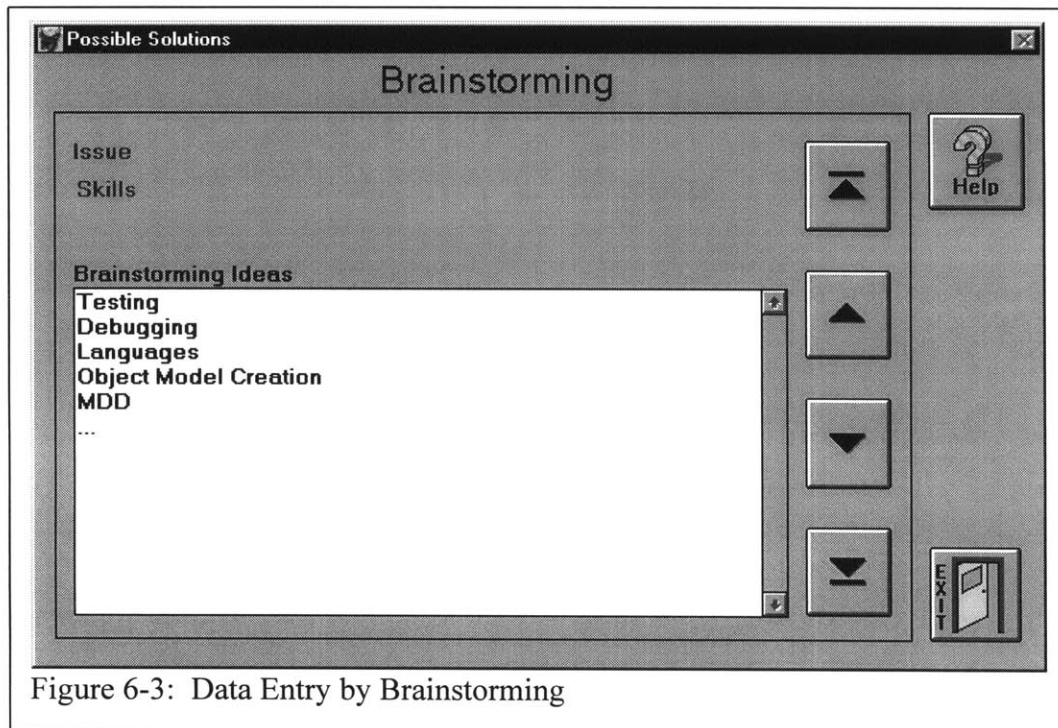


Figure 6-3: Data Entry by Brainstorming

6.3 Data Organization

The computer process by which all of the data gathered during the brainstorming is categorized and sorted is one of the most complex in this system. A user friendly interface for the creation of new categories, and the assignment of ideas to different categories is a difficult thing to design and create. However, the benefits from the stage, like the data entry stage, are easily apparent.

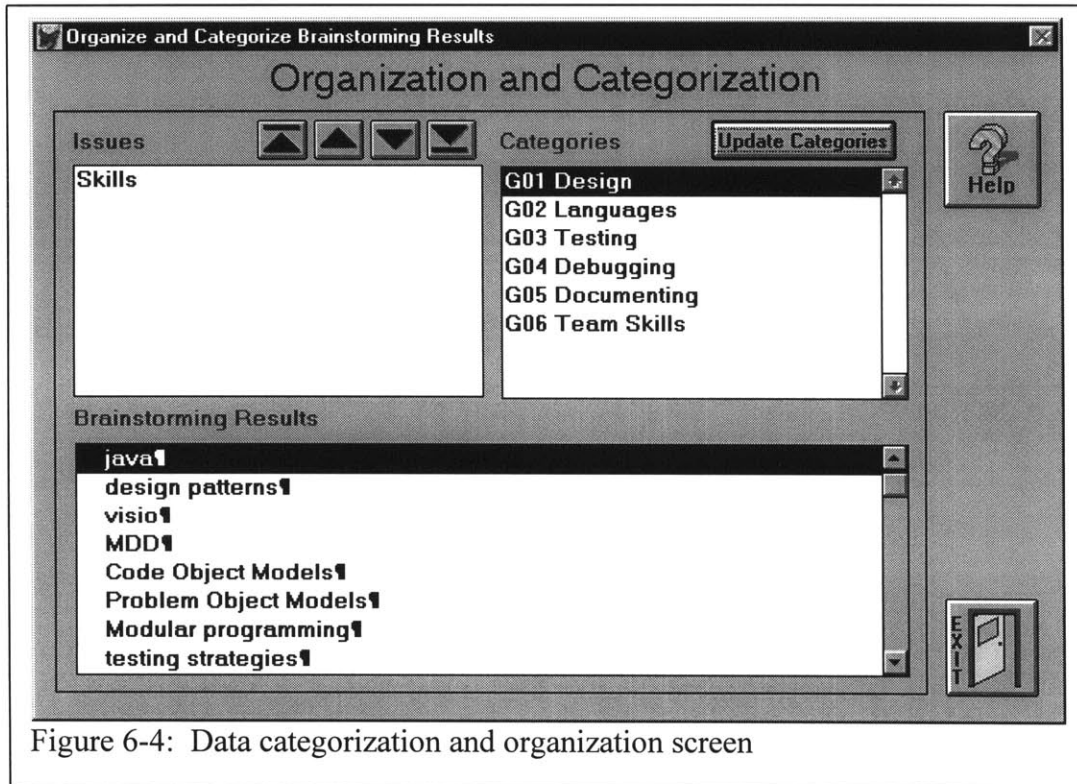


Figure 6-4: Data categorization and organization screen

As stated in Chapter 4, the data organization helps expose the unstated assumptions that the individual team members have. It also drastically affects the speed with which a group can undergo this endeavor. By automating the process, what normally would be done with stacks of papers, or cutting and pasting in a work processor, or highlighting, is done with the click of a mouse. Chapter 2 defined a component of good decision making to be the speed of the decision. This part of the process is sped up drastically by having an expert computer system manage the data.

6.4 Deciding the Goals

To facilitate the agreement on goals, a number of questions are asked to determine what the group members feel to be the most important aspects from the categories. Once all of the group members can clearly state their own opinion and see the opinions of others, reaching a common goal, or goals, is a relatively simple process. By asking the questions of all of the members, the difference in their utility functions can be determined. They all can see the same set of problems and opportunities. The unstated assumptions have been flushed out as much as they can. The differences that the group now has are differences in utility functions. Compromise is needed.

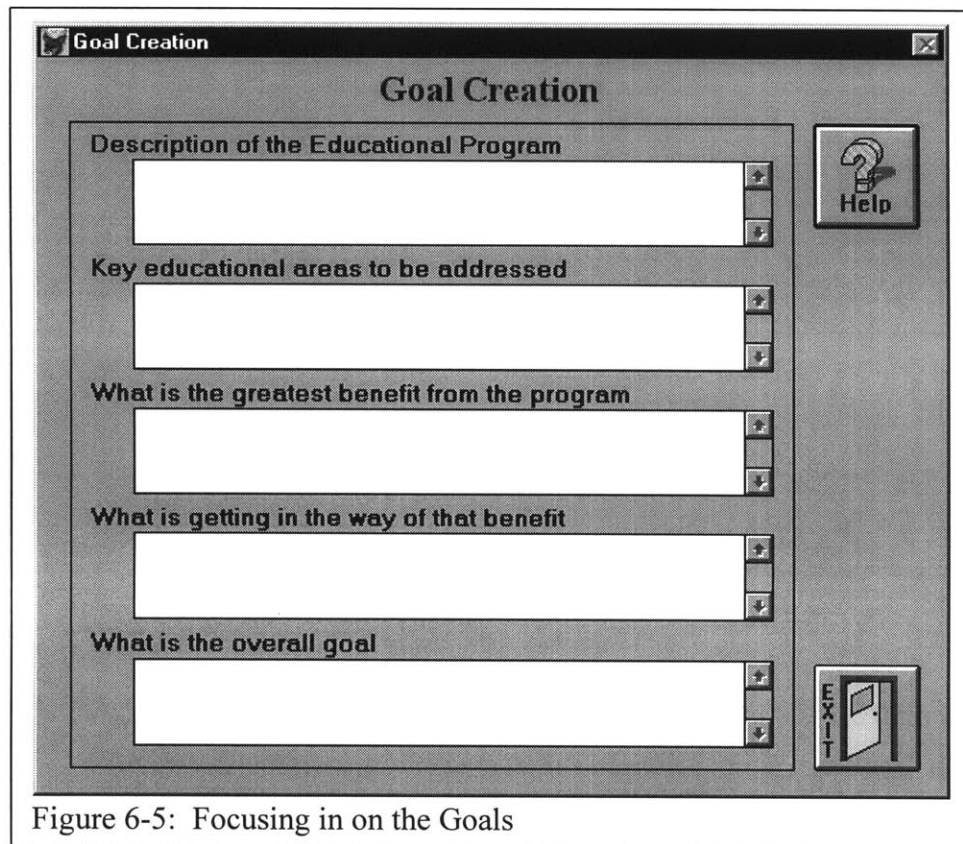


Figure 6-5: Focusing in on the Goals

6.5 Creating the Solutions

The possible solutions are simply another data entry screen. This time they are gathered under the different categories rather than under the different issues involved in educational program development. The only part left in the model is deciding which solution to adopt as the group strategy. This selection is left out of the program, instead a list of all possible solutions that are identified is printed so that the group, after researching the Means necessary to fulfill those possible solutions, can easily choose the one that they agree upon.

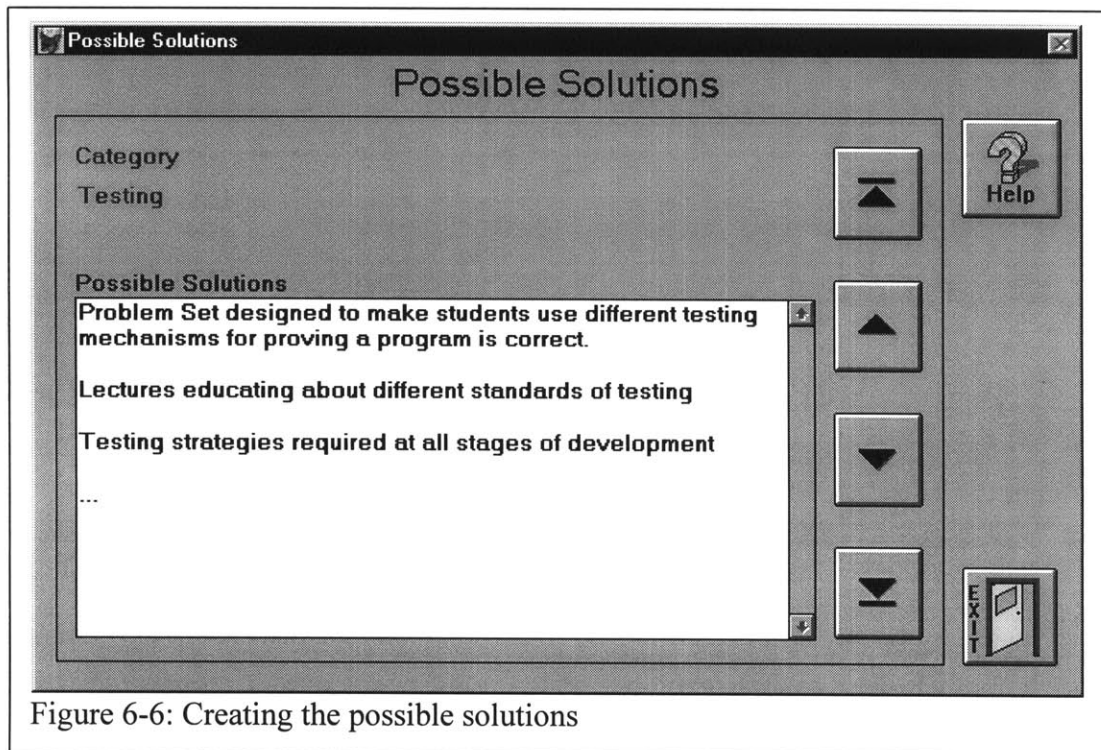


Figure 6-6: Creating the possible solutions

6.6 Overall Effectiveness

Out of all of the problems that were raised in Chapter 2 regarding group decision making, only one was not fully addressed by the computer based process. When the problem faced by the group is that the members have a difficult time attending a meeting for reasons of travel, this process does not help them. This indicates that the process developed can help in group decision making. Furthermore, the last problem could also be addressed. A web-enabled computer process could handle this last problem -- virtual meetings could be held and travel problems could be diminished. However, due to implementation issues web-enabled software was not feasible for this thesis. As stated in the beginning of Chapter 4, the ability to implement a program was of prime concern.

Chapter 7

Conclusions

The final chapter will be dedicated to a review of the contributions of this work and a discussion of the future avenues of research that this work has proposed.

7.1 Summary of Contributions

We started by examining the problems that exist within groups as they go about making decisions. We then introduced a way of describing group performance so that good group performance could be established. What this work has demonstrated is that with a computer system that guides a group through a decision making process, a structure can be enforced on the operation of the group during that process. Thus it can reduce, if not avoid, many of the common problems that groups face.

7.2 Future Avenues of Research

This thesis has opened up many lines of research. The development process could handle more barriers than the one proposed in this thesis does. As discussed, a web-enabled program could decrease the problems associated with getting all members of the group involved. Subject specific barriers could be diminished if the educational program was more known. A program that informed a group of what members needed to be included, rather than just suggest to them areas where they might need more expertise, could be a very useful tool.

Other models could be developed to test the efficacy of this approach to educational program development. As stated in Chapter 2, good decision making is actually quite hard to define, however, with another model, the better tool could be identified. In this manner a standard for group decision making could be established, and it could be improved all the more.

The last large area where this work exposes more work to be done is that of other specific models that adhere to the Group Performance Model. Computer based assistance for decision making can be useful in many different areas. Research into specific areas besides education, could lead to better computer based support for groups.

Bibliography

- [PGI95] Potomac Group, *Tech Payback Consultive Skills*, Internal publication, 1995.
- [PGI295] Potomac Group, *Tech Payback Concepts and Process*, Internal publication, 1995.
- [BAI88] Lloyd Baird, Managing Two Fits of Strategic Human Resource Management. *Academy of Management Review*, 1988
- [BON92] Edward de Bono, *Serious Creativity*, HarperBusiness, New York, US, 1992.
- [CQM96] Toolkit Document ML0020, *The Seven Steps Method*, Center for Quality of Management, 1996.
- [DHE93] Anidrudh Dhebar. Managing the Quality of Quantitative Data. *Sloan Management Review*, Winter 1993.
- [DRU67] Peter F. Drucker. The Effective Decision. *Harvard Business Review*, vol. 45, #1, Jan/Feb, 1967.

- [NT80] David A. Nadler, Michael L. Tushman. A Model for Diagnosing Organizational Behavior. *Organizational Dynamics*, August, 1980, American Management Association.
- [SPE89] Laura J. Spencer. *Winning Through Participation*. Kendall/Hunt Publishing Company, 1989.
- [SDG95] James A. F. Stoner, R. Edward Freeman, Daniel R. Gilbert, Jr. Chapter 9: Decision Making. *Management*, 6th edition, 1995, Prentice Hall.
- [SGI97] The Standish Group International, quoted in Computerworld, June 9, 1997.