CRITICAL THINKING IN MIS AND DSS: USING BLOOM TO REVISE COURSE MATERIALS

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ABSTRACT

This paper explores the application of critical thinking techniques to revising course content. Specifically, Bloom's Taxonomy is described and literature is reviewed from MIS articles. Since DSS is particularly appropriate for a discussion of critical thinking, this paper focuses on revising DSS materials in the MIS course. Finally, course materials, including course objectives and discussion questions, are revised using Bloom.

AN INTRODUCTION TO CRITICAL THINKING

What is critical thinking? We, as teachers, have a definition of critical thinking in mind, but few of us have really externalized that definition so that it can serve as a basis for stating and measuring outcomes (Halx & Reybold, 2005; and Paul Summer 2005). Indeed, critical thinking is recognized as a general goal of higher educational institutions in schools or departments of business. Also, business associations of certification champion teaching critical thinking as a means to reach desirable student outcomes. For instance, the Association of Advance Collegiate Schools of Business (AACSB 2006, p18) says that …

> "in designing a course syllabus a mission statement might remind a faculty member that the school aims to emphasize critical thinking skills."

The Association of Collegiate Business Schools and Programs (ACBSP 2006) also lauds the teaching of critical thinking in their standards. However, ACBSP only mentions the term once in their statement of standards, while AACSB mentions the term twice. While this paper will not specifically explore the significant discussion of critical thinking, particularly in schools of education, there are many approaches to defining and applying critical thinking approaches to teaching and outcomes assessment (Bers Summer 2005; Halx and Reybold 2005).

For instance, Kurfiss (1988) proposes that three processes function in critical thinking: declarative knowledge, which informs the student of the basic facts and concepts in some discipline; procedural knowledge, which directs the student in reasoning, inquiring, and presenting knowledge; and metacognition, which guides the student in setting goals, and evaluating the usefulness of information or the effectiveness of an investigative technique in some knowledge area. On the other hand, Taylor (2004) pragmatically defines critical thinking as an exercise in face validity; where critical thinking is defined as the thinking that professionals in some discipline exhibit when they practice their trade

Bloom (1956) approaches the discussion of thinking processes from a cognitive perspective focusing on the study of mental processes such as, comprehension, making inferences, decision-making, problem-solving, planning, and learning. He proposed that higher level mental processes are layered. The lower layers are hierarchically related and support the higher layers, which are the critical thinking processes. Figure 2 on page 106 illustrates Bloom's concept of cognitive layers. The lower layers, knowledge, comprehension, and application are prerequisite conditions to the student reaching the higher layers, analysis, synthesis, and evaluation.

A student who exhibits the ability to recall the basic facts, principles, or techniques in a given discipline has achieved academic ability to operate at the knowledge level of Bloom's Taxonomy. A student who can organize facts, compare principles, or translate ideas from one context to another is at the comprehension level. A student who can apply knowledge or use the tools of a discipline to solve problems common to some profession is at the application level. The first three levels are said to be hierarchical because they are necessary or fundamental to achieving the higher levels. However, many researchers, and Bloom himself, felt that many teachers over-emphasized the lower level of mental processing at the expense of the higher levels in their instruction and choice of educational materials (Bissell and Lemmons 2006, Hampton and Krentler 1993).

The higher level mental processes are not hierarchical in the sense that one level requires the skills of the other for the student to successfully proceed. The higher level critical thinking skills are networked and can operate in parallel. For instance, a student who has achieved the analysis level can create a model or specification of some problem in some narrowly defined area of interest. On the other hand, a student who has achieved the synthesis level can solve that problem by assembling various parts into a whole solution. Finally, a student who can assess the efficacy of a solution to a problem, or make a judgment about the applicability of a solution is operating at the evaluation level (Oliver et al 2004).

So, what is critical thinking? Critical thinking is the application of higher level cognitive skills to solve difficult problems or learn new material. The discipline of the professional will often guide the student as to the specific sequence of tasks; however, the high level cognitive skills of application, analysis, synthesis and evaluation will be present in those tasks. For instance, accountants use critical thinking when performing a financial audit, human resources personnel use critical thinking in the selection and evaluation of potential candidates to a position, and computer support analysts use critical thinking when trouble-shooting computer systems. Of course, the granddaddy of all critical thinking techniques used by management scientists is hypothesis testing and the scientific method.

The purpose of this paper is to explore the application of Bloom's Taxonomy to teaching techniques in a course taught in many schools or departments of business known as Management Information Systems (MIS). This paper will focus on the course taught at York College of Pennsylvania known as IFS305-Management Information Systems. More specifically, the paper explores the application of Bloom's Taxonomy to an area or topic covered in many MIS courses known as Decision Support Systems (DSS). While the definition of DSS is not universally agreed upon, it has come to mean the application of computer-based systems to higher level organizational activities such as problem-solving and decision making (Turban 1995, and Finlay 1994). Some researchers feel that DSS are particularly useful when they serve as decision aids that structure a problem so that individuals can couple their intellectual resources with the resources of the computer resulting in insight and better decision making (Keen and Scott Morton 1978). Thus, a discussion of DSS and critical thinking in MIS is particularly relevant.

DISCUSSION OF BLOOM IN MIS

The discussion section has five topics. First is a review of a literature on critical thinking in MIS. Second, DSS tools in Excel are introduced. Third, two specific DSS tools, the Scenario Manager and Solver, are examined more closely. Fourth, the educational objectives in an MIS course are revised in order to apply Bloom's Taxonomy. Finally, the discussion closes with possible test questions that an instructor might use to gage the outcome of instruction based upon the Bloom levels.

Critical Thinking in MIS

Critical thinking is an important skill for professionals in MIS. Managers who would be involved in the use or development of DSS must have critical thinking skills as well. The problem-solving and decision making skills that are based upon critical thinking and Bloom's Taxonomy can be thought of as a two dimensional framework with primary concepts or principles of MIS along one axis and the levels of critical thought along the other (Vitolo and Coulston 2002). The Vitolo and Coulson framework identifies the primary concepts in MIS as hardware, software, data, procedure, and people. For instance, a DSS is a software system that supports problem-solving and decision making in organizations.

Educators often discuss the levels of Bloom's Taxonomy from the perspective of the questions, cues or behaviors that a student should be able to perform if operating at a specific Bloom level. The first row in Table 1 on page 105 presents the tasks that might be required at each Bloom level along the software dimension of the Vitolo and Coulston (2002) framework. The reader should note that the questions become more complicated as the Bloom level increases.

The cues or action verbs in Table 1 are taken from a review of occupational descriptions of MIS positions in the United States, Taiwan, and Australia (Ven and Chuang September 2005). Ven and Chuang performed a job-related content evaluation of positions in MIS including positions such as systems manager, software designer, systems programmer, programmer, and analyst. The cues in Table 1 are a sample of action verbs in the job descriptions that they examined. These cues illustrate how Bloom's Taxonomy can be applied to the statement of competencies of professionals desiring positions in MIS. It should be noted that over 60% of the cues or action verbs found by Ven and Chuang (September

2005) appear in the synthesis and evaluation category indicating that software related positions have a significant critical thinking requirement.

Finally, the behaviors in Table 1 are taken from Bers (Summer 2005). The Bers paper demonstrates that it is possible to assess measurable behavior based upon Bloom's levels of critical thinking by means of standardized tests, and other methodologies developed by educational institutions. In summary, Table 1 provides a set of tasks, cues, and behaviors along the Bloom levels and is typical of the style of research done around Bloom.

As seen in the discussion above, Bloom's Taxonomy can be used to make conclusions regarding the cognitive level of job applicants in MIS; however it has been applied to many other assessment situations. For instance, Bissell and Lemons (2006) propose a technique for developing and assessing the validity of college discussion questions. Their technique is particularly interesting because it allows for the inclusion of level of cognitive performance and specific content related to some professional discipline. Other areas where Bloom can be applied include statements of abilities on resumes, job position advertisements, teaching objectives, learning outcomes, and career goals (Ven and Chuang September 2005; and Bers Summer 2005).

DSS Tools in Excel

While Excel is probably the most popular spreadsheet in education, many students do not fully appreciate its potential as a DSS tool. For instance, an examination of Excel's Tools menu shows several DSS tools: Goal Seek, Scenarios, and Solver. Also, Formula Auditing might be considered a DSS tool to an accountant or auditor. That by the way is one of the salient features of DSS making DSS a difficult topic to define. The beauty of the tool is in the eye of the beholder. Another characteristic of DSS tools is that their usefulness can be dependent upon to the decision making style of the user, the structure of a problem, or the nature of the organization. See Figure 1 for Excel's Tools menu.

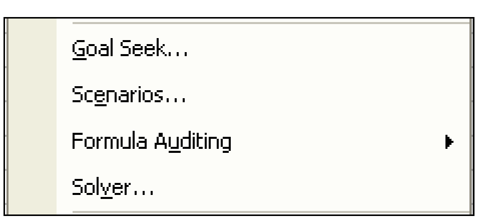

Figure 1 - Excel's Tools Menu

Other DSS tools can be found in the Data menu such as Table, and PivotTable and PivotTable Report. Finally, the Data Analysis tool pack provides an amazing array of statistical tools. The statistical tools include Anova, Correlation, Descriptive Statistics, F-Test, Regression, t-Test, and z-Test to name a few of the most important.

The hard part in using Excel's DSS tools is being conversant in the underlying knowledge that the tool is based upon. For instance, the hardest part in using a statistical tool is knowing statistics. Next, we will briefly examine two of Excel's DSS tools: Scenarios and Solver. These tools are illustrated because the case book used in IFS305-Management Information Systems has sections on these two tools and they are extensively discussed in the course (Brady and Monk, 2007).

Excel's Scenario Manager and Solver

While this paper is not a tutorial per se, we will briefly examine Excel's Scenario Manger and Solver. The Scenario Manager can be seen in Figure 3 on page 107. The steps to use the Scenario Manager require that the decision maker to enter and name scenarios to be evaluated, indicate the cells that the tool can change, provide values that Excel will enter into the worksheet, and generate a summary report. When generating the summary report, the Scenario Manager gives the user the opportunity to specify result cells. The result cells should have a formula such as a net income calculation or a function such as Net Present Value (NPV) or Internal Rate of Return (IRR).

The Scenario Manager is appropriate when one desires to perform a what-if analysis and have the Scenario Manager change multiple cells in an automated fashion. This tool allows one to set up numerous scenarios that can be evaluated by the decision maker in order to find the optimum scenario. For example, one might wish to perform a what-if analysis on retirement options. One could enter a set of revenue and spending calculations in the format of a net income statement related to retirement expectations. The Scenario Manager keeps each retirement option stored in memory giving the user the ability to quickly change between the options. It also provides a summary report that is well formatted allowing easy identification of the optimal scenario.

Excel's Solver is illustrated in Figure 4 on page 107. The steps to use the Solver require that the user specify a target cell with a function or a formula which will be monitored by the Solver, identify changing cells to be manipulated by the Solver, enter rules that might constrain the answer in the target cell, and solve the problem.

The Solver is a utility that is based upon a family of optimization problems which use linear programming. It can calculate a maximum or minimum value of a target cell by changing other cells that are related to the target cell by rules or formulae using the linear programming technique. While the Solver requires some thought to set up, it is particularly useful when constraints or limits are involved in the problem. For instance, one might want to find the optimum number of items to manufacture. The decision maker could create an income statement with formulae based on the number of items to be manufactured. Solver can manipulate the items to be manufactured arriving at an answer very quickly.

Using Bloom to Describe MIS Outcomes

A statement of course outcomes should describe a set of competencies or abilities that a student can perform upon completion of that course. When the competencies are observable, measurable, and validated, then one can argue that the course is effective based upon an evaluation of samples of student tests or surveys, for instance. In order to make the linkage between the statement of the course outcome and the assessment of effectiveness, one should state those outcomes depending upon several factors such as the instructional level of the course and nature or preparedness of the students. That is, freshmen level courses probably should not be as rigorous as junior courses. In other words, one would expect that the outcomes of a freshman level course should use more action verbs in Bloom's Knowledge, Comprehension, and Application cognitive levels. Also, the nature of the student should be considered. If most of the students are non-majors in the content area, then the statement of course outcomes should include few if any Evaluation level cognitive abilities.

IFS305-Management Information Systems is a junior level course taught by the Information Systems (IFS) faculty at YCP. The prerequisites for entry into the course include basic computer literacy and knowledge of management concepts. The computer literacy prerequisite is enforced by means of a formal computer-based assessment tool known as SAM (Skills Assessment Manager published by Thompson Course Technologies). The SAM test covers Word, Excel, PowerPoint and Windows. The management concepts prerequisite is enforced by the requirement that students have passed MGT250-Principles of Management. Finally, the majority of the students are not IFS majors; instead the majority is business majors in management, accounting, or finance. Table 2 on page 1061 lists the current objectives of IFS305. These objectives have evolved over several years as topics have been added by different faculty at YCP. Also, the course has been modified to include more computer hands on experience, specifically in DSS tools. Thus, it is time to reevaluate the course objectives.

A review of Table 2 shows that the course objectives are very general and do not permit one to ascertain the level of cognitive ability each is attempting to achieve. All of the objectives are prefaced by two verbs "understand" and "discuss." In addition, DSS is to be presented only as a tool to be used with no mention of the development of DSS. See item # 5. This course objective hardly conveys the notion of DSS as a higher level organizational activity involving problem-solving and decision making requiring the active involvement of decision makers for optimal use (Turban 1995, and Finlay 1994). As an aside, item # 2 above is the list of MIS topics in the Vitolo and Coulson (2002) framework and is found in many recommended lists of objectives for MIS courses.

To revise the objectives in MIS, this paper will use an approach suggested by Ven and Chuang (September 2005). They advocate a task-based approach that uses << verb + object + condition >> to identify competencies. The "verb" is a task, cue, or behavior. The "object" is the entity or thing that is acted upon. The "condition" is a phrase that qualifiers the verb or the object indicating a refinement of the action verb, a goal to be met, a tool to be used, or some time period that limits the action.

Table 3 on page 106 gives the revised objectives of IFS305. Since the critical thinking skills are Bloom's analysis, synthesis, and evaluation levels, then it is appropriate that a majority of the objectives (5 out of 9) in a junior level MIS course should be at the higher levels of Bloom's Taxonomy. Items # 1, 2, 3 and 6 in Table 3 are at Bloom's analysis level. Since students coming into IFS305 have basic computer literacy skills and have a fundamental grasp of management concepts, it also is reasonable for IFS305 that the objectives go a step further than the basic introductory course in information systems. Finally, item # 5 has the student achieve the synthesis level. The wording of item # 5 highlights the characteristic feature of DSS as a decision aid for structuring semi-structured problems which might lead to individual insight and better decision making (Keen and Morton 1978).

Using Bloom to Devise MIS Test Questions

An impetus for Bloom to develop his taxonomy was his belief that most assessment of student abilities occurred at the lower levels of cognitive processing. Another impetus for Bloom was his theory that higher level processing is an indicator of superior student achievement; and that the higher level processing was more beneficial to learning than memorization and recall alone.

Table 4 on page 107 summarizes potential DSS tasks and student responses based upon Bloom. For instance, fundamentally a student who has had instruction in DSS should be able to define the components of a DSS and summarize the role of DSS. The student's answer should state that the components are the dialog which is also known as the interface, the data is the database or some other data store, and the model is the math component such an NPV or IRR function. The student response concerning the role of DSS is to state that DSS assist in decision making, problem solving, and problem structuring. It is the role of problem structuring that is particularly useful to achieving insight when the problem is semi-structured and, in some cases, ill-structured. Another fundamental skill that a student should have achieved in taking an MIS course with a heavy emphasis on DSS is knowing how to apply Excel's DSS tools. For instance, students who pass IFS305 will be able to use the Scenario Manager or the Solver as discussed above.

The critical thinking skills are those at the analysis, synthesis, and evaluation levels of Bloom. If students are operating at the analysis level, they should be able to respond to a question to analyze the requirements of a DSS by giving examples of pseudocode, data flow diagrams (DFD), and entity relations ship diagrams (ERD). Of course the requirements modeling techniques may vary according to faculty desires. For instance, some faculty may prefer object-oriented techniques, but the same goal will be achieved, to determine whether the student has achieved the analysis level for the requirements question.

At the synthesis level of Bloom's levels, one might ask the student a discussion question regarding development of a DSS. Again, the answers will vary; however students might address key characteristics of DSS development such as the phases of DSS development (requirements analysis, design and implementation). The student might address the fact that DSS are normally developed in organizational teams using an iterative approach. The student also might state that many DSS would be impossible without the use of modern day computing.

Finally, the evaluation question could determine whether the student can assess the quality of a DSS solution. An appropriate answer would state that it depends upon management's requirements related for instance to NPV or IRR. A particularly insightful answer by a student might give situations where management might adjust their requirements of a solution. For example, if a student were to respond with a well reasoned example of a solution that could be judged adequate were management willing to revise the rate component of the NPV; that student would be considered shrewd and certainly operates at the evaluation level of Bloom.

SUMMARY – NEXT STEPS

This paper addressed the revision of an MIS course objectives using Bloom's Taxonomy for the purpose of publicizing the cognitive level at which each of the topics is discussed. We also examined potential examination or discussion questions related to the DSS content in an MIS course, thereby, giving the instructor some capability to assess the cognitive level of mental functioning achieved by a student. Next steps could involve assessing other courses in the IFS curriculum using Bloom's Taxonomy as a guide. Then, other courses in the Business Administration Department might be assessed by appropriate faculty. Of course, a committee might be called for to coordinate activities.

Beyond assessing course objectives, other activities could be interesting. This paper did not address the linkage between course objectives, and test questions. An interesting methodology is proposed by Bissel and Lemons (2006). Their methodology has the following steps:

1. Write discussion test questions to address specific content.
2. Document content and critical thinking skills required by the question.
3. Create a scoring rubric for the question.
4. Validate the question and rubric, possibly, by experts.
5. Administer the question.
6. Score the answer.
7. Revise the question and/or rubric.

Furthermore, the test questions, rubric and validation could be done online. Faculty could submit questions and rubrics using a browser. Other faculty who are expert in the content area could assess the validity of the questions or rubrics. Then, interested faculty could download the questions and rubrics for administration. Once the interested faculty have scored the question, they could submit results of the scoring with additional information such as the grade students made for the question and the course. Other information might be submitted as well: demographic information on the students, and information about the program of study, or the college.

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APPENDIX

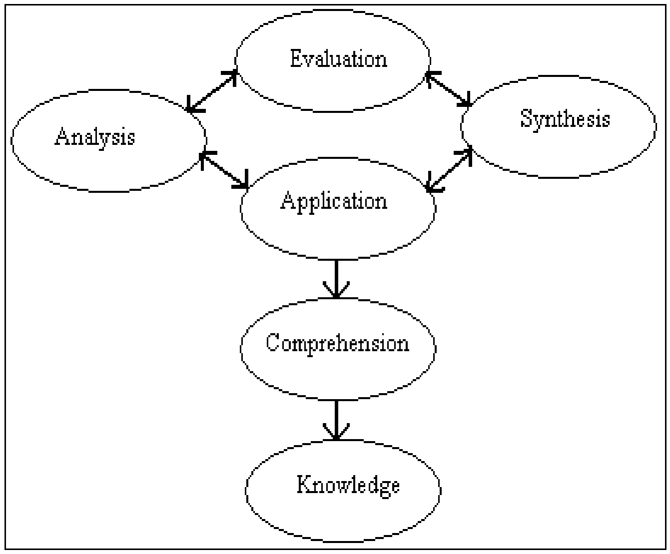


Figure 2 - Bloom's Cognitive Taxonomy

Table 1 – Tasks, Cues, Behaviors and Bloom's Taxonomy

	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Task	What are the components of software?	What is the role of software in an organization?	When does software fit a situation?	How does a specific piece of software work?	How does one build a specific piece of software?	When is high quality software produced?
Cues	acquire, attend, check, cite, count, delineate, duplicate, eliminate	account, alter, articulate, characterize, clarify, comprehend	access, action, adopt, answer, apply, assign, assist	abstract, analyze, apart, ascertain, associate, audit, blueprint	adapt, adjust, advise, animate, arrange, assemble, blend, budget, categorize	appraise, approve, argue, assess, attach, choose, compare, conclude, confirm, contrast, criticize
Behaviors	N/A	N/A	N/A	Examine, classify, categorize, research, contrast, compare, disassemble, differentiate, separate, investigate, subdivide	Combine, hypothesize, construct, originate, create, design, formulate, role-play, develop	Compare, recom-mend, assess, value, apprise, solve, criticize, weigh, consider, debate

Table 2 – Current Objectives of IFS305-Management Information Systems	
#	Course Objectives: The student will understand and be able to discuss the:
1	Importance of considering Management of Information Systems as the management of an integrated collection of subsystems.
2	Components of Information Systems and how they interact.
3	Conceptual foundations, structure and technology of Information Systems.
4	Planning and development involved in the implementation of an information system.
5	Use of information-based decision support systems within the overall MIS concept.
6	Role of Information Systems in support of management, users and functional area.
7	Implications and requirements of applying global information resources.
8	How e-commerce and emerging telecommunication technologies are utilized in various organizations and global enterprises.
9	Impact of security and ethical issues on MIS development and operations.

Table 3 – Revised Objectives of IFS305-Management Information Systems		
#	Bloom Level	Course Objectives: The student will be able to:
1	Analysis	Analyze Management Information Systems within a context of an integrated collection of subsystems.
2	Analysis	Categorize the components of information systems and differentiate how they interact.
3	Analysis	Classify the conceptual foundations, structure and technology of information systems.
4	Application	Apply planning and development techniques involved in the implementation of an information system, specifically a DSS.
5	Synthesis	Create an information-based DSS within an MIS supporting improved decision making and problem solving by means of improved individual insight.
6	Analysis	Research the role of Information Systems in support of management, users and functional areas.
7	Comprehension	Articulate the implications and requirements of applying global information resources.
8	Comprehension	Characterize how e-commerce and emerging telecommunication technologies are utilized in various organizations and global enterprises.
9	Comprehension	Articulate the impact of security and ethical issues on MIS development, operations and our daily lives.

Table 4 – DSS Tasks, Responses and Bloom's Taxonomy						
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
DSS Task	Define the components of DSS.	Summarize the role of DSS.	Apply a DSS tool to a specific problem.	Analyze and model the requirements of a DSS.	How does one develop a DSS?	How does one assess the quality of a DSS solution?
Response	Dialog, data and model.	Support for decision-making, and problem solving and structuring.	Hands on use of the Scenario Manager or the Solver.	Uses pseudo-code, DFD, and ERD.	In phases, in a team, iteratively, conducted with a computer.	Reviewing NPV or IRR.

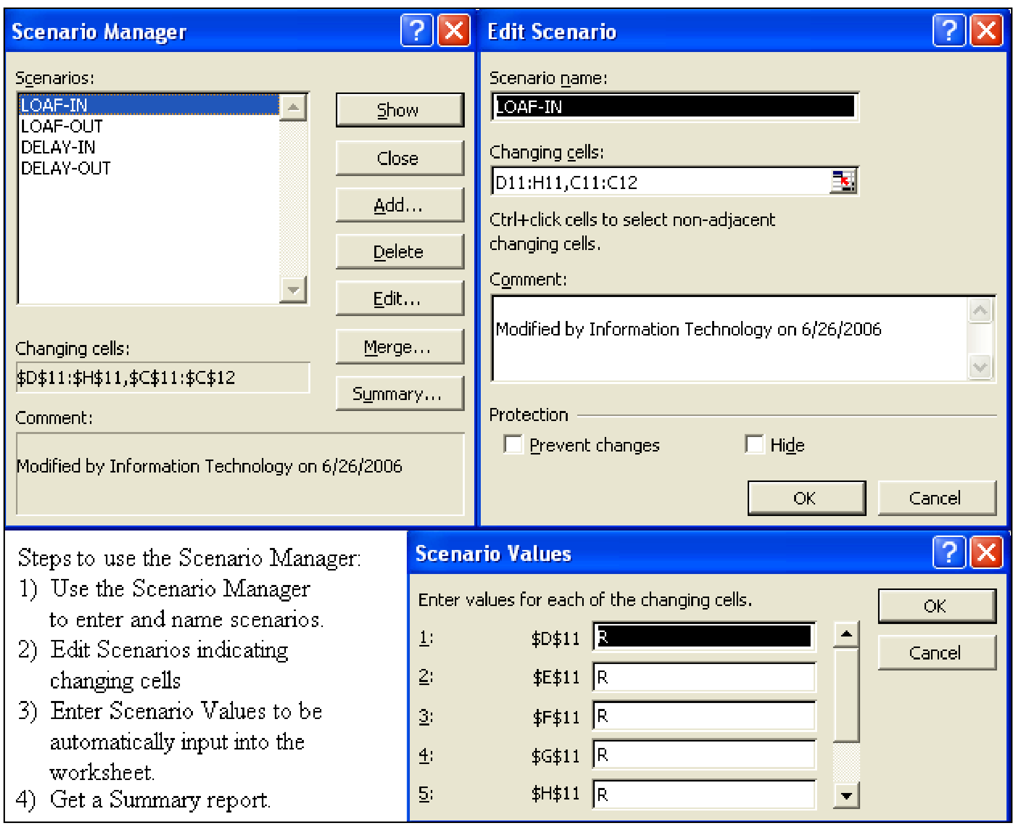
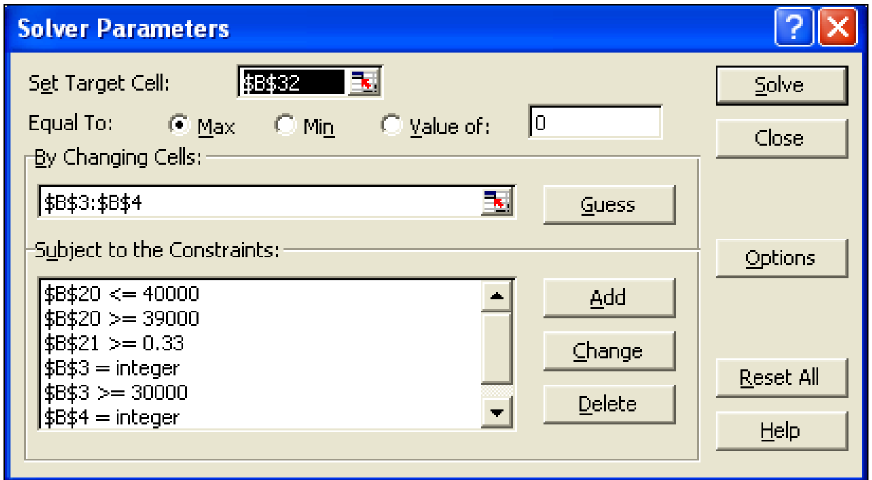


Figure 3 - Using the Scenario Manager



Steps to use the Solver:

1) Set a Target Cell to Maximize, Minimize or set to a Value.
2) Identify Changing Cells which the Solver will manipulate.
3) Enter Constraints or rules that the Solver obeys when manipulating the Changing Cells.
4) Solve the problem.

Figure 4 - Using the Solver