AN EXPERIMENTAL INVESTIGATION OF THE IMPACT OF CONFLICTING PROJECT GOALS ON STAFF RESOURCE ALLOCATION

by

Clinton L. Swett

June, 1995

Co-Advisors: Tarek Abdel-Hamid
Kishore Sengupta

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AN EXPERIMENTAL INVESTIGATION OF THE IMPACT OF CONFLICTING PROJECT GOALS ON STAFF RESOURCE ALLOCATION

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of the requirements for the degree of

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from the

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June 1995

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Department of Systems Management
ABSTRACT

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I. INTRODUCTION

A. BACKGROUND

The Department of Defense (DOD) spends big money each year on computer software. Currently, the Information Technology budget stands at nine billion and is under severe scrutiny while the backlog of required software continues to grow. It is thereby necessary to improve the efficiency of managing the software process.

Prior research suggests that programmers are goal driven. In a 1974 paper, (Weinberg and Schulman, 1974) showed that programming team performance is highly sensitive to given objectives. The paper showed that each team finished best with respect to the objective they were asked to optimize. The results also showed that none of the teams performed consistently well on all of the objectives. Two important conclusions have been drawn from this research. First, that programmers have very high achievement motivation. Second, that different software objectives are in conflict with each other.

B. PURPOSE OF RESEARCH

The purpose of this thesis is to design, develop, and conduct an experiment using the Systems Dynamic Model (SDM) of Software Project Management developed in (Abdel-Hamid and Madnick, 1991) to investigate whether managerial goals (i.e. schedule, cost, and quality) will also have a significant influence on managerial behavior and project outcome. Specifically, this research will investigate the impact of different schedule, cost, and quality goals on managerial decisions in allocating staff resources, and whether this leads to significant differences in project outcomes. Even though research has been conducted into the affect of goals on programmers in the Weinberg and Schulman experiment, no study on the affects of goals on project managers using this type of tool has been published.

C. SCOPE OF RESEARCH

The scope of this research is the design, construction, and conduct of an experiment using the Systems Dynamic Model of Software Project Management to
analyze the effects of conflicting goals on software project managers. The Systems Dynamics Model of Software Project Management will be used to simulate the programming phase of an actual software project. Graduate students, representing software managers, will be divided into four groups and will be asked to make staffing decisions for their project every 40 days throughout the programming phase of the project life cycle.

The four groups represent different combinations of project size and goal sets and will be designated as groups A1, A2, B1, and B2. The letter will indicate the project to be managed. Project A will be initially underestimated in size and grow throughout the programming phase. Project B will be initially overestimated and will decrease in size throughout the programming phase. The number indicates the goal set. Goal set 1 is cost and schedule. Goal set 2 is quality and schedule.

Data will be collected on several dependent variables after each 40 day period. This data will then be statistically analyzed to determine differences in decision making performance among the groups. The experiment will seek to investigate the following research questions: 1. What degree of influence do project goals have on a software project manager’s staffing decisions? 2. How will a project manager allocate resources in both constrained and relaxed resource environments?

D. LIMITATIONS

The participants for this experiment were graduate students in their fifth quarter of an eight quarter graduate program leading to a MS degree in Information Technology Management at the Naval Postgraduate School in Monterey, California. Although these students are not actual software managers, they have received extensive education in software design and management. Their experience as managers in a myriad of military specialities to date lends credibility to the assumption that the results would be representative of the software industry. This assumption is further supported by the findings of William Remus. (Remus, 1986)
E. THESIS ORGANIZATION

Chapter II describes the required software files, and design of the documentation, as well as the design considerations taken into account during the creation of the experiment. Chapter III describes the experimental tasks, characteristics, organization, methodology, and experimental group. Chapter IV analyses the results. Chapter V summarizes the accomplishments and findings and provides suggestions for further research.
II. PREPARATION OF THE EXPERIMENTAL INTERFACE

A. EXPERIMENTAL DESIGN

The Systems Dynamic Model of Project Management enables the conduct of controlled software management experiments. Depending on the interface used, the model can be used to simulate any or all aspects of a software management project, similar to a flight simulator mimicking any particular type of flight environment. Although the model is capable of simulating any phase of the software development life cycle, in this experiment, the system only mimics the development phase of a software project. That is, the period from the completion of the design phase to the beginning of the testing phase. The player, or subject, plays the role of manager of a software project. Prior to starting the game, the subject is given an instruction sheet that includes a specific goal set.

Two separate project scenarios were constructed to investigate decisions under both relaxed and constrained resource environments. Project A’s initial size was underestimated while Project B’s size was initially overestimated. For each project, two goal combinations were used for experimental analysis. All combinations contained the element of schedule, for without a schedule constraint, dysfunctional behavior would be invited. Figure 2-1 is a matrix that depicts the goal and project combinations.

<table>
<thead>
<tr>
<th>Cost and Schedule</th>
<th>Quality and Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project A</td>
<td>A11</td>
</tr>
<tr>
<td>Project B</td>
<td>B11</td>
</tr>
</tbody>
</table>

Figure 2-1 Project/Goal Numbering Scheme

1. Cost and Schedule Goal Set

The first goal set is cost and schedule. “Cost and Schedule” was given the number 11. The identical goal set stated in the reverse order as “Schedule and Cost” is given the number 12. For example, goal A11 is stated as “Minimize overruns in both cost and schedule.” Goal A12 is stated as ”Minimize overruns in both schedule and cost.”
Appendix J contains the specific phrasing for the eight project/goal combinations.

2. Quality and Schedule Goal Set

The second combination is Quality and Schedule and is numbered 21. The identical goal set stated in the reverse order as Schedule and Quality is numbered 22. When this number is combined with the specific project the result is a three character alphanumeric that denotes the Project, Goal Set, and the Goal Order. For example, B12 denotes: Project B that decreases in size, Goal 1 of Cost and Schedule, and Order 2 that changes the ordering of the goal set to Schedule and Cost.

3. Experimental Groups

The experimental population had no previous experience with the SDM model. In order to prepare the subjects in running the simulation, each subject received a classroom lecture where the interface was demonstrated. During this period the subjects were told that the experiment was “very real.” For example, they understood that hiring delays, turnover, transfers, work force ceilings, and training delays would all affect the actual workforce number. After this training session, each subject performed a practice session named “TOY.” Toy was a benign environment that had no specific goal other than to familiarize the subject with the experiment. The project that was managed remained constant in size. The purpose of the training session was to alleviate any unfamiliarity, or discomfort with the gaming interface and to provide a constant level of experience across the experimental group.

4. Independent and Dependent Variables

Each subject made four inputs at each interval throughout the experiment. They were the total workforce requested, the percent of this workforce dedicated to quality assurance activities, the estimated cost to complete the programming phase, and the estimated programming phase duration. The ten project outcome variables shown in Figure 2-2 were captured at the end of the project simulation.
<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>FNCOST</td>
<td>Final Cost (in Man Days)</td>
</tr>
<tr>
<td>FNTIME</td>
<td>Final Cumulative Time (Days)</td>
</tr>
<tr>
<td>FNERR</td>
<td>Final Errors Remaining Undetected</td>
</tr>
<tr>
<td>FNERG</td>
<td>Final Cumulative Errors Generated</td>
</tr>
<tr>
<td>FNERD</td>
<td>Final Cumulative Errors Detected</td>
</tr>
<tr>
<td>FNERES</td>
<td>Final Cumulative Errors Escaping Detection</td>
</tr>
<tr>
<td>FNPRDT</td>
<td>Final Percentage of Errors Detected</td>
</tr>
<tr>
<td>FNQAMD</td>
<td>Final Cumulative Quality Assurance Man Days</td>
</tr>
<tr>
<td>FNRTRMD</td>
<td>Final Cumulative Training Man Days</td>
</tr>
<tr>
<td>FNRWMD</td>
<td>Final Cumulative Rework Man Days</td>
</tr>
</tbody>
</table>

Figure 2-2 Project Outcome Variables

In addition, at each decision point in the simulation (i.e. every 40 days) 27 variables were automatically captured by the software. These variables include the four decisions made by the subject plus the process variables on the specific type of report or graph that was viewed by the subject and the length of time that the information was presented on the screen.

B. SOFTWARE AND DOCUMENTATION

In order to conduct the experiment, there were three distinct efforts in the design of the components. The software interface for the experiment, the instructions for its use, and the questionnaire to be completed at the end of the experiment. The subjects input their decisions into the computer and also wrote them on the documentation sheet to provide a failsafe should there be any computer problems.

The SDM and its associated interface includes many Dynamo executable files as well as Dynex and other programs written in C code. The conduct of the experiment initially requires 28 files on the subject’s floppy disk. The files that appear in Figure 2-3 are necessary to start and run the simulation.
<table>
<thead>
<tr>
<th>FILENAME</th>
<th>SIZE (bytes)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAT.COM</td>
<td>36,018</td>
<td>EBL Batch file Enhancement Language</td>
</tr>
<tr>
<td>CAPTURE.EXE</td>
<td>13,751</td>
<td>Works with TIMESTAMP.EXE</td>
</tr>
<tr>
<td>DYNEX.EXE</td>
<td>67,833</td>
<td>Dynamo executable (Executes *.DNX files)</td>
</tr>
<tr>
<td>START.BAT</td>
<td>205</td>
<td>Begins the Experiment, copies files to hard disk</td>
</tr>
<tr>
<td>INIT.EXE</td>
<td>12,545</td>
<td>C Language file that writes SUBINFO file</td>
</tr>
<tr>
<td>INTERVAL.DRS</td>
<td>62</td>
<td>Report that contains current interval day</td>
</tr>
<tr>
<td><a href="mailto:PRO@.DNX">PRO@.DNX</a></td>
<td>7,824</td>
<td>Instructions that create interface</td>
</tr>
<tr>
<td><a href="mailto:PRO@.RSL">PRO@.RSL</a></td>
<td>1,099</td>
<td>Results file of all experiment data</td>
</tr>
<tr>
<td><a href="mailto:PRO@.STT">PRO@.STT</a></td>
<td>2,476</td>
<td>Temporary storage file of user inputs</td>
</tr>
<tr>
<td>FINISH.BAT</td>
<td>28</td>
<td>Ends the experiment, copies files back to floppy</td>
</tr>
<tr>
<td>DEF.DRS</td>
<td>1,282</td>
<td>Report Specification, Defect Report</td>
</tr>
<tr>
<td>DEFPLOT.DRS</td>
<td>168</td>
<td>Report Specification, Defect Graphs</td>
</tr>
<tr>
<td>REP.EXE</td>
<td>95,312</td>
<td>Report generation executable, reads *.drs files</td>
</tr>
<tr>
<td>SMLT.EXE</td>
<td>101,877</td>
<td>Simulation Executable</td>
</tr>
<tr>
<td>STAFFING.DRS</td>
<td>624</td>
<td>Report Specification, Staffing Report</td>
</tr>
<tr>
<td>STAFFPLOT.DRS</td>
<td>147</td>
<td>Report Specification, Staffing Graphs</td>
</tr>
<tr>
<td>STATPLOT.DRS</td>
<td>177</td>
<td>Report Specification, Status Report</td>
</tr>
<tr>
<td>STATUS.DRS</td>
<td>1,430</td>
<td>Report Specification, Status Graphs</td>
</tr>
<tr>
<td>TIMESTAMP.EXE</td>
<td>8,667</td>
<td>Captures number of seconds a report was in view</td>
</tr>
<tr>
<td>PERFORM.DRS</td>
<td>166</td>
<td>Writes 10 dependent variables at project end</td>
</tr>
<tr>
<td>PROCESS.DRS</td>
<td>350</td>
<td>Writes 27 variables at each decision interval</td>
</tr>
<tr>
<td><a href="mailto:PROJECT@.BAT">PROJECT@.BAT</a></td>
<td>6,600</td>
<td>Overall batch control file</td>
</tr>
<tr>
<td>PROCESS.EXE</td>
<td>12,419</td>
<td>Combines subject &amp; process with decision data</td>
</tr>
<tr>
<td>PERFORM.EXE</td>
<td>12,079</td>
<td>Combines subject with final performance data</td>
</tr>
<tr>
<td><a href="mailto:PROJ@.INS">PROJ@.INS</a></td>
<td>5,798</td>
<td>Dynamo required simulation file</td>
</tr>
<tr>
<td><a href="mailto:PROJ@.DAT">PROJ@.DAT</a></td>
<td>1,348</td>
<td>Dynamo required simulation file</td>
</tr>
<tr>
<td><a href="mailto:PROJ@.SMT">PROJ@.SMT</a></td>
<td>7,620</td>
<td>Dynamo required simulation file</td>
</tr>
</tbody>
</table>

**Figure 2-3** Initial Experiment Simulation Files
After the simulation is complete there will be 18 additional files created during the run. The additional files appear in Figure 2-4. The files with the extension of .DAT append throughout the experiment. These files must not be on the disk at the beginning or the previous data will contaminate the results.

<table>
<thead>
<tr>
<th>FILENAME</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBINFO</td>
<td>The User's name, SMC, Project, Goal, Instruction Set</td>
</tr>
<tr>
<td>ERRORS</td>
<td>Created by Dynamo to hold error messages</td>
</tr>
<tr>
<td><a href="mailto:PROJ@.WAS">PROJ@.WAS</a></td>
<td>The previous <a href="mailto:PROJ@.CHG">PROJ@.CHG</a></td>
</tr>
<tr>
<td><a href="mailto:PROJ@.CHG">PROJ@.CHG</a></td>
<td>Holds changes since last <a href="mailto:PROJ@.OUT">PROJ@.OUT</a></td>
</tr>
<tr>
<td>TIME.TMP</td>
<td>Last clock time (used with TIMESTAMP.EXE)</td>
</tr>
<tr>
<td>CAPTURE.DAT</td>
<td>Historical data of screens viewed *</td>
</tr>
<tr>
<td>PROCESS.DAT</td>
<td>Historical data set of variables *</td>
</tr>
<tr>
<td>ERRORS.OUT</td>
<td>Historical errors generated by TIMESTAMP.EXE</td>
</tr>
<tr>
<td>PERFORM.DAT</td>
<td>Final performance data written at project finish *</td>
</tr>
<tr>
<td>*.OUT</td>
<td>Copy of all reports generated by REP.EXE (9 total if all are viewed)</td>
</tr>
</tbody>
</table>

* MUST BE DELETED

Figure 2-4 Files Created During the Experiment

1. Overall Description of System's Architecture

Figure 2-5 is the structure chart of the experiment's software. The main module is PROJECT@.BAT and appears in Appendix A. All of the programs are initially called by the PROJECT@.BAT file. Through the remainder of this thesis, the "@" symbolizes either an A, or B depending on the project in reference. TOY.BAT operates similarly and appears as Appendix B.
Figure 2-5 Structure Chart of Experiment's Software
a. Experiment Initialization

The experiment starts when the subject types START at the B:\ prompt. At this time START.BAT creates a subdirectory on the subject’s computer named C:\SWPROJ. START.BAT then copies the 28 initial files to this directory and calls PROJECT@.BAT (or TOY.BAT for the practice experiment).

PROJECT@.BAT calls INIT.EXE and passes it three parameters; Project, Goal, and Instruction Set. INIT.EXE prompts the subject for their name and Student Mail Center (SMC) number. INIT.EXE then formats and writes this information to the file named SUBINFO. PROJECT@.BAT then calls GRAPHICS.COM. This program is loaded memory resident and is required to display graphical menu information throughout the experiment. Extended Batch Language Plus (BAT.COM) is then loaded to allow a more diverse set of programming constructs than is available through the DOS batch file language. RAM.COM then loads memory resident to speed screen writes throughout the experiment. The preliminary modules necessary to run the repetitive portion (40 day simulation intervals) of the experiment have now been executed.

b. Main Routines

SMLT.EXE is first called to initialize the Dynamo files to day zero. Subsequent calls to SMLT.EXE will happen every 40 days until the project is completed. SMLT.EXE is the Dynamo program that performs the actual simulation calculations. It reads the PROJECT@.STT file and writes the results to the file called PROJECT@.RSL. The PROJECT@BAT file then prompts the user for their first decisions and then displays the decision menu. The user has six menu selections available that will generate either a report or graph. Selecting one of the first six items will invoke the following sequence of operations: TIMESTMP.EXE will record the current time from the system clock and write this time to TIME.TMP. Next, REP.EXE is called and passed the appropriate *.DRS file depending on the menu item selected. All of the *.DRS files appear as Appendices D, E, F, and G. For example, selecting the Status Report will cause STATUS.DRS to be passed to REP.EXE. The *.DRS file serves as a report format in
which to read the PROJ@.RSL file previously written by SMLT.EXE. The PROJ@.RSL file contains the cumulative results of all variables throughout the entire experiment. The output is both sent to the display and saved as the file named *.OUT. When the subject is finished viewing the report or graph, control is returned to PROJECT@.BAT where CAPTURE.EXE is passed the report or graph identifier. CAPTURE.EXE reads the current time from the system clock and subtracts the time previously recorded in TIME.TMP to calculate the total viewing time that the report was displayed on the screen. This information is joined with the information in SUBINFO and appended to the file named CAPTURE.DAT. The subject can select as many reports or graphs as deemed necessary to assimilate all of the project information. When satisfied, the subject presses “P” to proceed with the next 40 day interval.

Upon pressing “P” PROCESS.EXE is called to perform data manipulation and recording. PROCESS.EXE combines the subject’s information from SUBINFO with the period that was recorded in INTERVAL.OUT. This information is merged with the current data residing in PROCESS.OUT and appended to the file PROCESS.DAT.

To complete the main routines, DYNEX.EXE is called and passed the appropriate PROJ@.DNX file. PROJ@.DNX appears as Appendix C and contains the prompting for the four independent variables WFS2, FRMPQ1, JBSZMD, FRMPQ1. Appendix O contains the full description of the variables. DYNEX.EXE, by executing the PROJ@.DNX commands, displays the current value of the variables and allows the subject to change and verify the new value. When satisfied, the user presses <ENTER>, PROJ@.STT is written, and the user is returned to the PROJECT@.BAT main menu. This sequence is repeated until the subject reaches project completion.

c. Experiment Finalization

The subjects were instructed to call the lab attendant when the project was complete. To finish the experiment and capture all of the recorded data the lab attendant pressed the <CONTROL> and <Q> keys simultaneously. This first invokes one last call to REP.EXE with PERFORM.DRS being passed. The resulting file is PERFORM.OUT.
PERFORM.EXE is then invoked and joins the contents of SUBINFO with PREFORM.OUT. The result is written to the file PERFORM.DAT. Finally, FINISH.BAT is called to copy the entire contents of C:\SWPROJ back to the B:\ drive where the disk was removed from the computer and retained by the lab attendant.

2. Files Critical to Experiment Operation

Appendix H contains the source code for all of the routines necessary to capture the experimental data. File names with the .C extension are written in the C language. START.BAT and FINISH.BAT are not shown in the structure chart but were previously discussed.

3. Documentation

The documentation was considered critical to the experiment's success. The documentation for the experiment was in three parts. The first portion was termed the “Instruction Set” and contained the instructions that were specific to each experimental group. Each subject also received a copy of the “Description of the Simulation Interface.” This document contained general instructions to operate the interface, i.e. view reports and graphs, and was distributed to each subject in their envelope at the beginning of both the Toy and Actual experiments. These two documents and the accompanying disk were placed in a large manilla envelope for each subject. The third part was the Project Questionnaire. The questionnaire was completed by each subject at the end of the actual experiment.

4. Instruction Set

The instruction set distributed to the subjects with project/goal/order A11 appears as Appendix I. Each combination was created from the Master Instruction Set that appears as Appendix J. The text contained between brackets in Appendix J contains instructions to the experiment designer on how to properly cut and paste the appropriate verbiage for each project/goal/order set. There were a total of nine different sets of instructions created. One for the practice experiment, and one for each of the eight project/goal/order combinations.
5. Description of the Simulation Interface

The Description of the Simulation Interface appears as Appendix K. This document’s intent was to help the subjects familiarize themselves with the user interface. The handout included an example of all of the reports and graphs available to the user between project intervals. A short description of the information was also included. This information was distributed prior to both the practice and actual experiments. All participants received the same information. A second (identical to the first) copy was distributed to participants for the actual experiment. This was to prevent any note taking or recording of formulas that might skew the experiment results.

6. Project Questionnaire

Two versions of the Project Questionnaire were developed. The composite version appears as Appendix K. Each questionnaire had either a X1X or X2X in the upper right hand corner. X1X denotes that Question 1 would ask for the percentages concerning cost and schedule. X2X asked for percentages concerning quality and schedule. All other questions were identical. The questionnaires were not included in the envelope that each subject received prior to conducting the experiment, but were retained by the lab attendants and distributed to the subjects at project completion. The questionnaires served to both gather demographic data on the subjects, and collect feedback concerning the conduct and performance of the experiment.

C. TEST EXPERIMENT

In order to validate the user interface, pilot experiments were conducted with seven subjects. The pilots were conducted at three separate sittings, allowing time to incorporate their suggestions between the sessions. Numerous incremental improvements were implemented concerning clarity and organization of the report and graph screens. Particular attention was paid to the scaling of the graphs. Every attempt was made to not “lead” the subject’s decisions by a too constrictive or too exaggerated scale being placed on a graph. A thorough scrubbing of the instructions was also accomplished concerning ease of understanding and organization.
D. FINAL PREPARATIONS

Having completed the interface design, documentation, and follow-up questionnaire, seven copies of each of the eight project disks were made. 25 copies of the follow-up questionnaire were made for both goal set 1 and 2. Individual envelopes were prepared for each participant and their name written on the outside. Signs were prepared and posted on the doors to both labs the evening before to prevent nonparticipants from entering the lab during the conduct of the experiment.
III. CONDUCT OF THE EXPERIMENT

A. TASKS AND PROJECT CHARACTERISTICS

Having completed the PRACTICE experiment, all of the participants were given an additional opportunity to ask questions prior to the actual experiment. Some questions were answered concerning whether there was any incentive to finish ahead of schedule. In response to these questions, the participants were told the project that they were managing was a portion of a larger project. Finishing their portion early would put them “out of sync” with the larger project and result in dead time for their staff. This left no questions that there was no reward for gross over staffing or other dysfunctional behavior in order to finish early.

The participants were reminded that they were to work alone and not to discuss anything with anyone other than the lab attendant. All participants were told that their performance on the experiment would be incorporated into their class participation portion of the grade for IS-4300.

B. ORGANIZATION OF THE EXPERIMENT

The introduction to the actual experiment consisted of a 15 minute training session in which each participant was given their personal envelope and informed of its contents. The experimental guidelines were reviewed for the last time. A seating chart was distributed to each subject and appears as Appendix N. All of the computers were checked prior to the experiment and making the seating assignments. None of the students with similar goals were seated next to each other. As noted in the appendix, several machines had mechanical problems and were not used. An opportunity was provided to settle any last minute questions before the participants were directed to the lab.

The size of the experimental group required that two separate sessions, each session split in half and distributed across two labs simultaneously. A lab assistant was present in each lab to ensure compliance with the seating chart and to provide general
guidance throughout the experiment. Lab assistants had special copies of the seating chart that also indicated the project/goal of each participant. This was done in the event that any subject's computer might malfunction creating the need for reassignment. Although not necessary in the actual assignment, with this information the lab assistant could ensure that no subjects with the same project/goal would be seated next to each other when reassigned. Both lab assistants also maintained the copies of the project questionnaire to be distributed to the subjects at the completion of the experiment. The experiment designer served as the lab assistant in one lab and made periodic checks with the other lab attendant to ensure that all of the subject's concerns were being handled uniformly between the labs. The same persons served as lab attendants in both the morning and afternoon sessions. Both experimental groups were started at the same time. No information was given to the subjects on how to calculate staffing levels or how to interpret the reports. Both lab assistants had readily at hand, spare disks for each of the eight project configurations, and had back-up copies of all of the documentation. The entire experiment was conducted within one day. All subjects were completed with the experiment within two hours.

C. THE EXPERIMENTAL SUBJECTS

The subjects in this experiment were students from two sections of the Software Engineering and Management course, IS-4300, taught at the Naval Postgraduate School. Section one consisted of 25 students, section two had 24 students. The groups were randomized and assigned to each of the eight project/goal sets in the following manner.

1. Random Number Assignment

Students in the two sections were listed sequentially in the order that they appeared on the registration roster as shown is the first portion of Appendix M. The first column is the sequential list of the 49 students. A standard list of random numbers was chosen (Daniel, 1975). The last three digits were used. Random numbers were assigned sequentially to each subject in the second column of the Appendix.
2. Project Assignment

The subjects were then sorted by their random number and appear as the second portion of Appendix M. Now that the subjects were in a random order, each was assigned a project in sequence. The projects were assigned in the order of A11, A12, A21, A22, B11, B12, B21, B22. Robinson, whose number was the highest at 978 was initially not assigned a project. Without Robinson, each group was balanced with 6 subjects each. Robinson was to be assigned to any project in the event of one of the other subjects was not present on the day of the actual experiment. All of the subjects were present however, and Robinson was assigned the next project in sequence, A11.

D. DEPENDENT MEASURES

Ten performance variables were captured at the completion of the experiment. Of these, three are the most indicative of project performance and will be used as the dependent variables. The first of these is Final Cost, FNCOST. (See appendix O for the key to deciphering variable names). FNCOST is the cost in person days expended to complete the project.

The second dependent variable is the Final Time. FNTIME is the day that the project was completed. All subjects had the goal of completing the project within the estimated time and were reminded that there was no incentive to finish early.

The third, and last dependent variable is FNERR. FNERR is the value indicating the number of cumulative errors remaining in the software at project completion. This value indicated the quality of the software, i.e. fewer errors indicating higher quality software.
IV. EXPERIMENTAL RESULTS AND ANALYSIS

A. MODEL OF ANALYSIS

For each subject, the raw data produced by this experiment was written to three files. The data concerning the final results of the experiment was captured to the file named PERFORM.DAT. Data was also captured at each decision interval (40 days) and written to the file called PROCESS.DAT. Between each interval, when the subjects were viewing reports and graphs, data was captured on the length of time and type of information that was being viewed. This data was written to the file named CAPTURE.DAT. The three data sets appear as Appendices P, Q, and R respectively.

Analysis of this data was conducted using Statistical Analysis System (SAS) software. Specifically, three procedures within the software were used. Procedure MEANS, was used to determine the means and significance. Procedure General Linear Model (GLM) was used for multi variate analyses due to the unequal populations within project groups. Procedure Correlation (CORR) was used to detect any correlation between independent and dependent variables. The SAS program files appear as Appendix S.

B. PROJECT A

Data was recorded on each participant throughout the project. At project completion, ten final performance variables were recorded in the file named PERFORM.OUT. A full description of the variable names appears in Appendix O. The file format appears in Appendix H. Analysis was performed on these ten variables to determine if there were significant differences between the two project groups.

1. Performance Data

The analysis of each subject’s performance focused on three dependent variables, namely FNCOST, FNSKED, and FNERR. Project A1 subject’s goals are cost and schedule. Project A2's goals are quality and schedule. Figure 4-1 depicts the means and the standard deviations for the performance variables in project A.
a. Schedule

The time taken to complete the project was recorded in the variable named FNSKED. There was no statistical difference between groups with respect to FNSKED. The null hypothesis cannot be rejected \((F(1,23)=1.28; P<0.2688)\). This is not surprising as both groups had schedule as a goal.

b. Cost

The final cost of the project was recorded in the variable named FNCOST. The units of FNCOST are person-days. Within project A, only group 1 had the goal of minimizing cost. The average cost to complete the project for goal 1 was significantly lower than goal 2. Thus the null hypothesis is rejected with respect to FNCOST \((F(1,23)=16.39; P<0.0005)\).

c. Quality

The final errors remaining in the project at completion were recorded in the variable named FNERR. Within project A, only goal 2 contained quality. The average number of final errors was significantly lower in group A2, thereby rejecting the null hypothesis with respect to FNERR \((F(1,23)=12.81; P<0.0016)\).

<table>
<thead>
<tr>
<th></th>
<th>FNSKED</th>
<th>FNCOST</th>
<th>FNERR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[in Days]</td>
<td>[in Person Days]</td>
<td># Errors</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>(Std. Dev)</td>
<td>(Std. Dev)</td>
<td>(Std. Dev)</td>
</tr>
<tr>
<td>Goal 1 - Cost and Schedule</td>
<td>297 (45)</td>
<td>1500 (165)</td>
<td>1591 (805)</td>
</tr>
<tr>
<td>Goal 2 - Quality and Schedule</td>
<td>319 (55)</td>
<td>1963 (375)</td>
<td>742 (166)</td>
</tr>
</tbody>
</table>

**Figure 4-1** Means and Standard Deviations for Project A

The results show that goals do matter. Each group performed significantly better in their unique goal. The performance of both groups showed no statistical difference with respect to the common goal, schedule.

22
2. Process Data

The subjects were required to make four decisions at each 40 day interval. The first decision was to select the total staffing level. This value was captured in the variable WFS2. The second decision was to allocate a percent of this staff to quality assurance activities. This value was captured in the variable FRMPQ1. The two additional decisions are estimates of the project's final cost and completion time. These decisions were captured in the variables JBSZMD and SCHCDT respectively. Appendix N contains the key to deciphering the variable names. All decision variables were written to the file named PROCESS.DAT.

The actual completion time of the project was dependent on the particular decisions made by the manager. In graphing the group means of the process data, the last interval shown for Project A is 240 days. This is the last interval in which all of the subjects had not completed the project and were still making decisions.

Three types of analyses were conducted on the means of the process data. The first was to determine if there is a period effect, i.e. the values changed over time. Next, the data was analyzed to determine if there was interaction between the groups with different goals. Lastly, analysis was conducted to determine if there was significant difference between subjects.

a. Total Staff

Figure 4-2 is a graph of the group means for total staff requested by subjects managing Project A. The analysis of the means as shown in the graph indicates that there is a period effect. The null hypothesis for no period effect is rejected with respect to WFS2 (F(6,18)=3.26; P<0.0239). The null hypothesis for interaction however, cannot be rejected due to the large standard deviation (F(6,18)=0.72; P<0.3704). The test for difference between groups indicates that the null hypothesis cannot be rejected, indicating that there is no significant difference between subjects with different goals (F(1,23)=2.84; P<0.1057).
Figure 4-2 Total Staff Requested for Project A.

b. Quality Assurance

Figure 4-3 is a graph of the percent of the total workforce allocated to quality assurance activities. The graph indicates that there is no period effect with respect to FRMPQ1. The null hypothesis cannot be rejected (F(6,18)=1.8459; P<0.1464). The test for interaction between groups over time also fails to reject the null hypothesis that there is interaction between goal groups (F(6,18)=1.0016; P<0.4543). Between subjects analysis does not reject the null hypothesis indicating that there is not significant difference between goals (F(1,23)=1.002; P<0.4543).
Figure 4-3 Percent of Requested Staff Allocated to QA for Project A

c. Cost Estimates

Figure 4-4 depicts the estimate for total project cost at for the subjects that managed Project A. The graph shows a strong time effect for the subject’s cost estimate, rejecting the null hypothesis with respect to JBSZMD (F(6,18)=9.27; P<0.0001). There is no interaction between groups (F(6,18)=.0652; P<0.7229). The between subjects analysis indicates that there is not a significant difference between goals over time. Therefore, there is no significance between groups with respect to JBSZMD (F(1,23)=2.65; P<0.1174).
Figure 4-4 Estimated Completion Cost for Project A

d. Schedule Estimates

Figure 4-5 illustrates the subject's estimated project schedule as the project progressed. Analysis for period effect shows that the null hypothesis of no period effect can be rejected with respect to SCHCDT (F(6,18)=3.0713; P<0.0300). There is no significant interaction between groups (F(6,18)=1.8736; P<0.1410). The null hypothesis for no between subjects effects also cannot be rejected (F(1,23)=2.18; P<0.1530).
Figure 4-5 Estimated Schedule for Project A

C. PROJECT B

1. Performance Data

Project B1 subject’s goals are cost and schedule. Project B2’s goals are quality and schedule. The time required to complete the project was recorded in the variable named FNSKED. Figure 4-6 indicates an abnormally high standard deviation for FNSKED. This was due to subject number 26 as indicated in Appendix P. Subject 26 allotted zero staff to quality assurance activities in order to obtain the absolute minimum cost. This subject is more than three standard deviations from the mean with respect to FNERR. Figure 4-6 depicts the means and the standard deviations for the final determinate variables in project B when subject 26 is included in the data set.
<table>
<thead>
<tr>
<th></th>
<th>FNSKED {in Days} Mean (Std. Dev)</th>
<th>FNCOST {in Person Days} Mean (Std. Dev)</th>
<th>FNERR {# Errors} Mean (Std. Dev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 1 - Cost and Schedule</td>
<td>247 (28)</td>
<td>1702 (212)</td>
<td>2080 (2422)</td>
</tr>
<tr>
<td>Goal 2 - Quality and Schedule</td>
<td>254 (28)</td>
<td>1983 (237)</td>
<td>1006 (481)</td>
</tr>
</tbody>
</table>

**Figure 4-6** Means and Standard Deviations for Project B with Subject 26

Figure 4-7 depicts the means and the standard deviations for the final determinate variables in project B when subject 26 is removed from the data set.

<table>
<thead>
<tr>
<th></th>
<th>FNSKED {in Days} Mean (Std. Dev)</th>
<th>FNCOST {in Person Days} Mean (Std. Dev)</th>
<th>FNERR {# Errors} Mean (Std. Dev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 1 - Cost and Schedule</td>
<td>245 (28)</td>
<td>1751 (133)</td>
<td>1396 (540)</td>
</tr>
<tr>
<td>Goal 2 - Quality and Schedule</td>
<td>257 (28)</td>
<td>1983 (237)</td>
<td>1006 (481)</td>
</tr>
</tbody>
</table>

**Figure 4-7** Means and Standard Deviations for Project B deleting Subject 26

**a. Schedule**

The SAS programs were rerun with subject 26 removed from the data set. This analysis of FNSKED shows that there is no statistical difference between groups. The null hypothesis is not rejected. (F(1,21)=.78; P< 0.4079)

**b. Cost**

The final cost of the project was recorded in the variable named FNCOST. The units of FNCOST are person-days. Again, only subjects with goal 1 were to minimize cost. The average cost to complete the project was significantly lower, thereby rejecting the null hypothesis (F(1,21)=8.15; P< 0.0095).
c. **Quality**

The final errors remaining in the project at completion were recorded in the variable named FNERR. Group B2 had the goal of producing quality software. Although the average number of final errors was lower, there is a weak significance. The null hypothesis could not be safely rejected as in the previous project ($F(1,21)=3.36; P<0.0810$).

2. **Process Data**

The requested total staffing levels for Project B including subject 26 are depicted in figure 4-8. The results were the same with subject 26 removed from the data set. The subjects with goal 2 maintained higher workforce levels throughout the project.

a. **Total Staff**

The graph indicates that there is a period effect with respect to WFS2. The null hypothesis is rejected ($F(5,18)=4.8165; P<0.0057$). The test for interaction between groups over time does not reject the null hypothesis indicating there is no interaction between goal groups ($F(5,18)=1.576; P<0.2171$). Between subjects analysis rejects the null hypothesis indicating that there is a significant difference between goals ($F(1,22)=4.22; P<0.0520$).
Figure 4-8 Total Staff Requested for Project B

b. Quality Assurance

Figure 4-9 depicts the percent of the requested workforce allocated to quality assurance activities for project B. The graph indicates that there is also a period effect with respect to FRMPQ1. The null hypothesis is rejected (F(5,18)=3.9476; P<0.0136). The test for interaction does not reject the null hypothesis indicating no interaction between goal groups (F(5,18)=0.9534; P<0.4714). Between subjects analysis rejects the null hypothesis indicating that there is significant difference between goals (F(1,22)=9.52; P<0.0054).
Figure 4-9  Percent of Requested Staff Allocated to QA for Project B

c. Cost Estimates

Figure 4-10 depicts the estimate for total project cost at completion for the subjects that managed Project B. There is no indication of period effect with respect to JBSZMD. The null hypothesis is not rejected (F(5,18)=1.3381; P<0.2932). The test for interaction does not reject the null hypothesis indicating no significant interaction between goal groups (F(5,18)=1.5331; P<0.2292). Between subjects analysis indicates that there is a slight significant difference between goals (F(1,22)=3.02; P<0.0947).
Figure 4-10 Estimated Completion Cost for Project B

d. Schedule Estimates

Figure 4-11 illustrates the subject’s estimated project schedule as the project progressed. Analysis for period effect shows that the null hypothesis of no period effect is not rejected with respect to SCHCDT (F(5,18)=1.5829; P<0.2152). There is no significant interaction between groups (F(6,18)=0.8939; P<0.5059). Between subjects effects do not reject the null hypothesis indicating no significant difference between groups (F(1,22)=0.68; P<0.4188).
Figure 4-11 Estimated Schedule for Project B

D. QUESTIONNAIRE AND DEMOGRAPHIC DATA

1. Sample Profile

The population exhibited some interesting demographics. The mean age of the subjects was 33.7 years. On average, the subjects had 12 years of work experience and had completed their undergraduate education 10.3 years ago. Not surprisingly, the subjects spend about 15.3 hours per week using a computer. The mean grade for the IS-4300 course was 3.45 grade points.

2. Correlations with the Results

SAS correlations were run to determine if any sample demographics were correlated with the experiment results. None of the population demographics were significantly correlated. In particular, the course grade for IS-4300 showed no significance for any of the project groups. Slight correlations were found between some of the determinate variables and the population demographics.

   a. Project A1

   Figure 4-12 indicates the correlations and (significance) for Project A goal 1 for the variables age, computer hours per week, work experience, years ago
undergraduate education completed, and grade in the IS-4300 course. A slight significance in the correlation between EDAGO and FNSKED can be seen.

<table>
<thead>
<tr>
<th></th>
<th>AGE</th>
<th>CHRSWK</th>
<th>WKEXP</th>
<th>EDAGO</th>
<th>GRADE</th>
</tr>
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<tbody>
<tr>
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<td>-0.3426</td>
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<td></td>
<td>(0.2518)</td>
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<td>(0.1988)</td>
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<td>FNSKED</td>
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<td></td>
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<td>(0.1402)</td>
<td>(0.6841)</td>
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</table>

Figure 4-12 Project A Goal 1 Demographic Correlations and (Significance) Levels

b. Project A2

Figure 4-13 indicates a correlation between AGE and FNCOST. No other correlations exist for Project A2.

<table>
<thead>
<tr>
<th></th>
<th>AGE</th>
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<th>WKEXP</th>
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<th>GRADE</th>
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</thead>
<tbody>
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<td></td>
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<td>(0.7048)</td>
<td>(0.8709)</td>
<td>(0.1970)</td>
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</table>

Figure 4-13 Project A Goal 2 Demographic Correlations and Significance Levels

c. Project B1

Figure 4-14 shows that there are no correlations between demographics and performance for Project B1.
<table>
<thead>
<tr>
<th></th>
<th>AGE</th>
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<th>WKEXP</th>
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<tr>
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<td>(0.8074)</td>
<td>(0.7963)</td>
<td>(0.9972)</td>
</tr>
</tbody>
</table>

Figure 4-14 Project B Goal 1 Demographic Correlations and Significance Levels

*d. Project B2*

Figure 4-15 depicts a slight correlation between WKEXP and FNCOST.

No other correlations are noted for this project.

<table>
<thead>
<tr>
<th></th>
<th>AGE</th>
<th>CHRSWK</th>
<th>WKEXP</th>
<th>EDAGO</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FNERR</td>
<td>0.3929</td>
<td>-0.2906</td>
<td>0.3444</td>
<td>0.5360</td>
<td>-0.1003</td>
</tr>
<tr>
<td></td>
<td>(0.2064)</td>
<td>(0.3596)</td>
<td>(0.2730)</td>
<td>(0.0725)</td>
<td>(0.7566)</td>
</tr>
<tr>
<td>FNSKED</td>
<td>-0.4271</td>
<td>0.1847</td>
<td>-0.4504</td>
<td>-0.2912</td>
<td>-0.1574</td>
</tr>
<tr>
<td></td>
<td>(0.1661)</td>
<td>(0.5655)</td>
<td>(0.1417)</td>
<td>(0.3585)</td>
<td>(0.6252)</td>
</tr>
<tr>
<td>FNCOST</td>
<td>0.5947</td>
<td>0.2537</td>
<td>-0.1619</td>
<td>-0.1916</td>
<td>0.1915</td>
</tr>
<tr>
<td></td>
<td>(0.8543)</td>
<td>(0.4264)</td>
<td>(0.0849)</td>
<td>(0.5508)</td>
<td>(0.5510)</td>
</tr>
</tbody>
</table>

Figure 4-15 Project B Goal 2 Demographic Correlations and Significance Levels
V. CONCLUSIONS

A. FINDINGS AND IMPLICATIONS

The objective of this thesis was to conduct a controlled experiment focused on gaining insight into the affect of stated goals on software project management. This thesis provides empirical findings regarding the software project managers' behavior in both relaxed and constrained resource environments.

The experimental results confirm that goals do matter. Managers perform best in the goals that they are given. This research also confirms that the affect of goals on programmers in the Weinberg experiment can be extended to software project managers. Additionally, it confirms that different software objectives, i.e. quality, cost, and schedule are indeed in conflict with each other.

B. FURTHER RESEARCH

There are several areas that can be potentially researched using the Systems Dynamic Model of Software Project Management. This experiment could be replicated with different subjects. One particular area would be to conduct the experiment with professional software managers to see if they respond similarly to stated goals. Project outcome may differ when managed by professional managers.

Another area to be researched concerns goal commitment. In this thesis goals were given to the manager. No attempt was made to analyze the level of commitment to these goals. Further research could be conducted to measure both the initial commitment to the goals and whether this commitment was maintained over time. The effects of goal commitment on project performance could be analyzed.

Lastly, interaction between feedback and goal commitment could be researched. Investigation into whether outcome feedback or process feedback has the greater effect on goal commitment.
APPENDIX A. PROJECT®.BAT

@echo off
rem PROJ® is the initially underestimated project
rem Ver 10 13 Nov 94
cls
rem init.exe requires 3 parameters i.e. [project,group,ins.set]
init @ #
graphics
bat /n /p /s
ram
smlt PROJ® -go = -prs = -ls -ns -plm 16
rep PROJ®.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
rep PROJ®.RSL PROCESS.DRS -outf PROCESSSS.OUT -t >NUL
-top   dynex PROJ® -in PROJ®.STT -sc -ls -plm 16
       smlt PROJ® -gm = -ns -plm 16
copy process.out process.old >NUL
rep PROJ®.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
rep PROJ®.RSL PROCESS.DRS -outf PROCESSSS.OUT >NUL
rep PROJ®.RSL INTERVAL.DRS -outf INTERVAL.OUT -t >NUL
process

call -top1
rep PROJ®.RSL PERFORM.DRS -outf PERFORM.OUT -t >NUL
perform
rem finish
exit
-top1 cls

-menu
color \1F
cls
begtype
REPORTS AND GRAPHS MENU

\1EREPOR\1F
|E 1   \1F PROJECT STATUS \1EREPOR\1F
|E 2   \1F STAFFING \1EREPOR\1F
|E 3   \1F DEFECT \1EREPOR\1F

\1BGRAP\1F
|B 4   \1F PROJECT STATUS \1BGRAP\1F
|B 5   \1F STAFFING \1BGRAP\1F
|B 6   \1F DEFECT \1BGRAP\1F

PRESS \1D P \1F TO \1DPROCEED\1F TO ENTER DECISIONS FOR THE NEXT 40 DAYS

Choose an option: (Do NOT hit <ENTER> after selection!!!)

end

-1stkey1 inkey %2 | type %2;
  if %2 = 1 goto -STATREP
  if %2 = 2 goto -STAFREP
  if %2 = 3 goto -DEFREP
  if %2 = 4 goto -STATPLOT
  if %2 = 5 goto -STAFFPLOT
  if %2 = 6 goto -DEFPLOT
  if %2 = P goto -proceed
  if %2 = KEY011 return
  beep goto -menu

-STATREP **** VIEW PROJECT STATUS REPORT ***********************
timestamp
rep PROJ@ STATUS.DRS -outf STATUS.OUT -t -sc -ls -plm 16
inkey
capture R1 >NUL
cls
color \1F
goto -menu

-STAFREP **** VIEW STAFFING REPORT ***********************
timestamp
rep PROJ@ STAFFING.DRS -outf STAFFING.OUT -t -sc -ls -plm 16
inkey
capture R2 >NUL
cls
color \1F
goto -menu
-DEFREP  **** VIEW DEFECT REPORT ********************
timestamp
  rep PROJ$ DEF.DRS -outf DEF.OUT -t -sc -1s -plm 16
  inkey
capture R3 >NUL
cls
color \1F
goto -menu

-STATPLOT **** VIEW PROJECT STATUS PLOT ****
timestamp
cls
color \1F
begtype

**************************************************************************************
\1A PROJECT STATUS VARIABLES \1F
**************************************************************************************

THE FOLLOWING PROJECT STATUS VARIABLES WILL BE PLOTTED:

TOTAL STAFF. . . . . . TOTAL STAFF LEVEL
EST SYSTEM SIZE. . . . . CURRENT ESTIMATE OF SYSTEM SIZE (KDSI)
EST PROGRAMMING COST . . . CURRENT ESTIMATE OF PROGRAMMING COST (Person Days)

\1A AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU \1F

\1A PRESS <ENTER> TO VIEW PLOT \1F

end
  inkey
cls
  rep PROJ$ STATPLOT.DRS
capture G4 >NUL
color \1F
cls
goto -menu

-STATPLOT **** VIEW GRAPHIC STAFFING PLOT ****
timestamp
cls
color \1F
begtype
STAFFING VARIABLES

THE FOLLOWING STAFFING VARIABLES WILL BE PLOTTED:

TOTAL STAFF . . . . . . TOTAL STAFF LEVEL
QA STAFF . . . . . . NUMBER OF PERSONS ALLOCATED TO QA
PROG STAFF . . . . . . NUMBER OF PERSONS DOING PROGRAMMING

AFTER VIEWING PLOT PRESS <ESC> TO CONTINUE

PRESS <ENTER> TO VIEW PLOT

end
inkey
cls
rep PROJ@STAFFLOT.DRS
capture G5 >NUL
color \1F
cls
goto -menu

DEFECT VARIABLES

THE FOLLOWING DEFECT VARIABLES WILL BE PLOTTED:

QA PERSON DAYS PER PERIOD . . . QA PERSON DAYS EXPENDED PER PERIOD
DEFECTS DETECTED PER PERIOD . . . DEFECTS DETECTED PER PERIOD

AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU
\1A PRESS <ENTER> TO VIEW PLOT \1F

END
inkey
cls
rep PROJ@ DEFPLOT.DRS
capture G6 >NUL
color \1F
cls
goto -menu

-proceed **** PROCEED WITH NEXT SIMULATION *************
cls
color \1F
begtype

******************************************************************************
* Press <ENTER> to continue *
******************************************************************************

deend
goto -top

-on.error-
if %R > 82 if %R < 90 type !! Floating Point Error !! |goto -Calc.
Cls beep type Unexpected batch file error %R in line %L |exit
APPENDIX B. PROJ@DNX

if #tm<.1 then
display clear

*****************************************************
!!!! Important Points to Remember !!!!
*****************************************************

- You are not allowed to discuss this exercise with anyone other than the lab attendant. Please refrain from discussing this with members in the other class until they have completed the exercise.

- The system will show you the size of the initial core team of software developers who have just completed the requirements/design specifications. You will then be asked for your desired staffing level for the programming phase. Then, the system will run through the first simulation time period (40 working days) and allow you to view various reports and graphs. You will then be allowed to update your estimates for project cost and duration and change your staffing levels.

- Record your decision for each interval on the documentation sheet provided before proceeding to the next interval.

THE LAB ATTENDANT MUST VERIFY YOUR FINAL RESULTS!

- GOOD LUCK! Press <ENTER> to continue.
dendq
choice 1
cend 1/1
display clear

*****************************************************
INITIAL ESTIMATES FOR THIS PROJECT:

- System Size: 15860, DSI
- Cost of Programming Phase: #TOTMD1 Person Days
- Duration of Programming Phase: #TDEV Days

- The initial core team of software developers who have just completed the requirements and design specifications is #WFS1 people.
- Your task is to take over as manager of the programming phase. At this point, you need to make 2 decisions:
- 1. The total staff level for the programming phase.
- 2. The percent of this staff to allocate to Quality Assurance.

*****************************************************

-----> FIRST DECISION: The total staff level

Enter your total requested staff level and press <ENTER>.
dendq
dq WFS1=0.5<
display clear

------> SECOND DECISION:

NEW_TOOL's estimate for the percent of the total staff to allocate to QA is #FRMPQA percent. Remember, NEW_TOOL has not yet been calibrated to your environment. Thus, this estimate is merely illustrative. It may or may not be appropriate for your unique project.

1) Enter a different desired percentage (a number from 0 - 100) and press <ENTER>.

OR

2) Press <ENTER> to allocate #FRMPQA percent of your staff to QA.

dendq
dq FRMPQA=0<100
display clear

Your total requested staffing level =       #WFS1 people.
The percent to be devoted to QA activities =  #FRMPQA percent.
(This means that you are devoting #WFS1 * #FRMPQA / 100 = #WFS1*FRMPQA/100 people to QA)

**************************************************************************
*        !! IMPORTANT !!                                                 *
*                                           *
*  This is your final opportunity to check and                             *
*  change the values for this period.                                     *
*                                           *
*  Press 1 then <ENTER> to change these values.                           *
*                                           *
*  If all values are correct, record them on                             *
*  the documentation sheet provided then                                *
*                                           *
*  Press 2 then <ENTER> to continue.                                      *
**************************************************************************

dend
choice 2
display
Your total requested staffing level =
dendq
dq WFS1=0.5<
display
The percent allocated to QA =
dendq
dq FRMPQA=0<100
cend
cend
else

choice 1
endif

display clear
*************************************************************************
* Make Your Desired Changes To The Variables *
* and press <ENTER>                           *
* OR                                           *
* Press <ENTER> to keep the displayed value    *
*************************************************************************

Your updated estimate for project cost (person days) =
dendq
dq TOTMD1=0<
display
Your updated estimate for project duration (days) =
dendq
dq PROJDR=0<
display
Your total requested staffing level =
dendq
dq WFS1=0.5<
display
The percent to allocate to QA (a number from 0-100) =
dendq
dq FRMPQA=0<100

display clear
Your updated estimate for project cost = #TOTMD1 person days
Your updated estimate for project duration = #PROJDR days
Your total requested staffing level = #WFS1 people
The percent to be devoted to QA activities = #FRMPQA percent
(This means that you are devoting #WFS1 * #FRMPQA / 100 = #WFS1*FRMPQA/100 people to QA)

*************************************************************************
* ! IMPORTANT ! *
* *
* This is your final opportunity to check and change the values for this period. *
* *
* Press 1 then <ENTER> to change these values. *
* *
* If all values are correct, record them on *
* the documentation sheet provided then *
* *
* Press 2 then <ENTER> to continue. *
* *
*************************************************************************

dend
choice 2
display
The updated estimate for project cost (person days) =
dendq
dq TOTMD1=0<
display
The updated estimate for project duration (days) =
dendq
dq PROJDR=0<
display
Your total requested staffing level =
dendq
dq WFS1=0.5<
display
The percent allocated to QA =
dendq
dq FRMPQA=0<100
cend
cend
end
display
******************************************************************************
* * Press <ENTER> to simulate this interval and return to the menu. *
* ******************************************************************************
dendq
choice 1
display clear

******************************************************************************
* * There will be a short pause while the model simulates the next period. *
* *
******************************************************************************
dendq
report
time=maxtime,
cend 1/1

spec md_length=#length+40
APPENDIX C. TOY.BAT

@echo off
rem TOY is the practice project
rem Ver 10  13 Nov 94
cls
rem init.exe requires 3 parameters i.e. [project,group,ins.set]
init T l l
 graphics
bat /n /p /s
ram
smlt TOY -go = -prs = -1s -ns -plm 16
rep TOY.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
rep TOY.RSL PROCESS.DRS -outf PROCESSS.OUT -t >NUL
-top dynex TOY -in TOY.STT -sc -ls -plm 16
smlt TOY -gm = -ns -plm 16
 copy process.out process.old >NUL
rep TOY.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
rep TOY.RSL PROCESS.DRS -outf PROCESSS.OUT >NUL
rep TOY.RSL INTERVAL.DRS -outf INTERVAL.OUT -t >NUL
process
call -top1
rep TOY.RSL PERFORM.DRS -outf PERFORM.OUT -t >NUL
perform
finish
exit
top1 cls

-menu
color \1F
cls
begtype

REPORTS AND GRAPHS MENU

\1EREPORTS: \1F
 \1E 1 \1F PROJECT STATUS \1EREPORT\1F
 \1E 2 \1F STAFFING \1EREPORT\1F
 \1E 3 \1F DEFECT \1EREPORT\1F
Choose an option: (Do NOT hit <ENTER> after selection!!!) ; end

-1stkey1 inkey %2 | type %2;
  if %2 = 1 goto -STATREP
  if %2 = 2 goto -STAFREP
  if %2 = 3 goto -DEFREP
  if %2 = 4 goto -STATPLOT
  if %2 = 5 goto -STAFPLOT
  if %2 = 6 goto -DEFPLOT
  if %2 = P goto -proceed
  if %2 = KEY011 return
  beep goto -menu

-STATREP  **** VIEW PROJECT STATUS REPORT ***********************
timestamp
rep TOY STATUS.DRS -outf STATUS.OUT -t -sc -ls -plm 16
inkey
capture R1 >NUL
cls
color \1F
goto -menu

-STAFREP  **** VIEW STAFFING REPORT ***********************
timestamp
rep TOY STAFFING.DRS -outf STAFFING.OUT -t -sc -ls -plm 16
inkey
capture R2 >NUL
cls
color \1F
goto -menu
goto -menu

-DEFREP  **** VIEW DEFECT REPORT ********************
timestamp
rep TOY DEF.DRS -outf DEF.OUT -t -sc -ls -plm 16
inkey
capture R3 >NUL
cls
color \1F
goto -menu
-STATPLOT **** VIEW PROJECT STATUS PLOT ****

  timestamp
cls
color \1F
begtype

******************************************************************************
\1A  PROJECT STATUS VARIABLES \1F
******************************************************************************

THE FOLLOWING PROJECT STATUS VARIABLES WILL BE PLOTTED:

TOTAL STAFF. . . . . . . TOTAL STAFF LEVEL
EST SYSTEM SIZE. . . . . CURRENT ESTIMATE OF SYSTEM SIZE (KDSI)
EST PROGRAMMING COST . . CURRENT ESTIMATE OF PROGRAMMING COST (Person Days)

\1A  AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU \1F

\1A  PRESS <ENTER> TO VIEW PLOT \1F

end
  inkey
cls
  rep TOY STATPLOT.DRS
capture G4 >NUL
color \1F
cls
goto -menu

-STATPLOT **** VIEW GRAPHIC STAFFING PLOT ****

  timestamp
cls
color \1F
begtype

******************************************************************************
\1A  STAFFING VARIABLES \1F
******************************************************************************

THE FOLLOWING STAFFING VARIABLES WILL BE PLOTTED:
TOTAL STAFF . . . . . . . . TOTAL STAFF LEVEL
QA STAFF . . . . . . . . . . NUMBER OF PERSONS ALLOCATED TO QA
PROG STAFF . . . . . . . . . NUMBER OF PERSONS DOING PROGRAMMING

\1A AFTER VIEWING PLOT PRESS <ESC> TO CONTINUE \1F
\1A PRESS <ENTER> TO VIEW PLOT \1F

end
inkey
cls
rep TOY STAFFPLOT.DRS
capture CS >NUL
color \1F
cls
goto -menu

-DEFPLOT **** VIEW DEFECT PLOT ****
timestamp
cls
color \1F
begtype

******************************************************************************
\1A  DEFECT VARIABLES \1F
******************************************************************************

THE FOLLOWING DEFECT VARIABLES WILL BE PLOTTED:

QA PERSON DAYS PER PERIOD . . . . QA PERSON DAYS EXPENDED PER PERIOD
DEFECTS DETECTED PER PERIOD . . . DEFECTS DETECTED PER PERIOD

\1A AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU \1F
\1A PRESS <ENTER> TO VIEW PLOT \1F

END
inkey
cls
rep TOY DEFPLOT.DRS
capture G6 >NUL
color \1F
cls
goto -menu

-proceed **** PROCEED WITH NEXT SIMULATION ***************
cls
color \1F
begtype

***************************************************************************
* Press <ENTER> to continue  *
***************************************************************************

end
goto -top

-on.error-
if %R > 82 if %R < 90 type !! Floating Point Error !! |goto -Calc.
Cls beep type Unexpected batch file error %R in line %L |exit
APPENDIX D. STATUS.DRS

REPORT
TIME=MAXTIME.
FORMAT="5<"
">>>>>>>>>>>>>>>>>>>>>>> PROJECT STATUS REPORT <<<<<<<<<<<<<<<<<<<<<<<<<<<<";

Format="30<,40<,47<",PICTURE="Z.ZZ9V"
"AT TIME =",TM,"DAYS";"
Format="5<"
"INITIAL ESTIMATES: (These will not change throughout the project)"
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZZV"
"System Size",IPRSZ,"DSI";
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZZV"
"Programming Cost",TOTMDO,"Person Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZZV"
"Programming Phase Duration (start-end)",TDEV,"Days";

Format="5<"
"UPDATED ESTIMATES"
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZ9V"
"Updated Est of System Size",PJSZT,"DSI";
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZ9V"
"Your Last Est of Programming Phase Cost",JBSZMD,"Person Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZ9V"
"Your Last Est of Prog Phase Duration (start-end)",SCHCDT,"Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZ9V"
"Time Remaining",TIERM,"Days";

Format="5<"
"REPORTED PROGRESS"
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZ9V.99"
"% DSI Reported Complete",PRCMPL,"Percent";
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZ9V"
"Total DSI Reported Complete to Date",CMDSI,"DSI";
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZ9V"
"Total Person Days Expended to Date",CUMMD,"Person Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ.ZZ9V"
"Reported Productivity",RPPROD,"DSI/Person Day";

FORMAT="5<"
"PRESS <ENTER> TO RETURN TO THE MENU"
APPENDIX E. STAFFING.DRS

; ;
report
time=maxtime,
FORMAT="5<"
".isSuccess"="1"
"time=${time1}";
; ;
Format="30<,40<,47<",PICTURE="Z,ZZ9V"
"AT TIME =",TM,"DAYS";
; ;
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZZV.9"
"Current Total Staff Size",FTEQWF,"People";
FORMAT="11<,54<,66<",PICTURE="ZZZ,ZZZV.9"
"Staff Allocated to Programming",CRDVF,
"People";
FORMAT="11<,54<,66<",PICTURE="ZZZ,ZZZV.9"
"Staff Allocated to QA",CRQAFW,"People";
FORMAT="8<,54<,66<",PICTURE="ZZ,ZZ9V"
"Percent of Workforce that is Experienced",FRWFEX*100,"Percent";
; ;
; ;
FORMAT="5<"
"PRESS <ENTER> TO RETURN TO THE MENU";
APPENDIX F. DEF.DRS

; ;
report
time=maxtime,
FORMAT="5<"
">>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>> DEFECT REPORT <<<<<<<<<<<<<<<<<<<<<<<<<<<<"
; ;
FORMAT="1<,69<,72<".PICTURE="ZZ9V"
"-----CUMULATIVE STATUS FROM START OF PROGRAMMING TO CURRENT DAY
=>".TM. "--------";
FORMAT="8<,54<,66<".PICTURE="ZZZ,ZZZV"
"TOTAL Person Days Expended to Date",CUMMD,"Person Days";
FORMAT="11<,54<,66<".PICTURE="ZZZ,ZZZV"
"Programming Person Days Expended to Date",CUMMD-CMQAMD,"Person Days";
FORMAT="11<,54<,66<".PICTURE="ZZZ,ZZZV"
"QA Person Days Expended to Date",CMQAMD,"Person Days";
; ;
FORMAT="8<,54<,66<".PICTURE="ZZZ,ZZ9V"
"TOTAL Defects Detected",CMERD,"Defects";
FORMAT="8<,54<,66<".PICTURE="ZZZ,ZZ9V.99"
"TOTAL KDSI Completed",CMDSI/1000,"KDSI";
FORMAT="8<,54<,66<".PICTURE="ZZZ,ZZ9V.9"
"Defect Density",CMERD*1000/CMDSI,"Defects/KDSI";
; ;
FORMAT="1<"
"-----------------STATISTICS FOR THE LAST 40 DAY PERIOD ONLY------------------",
FORMAT="8<,54<,66<".PICTURE="ZZZ,ZZZV"
"QA Person Days Expended Last 40 Days",PRQAMD,"Days";
FORMAT="8<,54<,66<".PICTURE="ZZZ,ZZ9V"
"Defects Detected Last 40 Days",PRERD,"Defects";
FORMAT="8<,54<,66<".PICTURE="ZZZ,ZZ9V.9"
"Defect Density Observed Last 40 Days",PRDFDS,"Defects/KDSI";
; ;
FORMAT="5<"
"PRESS <ENTER> TO RETURN TO THE MENU";
APPENDIX G. *PLOT.DRS FILES

STATPLOT.DRS:

plotxy <TM"TIME (DAYS) ",0,480>,<FTEQWF"TOTAL STAFF (PERSONS) ",0,16>,
      <PJBZST/1000"EST SYSTEM SIZE (KDSI) ",0,40>,
      <JBSZMD"EST PROGRAMMING COST (PERSON DAYS) ",0,4000>

STAFPLOT.DRS:

plotxy <TM"TIME (DAYS) ",0,480>,<FTEQWF"TOTAL STAFF (PERSONS) ",0,24>,
      <CRQAWF"QA STAFF (PERSONS) ",0,24>,<CRDVWF"PROG STAFF (PERSONS) ",0,24>

DEFPLOT.DRS:

plotxy <TM"TIME (DAYS) ",0,480>,<PRQAMD"QA PERSON DAYS PER PERIOD ",0,160>,
      <PRERD"DEFECTS DETECTED PER PERIOD ",0,160>
APPENDIX H. DATA CAPTURING FILES

START.BAT:

cls
@echo off
@echo.
@echo.
@echo Starting the Project Simulation.
@echo.
@echo Copying files...
@echo.
mkdir c:\swproj
copy *.* c:\swproj

INT.C:

/* INT.C - Put init info in file */

#include "stdio.h"
#include "dos.h"
#include "ctype.h"
#include "se.h"

#define OUTFILE "subinfo"

main(argc, argv)
int argc;
char *argv[];
{
    char name[30], smc[10];
    FILE *fo, *fopen();

    if(argc<3)
    {
        printf("Please enter arguments in the following order: ");
        printf("Project, objectives, order");
        exit(0);
    }
/* Get init info from screen */
    cls();
    set_cursor(6,5);
    printf("Please enter Your Last Name");
    set_cursor(6,35);
    scanf("%s", name);
    set_cursor(7,5);
    printf("Please enter your smc");
    set_cursor(7,35);
    scanf("%s", smc);
    if((fo=fopen(OUTFILE, "w"))==NULL) {
        printf("Couldn't open %s for write", OUTFILE);
        exit(0);
    }

    fprintf(fo, "\n%8s %8s %8s %8s",name,smc,argv[1],argv[2],argv[3]);
    fclose(fo);

    TIMESTAMP.C:

    /* INFOCFB.C - Read infile containing data and put it in outfile.
       Reads 14 lines and prints out 12 values.*/

#include   "stdio.h"
#include   "dos.h"
#include   "ctype.h"
#include   "se.h"

#define TIMESTAMP   "time.tmp"

main(argc, argv)
int argc;
char *argv[];
{
    FILE  *fo, *fopen();
    struct info userinfo;
    /*
    printf("\nEntered timestamp");
    getch();
    */
    _dos_gettime(&userinfo.start_time);
    if((fo=fopen(TIMESTAMP, "w"))==NULL) {
        printf("Couldn't open %s for write", TIMESTAMP);
        exit(0);
    }
INTERVAL.DRS:

REPORT
TIME=MAXTIME,
FORMAT="5<",PICTURE="ZZZ,ZZ9V";
TM

CAPTURE.C:

/* Capture.C - Read infile containing data and put it in outfile.
   For the goals experiment */

#include "stdio.h"
#include "dos.h"
#include "ctype.h"
#include "se.h"

define INFILE "inrval.out"
/*
define OUTFILE "info"
*/
define TIMESTAMP "time.tmp"
define TMP "tmp.tmp"
define ERRFILE "errors.out"

main(argc, argv)
int argc;
char *argv[];
{
    char outfile[15], tmp[30], estimate[10];
    float input;
    double period;
    int i, hr[3], min[3], sec[3], ch, starttime[6], endtime[6], time;
    struct info userinfo;

}
struct find_t c_file;

/*
Entered capture
*/
getch();

/ *open errors file */
if((ferr=fopen(ERRFILE, "a"))==NULL) {
    printf("can't open %s for append", ERRFILE);
    exit(0);
}

/*Get previous time and read it into array */
if(_dos_fndfirst(TIMESTAMP, _A_NORMAL, &c_file)==0)
    /* printf("time file found\n"); */
else
    fprintf(ferr, "\nCouldn't find %s", TIMESTAMP);
if((fi=fopen(TIMESTAMP, "r"))==NULL) {
    fprintf(ferr, "\ncouldn't open %s for read", TIMESTAMP);
}
for(i=0; i<2; i++) {
    ch = fgetc(fi);
    if(isdigit(ch))
        hr[i]=(ch - toascii(48));
    else
        hr[i] = 0;
}
ch=fgetc(fi);
for(i=0; i<2; i++) {
    ch = fgetc(fi);
    if(isdigit(ch))
        min[i]=(ch - toascii(48));
    else
        min[i] = 0;
}
ch=fgetc(fi);
for(i=0; i<2; i++) {
    ch = fgetc(fi);
    if(isdigit(ch))
        sec[i]=(ch - toascii(48));
    else
        sec[i] = 0;
}
fclose(fi);
/*Fill up the start_time array*/
for(i=0; i<2; i++)
    starttime[i]=hr[i];
for(i=0; i<2; i++)
    starttime[i+2]=min[i];
for(i=0; i<2; i++)
    starttime[i+4]=sec[i];
/*
for(i=0; i<6; i++)
    printf("%d", starttime[i]);
*/
strcpy(outfile, "");
strcat(outfile, OUTFILE);
strcat(outfile, argv[1]);
if((fi=fopen(INFILE, "r"))==NULL) {
    fprintf(stderr,"cant't open %s for read", INFILE);
}
if((fo=fopen(outfile, "a"))==NULL) {
    fprintf(stderr,"cant't open %s for append", outfile);
}

fscanf (fi, "%s", estimate);
fscanf (fi, "%f", &input);
period = input;
/* printf("Input and period are %f %f\n", input, period); */
fprintf (fo, "%f ", period); /*
if(period==0) {
    fprintf(fo, "%#3.1f ", period);
    for (i=0; i<15; i++) {
        fscanf(fi, "%s ", tmp);
        fprintf(fo, "%s ", tmp);
    }
}
else {
    fprintf(fo, "%s ", estimate);
    fprintf(fo, "\n");
    fprintf(fo, "%#2f ", period);
    for(i=0; i<15; i++) {
        fscanf(fi, "%s ", tmp);
        fprintf(fo, "%s ", tmp);
    }
}
fclose(fi);
/*get end_time and print to file*/
_dos_gettime(&userinfo.end_time);
if((ftmp=fopen(TMP, "w"))==NULL) {
    fprintf(stderr, "ncouldn't open %s for write", TMP);
    exit(0);
}
fprintf(ftmp,"%#2d:%#2d:%#2d ", userinfo.end_time.hour,
    userinfo.end_time.minute, userinfo.end_time.second);
fclose(ftmp);

/*Read back end_time into array */
for(i=0; i<2; i++) {
    hr[i]=0;
    min[i]=0;
    sec[i]=0;
}
if((fi=fopen(TMP, "r"))==NULL) {
    fprintf(stderr, "ncouldn't open %s for read", TMP);
}

for(i=0; i<2; i++) {
    ch = fgetc(fi);
    if(isdigit(ch))
        hr[i]=(ch - toascii(48));
    else
        hr[i] = 0;
}

ch=fgetc(fi);
for(i=0; i<2; i++) {
    ch = fgetc(fi);
    if(isdigit(ch))
        min[i]=(ch - toascii(48));
    else
        min[i] = 0;
}

ch=fgetc(fi);
for(i=0; i<2; i++) {
    ch = fgetc(fi);
    if(isdigit(ch))
        sec[i]=(ch - toascii(48));
    else
        sec[i] = 0;
}

fclose(fi);
/*Fill up the end_time array*/
for(i=0; i<2; i++)
    endtime[i]=hr[i];
for(i=0; i<2; i++)
    endtime[i+2]=min[i];
for(i=0; i<2; i++)
    endtime[i+4]=sec[i];

/*
printf("n");
for(i=0; i<6; i++)
    printf("%d", endtime[i]);
*/

/*Get time diff and write to outfile*/
time = get_time(starttime, endtime);

fprintf(fo, " %3d ", time);
fclose(fo);
fclose(ferr);
remove("tmp.tmp");
remove("time.tmp");

}

get_time(start_time, end_time)
int start_time[], end_time[];
{
    int start_sec, end_sec, tot_time;

    start_sec=(start_time[0]*10+start_time[1])*3600\
        +(start_time[2]*10+start_time[3])*60\
        +(start_time[4]*10+start_time[5]);

    end_sec=(end_time[0]*10+end_time[1])*3600\
        +(end_time[2]*10+end_time[3])*60\n        +(end_time[4]*10+end_time[5]);

    tot_time=end_sec-start_sec;
    return(tot_time);
PROCESS.DRS:

REPORT
TIME=MAXTIME,
FORMAT="5<,5<,15<,25<,35<,45<,55<,65<",PICTURE="ZZZZz9V.99";;
TM
Format="5<,15<,25<,35<,45<,55<,65<",PICTURE="ZZZZz9V.99";
IPRJSZ,TOTMDO,TDEV,PJSZT,FNERR,FNERG,TIMERM
Format="5<,15<,25<,35<,45<,55<,65<",PICTURE="ZZZZz9V.99";
PRCMLP,CMDSI,CUMMD,RPPPROD,FTEQWF,CRDVWF,CRQAWF
Format="5<,15<,25<,35<,45<,55<,65<",PICTURE="ZZZZz9V.99";
FRWFEX*100,CMQAMD,CMERD,PRQAMD,PRERD,PRDFDS,PRTKDV
Format="5<,15<,25<,35<,45<",PICTURE="ZZZZz9V.99";
TOTMD1,WFSC,CRWWF,AFMDP1,SCHPR
Format="5<,15<,25<,35<",PICTURE="ZZZZz9V.99";
WFS2,FRMPQ1,JBSZMD,SCHCDT

PROCESS.C:

/* process.c - Read infile containing data and put it in outfile.
   For the goals experiment */

#include  "stdio.h"
#include  "dos.h"
#include  "ctype.h"
#include  "se.h"

#define INFOFILE  "subinfo"
#define INFILE1  "process.old"
#define INFILE2  "process.out"

#define OUTFILE  "process.dat"

#define ERRFILE  "errors.out"

main()
{
    char  outfile[15], tmp[30], estimate[15];
    char  lname[30], smc[15], project[5], objectives[5], order[5];
    char  duration[30], cost[30], staff[30], percent[30];
    int  i;
    float input;
    struct find_t c_file;

    72
/*open errors file */

if((ferr=fopen(ERRFILE, "a"))==NULL) {
    printf("\ncouldn't open %s for append", ERRFILE);
    exit(0);
}

/*Open infofile */
if((finfo=fopen(INFOFILE,"r"))==NULL) {
    fprintf(ferr, "\ncouldn't open %s for read", INFOFILE);
    exit(0);
}

fscanf(finfo, "%s", lname);
fscanf(finfo, "%s", smc);
fscanf(finfo, "%s", project);
fscanf(finfo, "%s", objectives);
fscanf(finfo, "%s", order);

fclose(finfo);

if((fi1=fopen(INFILE1, "r"))==NULL) {
    fprintf(ferr,"\ncouldn't open %s for read",INFILE1);
    exit(0);
}

if((fi2=fopen(INFILE2, "r"))==NULL) {
    fprintf(ferr,"\ncouldn't open %s for read", INFILE2);
    exit(0);
}

if((fo=fopen(OUTFILE, "a"))==NULL) {
    fprintf(ferr,"\ncouldn't open %s for append", OUTFILE);
    exit(0);
}

fprintf(fo,"\n%5 s %5 s %5 s %5 s %5 s %5 s %5 s %5 s", lname, smc, project, objectives, order);
for(i=0; i<27; i++) {
    fscanf(fi1, "%s", estimate);
    fprintf(fo, "%s", estimate);

PERFORM.DRS:

REPORT
TIME=MAXTIME,
Format="5<,15<,25<,35<,45<,55<,65<,75<,85<,95<",PICTURE="ZZZZZ9V.99";
FNCOST,FNTIME,FNERR,FNERG,FNERD,FNERES,FNPRDT,FNQAMD,FNTRMD,FNRWMD
PERFORM.C

/* perform.c - Read infile containing performance date and put it in outfile perform.dat. For the goals experiment */

#include "stdio.h"
#include "dos.h"
#include "ctype.h"
#include "se.h"

#define INFOFILE "subinfo"
#define INFILE1 "perform.out"
#define OUTFILE "perform.dat"
#define ERRFILE "errors.out"

main()
{
    char outfile[15], tmp[30], estimate[15];
    char lname[30], smc[15], project[5], objectives[5], order[5];
    int i;

    /*open errors file */
    if((ferr=fopen(ERRFILE, "a"))==NULL) {
        printf("can't open %s for append", ERRFILE);
        exit(0);
    }

    /*Open infofile */
    if((finfo=fopen(INFOFILE,"r"))==NULL) {
        fprintf(ferr,"can't open %s for read", INFOFILE);
        exit(0);
    }
    fscanf(finfo,"%s", lname);
    fscanf(finfo,"%s", smc);
    fscanf(finfo,"%s", project);
    fscanf(finfo,"%s", objectives);
    fscanf(finfo,"%s", order);
    fclose(finfo);

    if((fi=fopen(INFILE1, "r"))==NULL) {
        fprintf(ferr,"can't open %s for read", INFILE1);
    }
exit(0);

if((fo=fopen(OUTFILE, "w")) == NULL) {
    fprintf(ferr, "\ncouldnt open %s for write", OUTFILE);
    exit(0);
}

fprintf(fo,"u%ss %s %s %s %s ", lname, smc, project, objectives, order);
for(i=0; i<10; i++) {
    fscanf(fi1, "%s", estimate);
    fprintf(fo, "%s", estimate);
}
fclose(fi1);
fclose(ferr);
fclose(fo);

}

for(i=0; i<10; i++)
    fscanf(fi2, "%s", tmp);

fscanf(fi2, "%s", duration);
fprintf(fo, "%s ", duration);
fscanf(fi2, "%s", cost);
fprintf(fo, "%s ", cost);
fscanf(fi2, "%s", staff);
fprintf(fo, "%s ", staff);
fscanf(fi2, "%s", percent);
fprintf(fo, "%s ", percent);

fclose(fi1);
fclose(fi2);
fclose(ferr);
fclose(fo);

}

FINISH.BAT:

echo off
cls
copy *.* b:
APPENDIX I. A11 INSTRUCTION SET

Your Name: ____________________________ A11
SMC No.: ____________________________

1. Introduction

The exercise you are about to undertake is similar in many ways to flight simulators that pilots use to mimic flying an aircraft from takeoff at point A to landing at point B. Instead of flying an aircraft, though, the simulator mimics the programming phase of a real software project. In this simulation, you will be more than an observer. In fact, you will play the role of manager of the programming phase of the project. Specifically, your role will be to track the progress of the project by reviewing status reports and graphs available every two-month interval (40 working days) during the programming phase. As the manager, you must then make two staffing decisions. First, the total number of staff you need. (You can hire additional staff, or decrease the staffing level as you deem necessary to complete your programming task successfully.) Second, you need to decide on what percent of your total staff to allocate to the Quality Assurance activity to be conducted throughout the programming phase (e.g. to do inspections).

2. Project

The project that you will manage happens to have been a real project conducted in a real organization. For the project, you will be given a project profile containing the following initial information:

Estimated Size of the System: in Delivered Source Instructions (DSI)
Estimated Cost of Programming Phase: in Number of Person Days
Estimated Duration of Programming Phase: in Number of Work Days
Size of initial Core Team: in People

The Core Team is a skeleton staff of software professionals who are there to ensure continuity between the requirements/design phase (which you may assume has just been completed), and the programming phase you are to manage.

The cost and schedule estimates are derived from a new off-the-shelf estimation tool, call it "NEW_TOOL", that has been recently acquired.

Historically, the defect density (i.e. number of defects detected during programming divided by the number of KDSI developed) has ranged from 5 - 20 Defects/KDSI.
3. Your task

Your task at every 40-day interval is to review the project’s status, and make any necessary adjustments to the staffing level and its allocation. In order to do so, you may feel that is necessary to first adjust the project’s cost and duration targets. The staffing decision should be done as follows:

1. Decide on the total staffing level, and

2. Decide on what percentage of the staff should be allocated to the quality assurance function (i.e. a number between 0 and 100).

4. Your Goal for the Task:

Minimize overruns in both cost and schedule

Your grade for the simulation will be based on an equal weighing of these two factors.

5. Some Important Points to Consider in Managing Your Task

1. As the manager of the programming phase, you specify the desired staffing level. You may find that your actual staffing level (as it will appear in the reports) is different from what you requested. This would be due to factors you cannot control, such as hiring delays and turnover.

2. The staff size that you select, and which appears in reports, may show fractions (e.g. 4.5 people) since people are allowed to work on more than one project.

3. When requesting additional staff, expect a delay in hiring. For modest additions to your staffing, the average hiring delay will be around 40 days. However, if you request a large number of additional staff, the average hiring delay will be much longer.

4. Once new people are hired, they must be trained and assimilated. The assimilation/training period is typically 80 days. During this assimilation/training period you can expect the new employee to be only half as productive as an experienced employee.

5. Adding more people increases communication and coordination overhead as happens in reality.
6. Rules of the Game

1. You must work alone. At no time are you to discuss the progress of the project with anyone.

2. If you have a question, ask the lab attendant.

3. You are not allowed to bring any notes or other "gouge" to use during the simulation. Feel free to write on the documentation sheets provided.

4. A calculator is allowed and recommended.

7. Instructions for Starting the System

Follow the instructions Carefully. If any problems arise, immediately seek out the lab attendant.

1. Insert the disk into the B: drive. Do not remove the disk from the drive!

2. From the C:\ prompt, type B: Do NOT start the network!

3. Start the simulation by typing START at the B:\ prompt.

4. Follow the instructions as they appear on the screen.

5. The simulation is complete when the % Programming Reported Complete in the PROJECT STATUS REPORT is 100%. When this occurs Call the lab attendant.
YOUR GOAL IS:

Minimize overruns in both cost and schedule

INITIAL ESTIMATES:

Project Size 15,860 DSI
Project Cost 944 Person Days
Project Duration (start-end) 272 Days

<table>
<thead>
<tr>
<th>TIME ELAPSED (DAYS)</th>
<th>ESTIMATED COST (PERS-DAYS)</th>
<th>ESTIMATED DURATION (DAYS)</th>
<th>STAFFING LEVEL (PERSONS)</th>
<th>QUALITY ASSURANCE (PERCENT)</th>
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<td>Initial Decision</td>
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<td>Time Elapsed - 480 Days</td>
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<tr>
<td>Time Elapsed - 520 Days</td>
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</table>

**** WHEN YOU ARE DONE, CALL THE LAB ATTENDANT ****

80
APPENDIX J. MASTER INSTRUCTION SET

Your Name: ________________________________________ XXX
SMC No.: _________________________________________

1. Introduction

The exercise you are about to undertake is similar in many ways to flight simulators that pilots use to mimic flying an aircraft from takeoff at point A to landing at point B. Instead of flying an aircraft, though, the simulator mimics the programming phase of a real software project. In this simulation, you will be more than an observer. In fact, you will play the role of manager of the programming phase of the project. Specifically, your role will be to track the progress of the project by reviewing status reports and graphs available every two-month interval (40 working days) during the programming phase. As the manager, you must then make two staffing decisions. First, the total number of staff you need. (You can hire additional staff, or decrease the staffing level as you deem necessary to complete your programming task successfully.) Second, you need to decide on what percent of your total staff to allocate to the Quality Assurance activity to be conducted throughout the programming phase (e.g. to do inspections).

2. Project

The project that you will manage happens to have been a real project conducted in a real organization. For the project, you will be given a project profile containing the following initial information:

- Estimated Size of the System: in Delivered Source Instructions (DSI)
- Estimated Cost of Programming Phase: in Number of Person Days
- Estimated Duration of Programming Phase: in Number of Work Days
- Size of initial Core Team: in People

The Core Team is a skeleton staff of software professionals who are there to ensure continuity between the requirements/design phase (which you may assume has just been completed), and the programming phase you are to manage.

The cost and schedule estimates are derived from a new off-the-shelf estimation tool, call it "NEW_TOOL", that has been recently acquired.

Historically, the defect density (i.e. number of defects detected during programming divided by the number of KDSI developed) has ranged from 5 - 20
Defects/KDSI.

3. Your task

Your task at every 40-day interval is to review the project's status, and make any necessary adjustments to the staffing level and its allocation. In order to do so, you may feel that is necessary to first adjust the project's cost and duration targets. The staffing decision should be done as follows:

1. Decide on the total staffing level, and

2. Decide on what percentage of the staff should be allocated to the quality assurance function (i.e. a number between 0 and 100).

4. Your Goal for the Task:

[Paste the appropriate goal from below in this box]

Practice: Familiarize yourself with the simulation

Group A11: Minimize overruns in both cost and schedule.

Group A12: Minimize overruns in both schedule and cost.

Group A21: Deliver a quality product (i.e. detect as many of the defects as possible) and minimize any schedule overrun.

Group A22: Minimize any schedule overrun and deliver a quality product (i.e. detect as many of the defects as possible).

Group B11: Minimize total cost incurred and minimize schedule overrun.

Group B12: Minimize schedule overrun and minimize total cost incurred.

Group B21: Deliver a quality product (i.e. detect as many of the defects as possible) and minimize any schedule overrun.

Group B22: Minimize any schedule overrun and deliver a quality product (i.e. detect as many of the defects as possible).
Your grade for the simulation will be based on an equal weighing of these two factors.

5. Some Important Points to Consider in Managing Your Task

1. As the manager of the programming phase, you specify the desired staffing level. You may find that your actual staffing level (as it will appear in the reports) is different from what you requested. This would be due to factors you cannot control, such as hiring delays and turnover.
2. The staff size that you select, and which appears in reports, may show fractions (e.g. 4.5 people) since people are allowed to work on more than one project.
3. When requesting additional staff, expect a delay in hiring. For modest additions to your staffing, the average hiring delay will be around 40 days. However, if you request a large number of additional staff, the average hiring delay will be much longer.
4. Once new people are hired, they must be trained and assimilated. The assimilation/training period is typically 80 days. During this assimilation/training period you can expect the new employee to be only half as productive as an experienced employee.
5. Adding more people increases communication and coordination overhead as happens in reality.

6. Rules of the Game

1. You must work alone. At no time are you to discuss the progress of the project with anyone.
2. If you have a question, ask the lab attendant.
3. You are not allowed to bring any notes or other "gouge" to use during the simulation. Feel free to write on the documentation sheets provided.
4. A calculator is allowed and recommended.

7. Instructions for Starting the System

Follow the instructions Carefully. If any problems arise, immediately seek out the lab attendant.

1. Insert the disk into the B: drive. Do not remove the disk from the drive!
2. From the C:\ prompt, type B: Do NOT start the network!

3. Start the simulation by typing START [or PRACTICE] at the B:\ prompt.

4. Follow the instructions as they appear on the screen.

5. The simulation is complete when the % Programming Reported Complete in the PROJECT STATUS REPORT is 100%. When this occurs Call the lab attendant.
YOUR GOAL IS [PASTED FROM EARLIER]

INITIAL ESTIMATES: [Proj. A, B, Practice--Delete 2]

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<td>Time Elapsed - 320 Days</td>
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<td>Time Elapsed - 520 Days</td>
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**** WHEN YOU ARE DONE, CALL THE LAB ATTENDANT ****
APPENDIX K. DESCRIPTION OF THE SIMULATION INTERFACE

REPORTS AND GRAPHS MENU:

After every 40-day simulation period, you will immediately get the Reports and Graphs Menu shown below. All of the reports and graphs concerning your project's progress are available from this menu. You may select any of them by pressing their corresponding number.

REPORTS AND GRAPHS MENU

REPORTS:
1  PROJECT SIZE & STATUS REPORT
2  STAFFING REPORT
3  DEFECT REPORT

GRAPHs:
4  PROJECT SIZE & STATUS GRAPH
5  STAFFING GRAPH
6  DEFECT GRAPH

PRESS P TO PROCEED TO ENTER DECISIONS FOR THE NEXT 40 DAYS

After viewing the pertinent information (you may view any report or graph more than once), use the "P" selection to proceed to enter your decisions for the next 40 day simulation period.
Report 1 (PROJECT SIZE & STATUS REPORT) A sample report is pictured below:

>>> PROJECT STATUS REPORT <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

AT TIME = 200 DAYS

INITIAL ESTIMATES: (These will not change throughout the project)
- System Size: 20,000 DSI
- Programming Cost: 1,400 Person Days
- Programming Phase Duration (start-end): 350 Days

UPDATED ESTIMATES
- New Est of System Size due to Changes in Requirements: 20,000 DSI
- Your Last Est of Programming Phase Cost: 1,567 Person Days
- Your Last Est of Prog Phase Duration (start-end): 353 Days
- Time Remaining: 153 Days

REPORTED PROGRESS
- % DSI Reported Complete: 63.33 Percent
- Total DSI Reported Complete to Date: 12,665 DSI
- Total Person Days Expended to Date: 817 Person Days
- Reported Productivity: 16 DSI/Person Day

PRESS <ENTER> TO RETURN TO THE MENU

This report contains Project Status information as of a particular day in the programming phase. The report is divided into 3 sections. The top section shows the INITIAL ESTIMATES provided to your customer. This information will not change throughout the project.

The middle portion is the UPDATED ESTIMATES section. The Updated Est of System Size can change (increase or decrease) to reflect the addition or deletion of requirements. The entries of Your Last Est of Programming Phase Cost and Your Last Est of Prog Phase Duration (start-end) would reflect any change in cost and duration that you feel you need to make. The Time Remaining is equal to your current estimate of total duration minus current time.

The bottom section is the REPORTED PROGRESS section. Remember that this is "reported" information and is not guaranteed to be totally accurate, especially early in the phase. Reported Productivity is simply calculated as Total DSI Reported Complete to Date divided by Total Person Days Expended to Date.

Your Task is complete when the % DSI Reported Complete is 100%.
Report 2 (STAFFING LEVEL REPORT)  A sample report is pictured below:

>>>>>>>>>>>>>>>>>>>>>>>>>>>> STAFFING REPORT <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

AT TIME = 200 DAYS

Current Total Staff Size 4.7 People
Staff Allocated to Programming 4.2 People
Staff Allocated to QA .5 People

Percent of Workforce that is Experienced 83 Percent

PRESS <ENTER> TO RETURN TO THE MENU

This report contains staffing information as of a particular day in the programming phase. The Current Total Staff Size consists of your total staff allocated to both programming activities and QA activities. It is the sum of Staff Allocated to Programming and Staff Allocated to QA.

The Percent of Workforce that is Experienced is also shown on this report. This is the number of experienced people (i.e. already trained/assimilated) divided by the total staff size (which is the sum of experienced and new staff). As mentioned above, once new people are hired, they go through an assimilation/training period. This is the time needed to train a new employee in the mechanics of the project and bring him/her up to speed. A new employee (i.e. one that is being trained) is only half as productive as an experienced employee.
Report 3 (DEFECT REPORT)  A sample report is pictured below:

---CUMULATIVE STATUS FROM START OF PROGRAMMING TO CURRENT DAY = 200---------

| TOTAL Person Days Expended to Date | 817 Person Days |
| Programming Person Days Expended to Date | 735 Person Days |
| QA Person Days Expended to Date | 82 Person Days |
| TOTAL Defects Detected | 137 Defects |
| TOTAL KDSI Completed | 12.67 KDSI |
| Defect Density | 10.9 Defects/KDSI |

------------------STATISTICS FOR THE LAST 40 DAY PERIOD ONLY---------------------

| QA Person Days Expended Last 40 Days | 18 Person Days |
| Defects Detected Last 40 Days | 38 Defects |
| Density of defects detected Last 40 Days | 11.6 Defects/KDSI |

PRESS <ENTER> TO RETURN TO THE MENU

This report recaps the TOTAL Person-Days Expended to Date and provides a breakdown of the number of person days expended on both the QA and programming activities. In the top section, this report gives cumulative defect data (i.e. from start of programming phase to current time). The bottom section shows data for the last 40 day period only.

Historically, the Defect Density (i.e. number of defects detected during programming divided by the number of KDSI developed) has ranged from 5 - 20 Defects/KDSI.

Comparing the aggregate data and the data for the last period can indicate trends.
Graph 4 (PROJECT SIZE & STATUS GRAPH)

This graph shows how the total staff level and the estimates of system size and programming cost are changing over time.
This graph shows how the level of the total staff, programming staff, and QA staff is changing over time.
Graph 6 (DEFECT GRAPH)

This graph shows how "QA Person Days per KDSI Developed in Period" and the "Defects Detected per KDSI Developed in Period" are changing over time.
APPENDIX L. MASTER PROJECT QUESTIONNAIRE

PROJECT QUESTIONNAIRE

Your Name: ____________________________________________________________
SMC No.: ____________________________________________________________

1. In making your decisions, how much weight out of 100 points did you accord to the following goals? (The numbers should total 100 points.)

Cost [or QUALITY] ______

Schedule ______

100

2. Describe (in words, numbers, equation, etc.) what decision rule you followed in deciding on the overall staffing level in this project:

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

3. Describe (in words, numbers, equation, etc.) how you allocated staff between programming and quality assurance.

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

95
4. Please try to elaborate on the thinking process you went through in making your decisions in this project (use back of page if necessary):

5. How clear were the instructions regarding the task?

   
   
   
   Not at all
   Very
   Clear
   Clear

6. To what extent was the graphical information provided on the progress of the project helpful in improving your own decisions?

   
   
   
   Not at all
   Very
   Helpful
   Helpful

7. To what extent were the reports on the progress of the project helpful in improving your own decisions?

   
   
   
   Not at all
   Very
   Helpful
   Helpful
8. In the project that you just completed, did you

(a) Use the PROJECT STATUS report (Y/N)?

(b) If you did, please describe how you used the information.


9. In the project that you just completed, did you

(a) Use the STAFFING LEVEL report (Y/N)?

(b) If you did, please describe how you used the information.


10. In the project that you just completed, did you

(a) Use the DEFECT report (Y/N)?

(b) If you did, please describe how you used the information.


97
11. In the project that you just completed, did you
(a) Use the PROJECT STATUS graph (Y/N)?
(b) If you did, please describe how you used the information.

12. In the project that you just completed, did you
(a) Use the STAFFING LEVEL graph (Y/N)?
(b) If you did, please describe how you used the information.

13. In the project that you just completed, did you
(a) Use the DEFECT graph (Y/N)?
(b) If you did, please describe how you used the information.
14. Have you in the past participated in project management (Y/N)? ___

If YES, to what extent was the task in this simulation similar to your previous experience?

```
1 2 3 4 5 6 7 8 9
Not at all
Similar
  Very
  Similar
```

15. How interesting was the task you just performed?

```
1 2 3 4 5 6 7 8 9
Not at all
Interesting
  Very
  Interesting
```

16. How serious were you in performing the task?

```
1 2 3 4 5 6 7 8 9
Not at all
Serious
  Very
  Serious
```

17. How clear were the instructions regarding the task, generally?

```
1 2 3 4 5 6 7 8 9
Not at all
Clear
  Very
  Clear
```

18. How easy was the simulation to use?

```
1 2 3 4 5 6 7 8 9
Not at all
Easy
  Very
  Easy
```
19. Please give us some information about yourself.

(a) Curriculum enrolled in: ____________________________

(b) Age ______

(c) Sex ________

(d) Full time work experience (in years) ______

(e) How long ago (in years) did you complete your undergraduate education? ______

(f) How familiar are you with computers, generally?

1 2 3 4 5 6 7 8 9
Not at all
Familiar

(g) How many hours (per week) do you use computers?

__________

20. Your general comments regarding the simulation:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

*** END OF SIMULATION ***
Thank you for your participation.
## APPENDIX M. POPULATION RANDOMIZATION WORKSHEETS

### Random Number Assignment:

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<td>978</td>
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<td>Sears, G.</td>
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<td>080</td>
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APPENDIX N. SEATING CHARTS

Seating Chart
(Morning)

IN-224

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<th>Tharpe</th>
<th>McQuay</th>
<th>Jo</th>
<th>Staten</th>
<th>Pemberton</th>
<th>Onorati</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
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<td>Robinson</td>
</tr>
<tr>
<td>Nault</td>
<td></td>
<td>Haffey</td>
<td></td>
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<td>down</td>
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IN-250

<table>
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<th>Sears</th>
<th>Slocumb</th>
<th>Swain</th>
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<td>McGibbon</td>
<td>Kelly James</td>
</tr>
<tr>
<td>Wilcox</td>
<td>Hernandez</td>
<td>X</td>
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X = Computer unavailable
Seating Chart
(Afternoon)

IN-224

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<th>Weiss</th>
<th>Larochele</th>
<th>Kelly, John</th>
<th>Lamb</th>
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<td>Hodges</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Emsde</td>
<td>Berry</td>
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IN-250

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X = Computer unavailable
APPENDIX O. KEY TO DATA FILE VARIABLES

Format explanation of PERFORM.DAT file:

One line containing 5 identifiers plus 10 variables captured at project completion:

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Subject's name</td>
</tr>
<tr>
<td>SMC</td>
<td>Student Mail Center Box Number</td>
</tr>
<tr>
<td>Project</td>
<td>A initially underestimated, B initially overestimated</td>
</tr>
<tr>
<td>Goal</td>
<td>1 = Cost and Schedule, 2 = Quality and Schedule</td>
</tr>
<tr>
<td>Order</td>
<td>The order that the goals were listed on the instructions (1 or 2)</td>
</tr>
<tr>
<td>FNCOST</td>
<td>Final Cost (in Man Days)</td>
</tr>
<tr>
<td>FNTIME</td>
<td>Final Cumulative Time (Days)</td>
</tr>
<tr>
<td>FNERR</td>
<td>Final Errors Remaining Undetected</td>
</tr>
<tr>
<td>FNERG</td>
<td>Final Cumulative Errors Generated</td>
</tr>
<tr>
<td>FNERD</td>
<td>Final Cumulative Errors Detected</td>
</tr>
<tr>
<td>FNERES</td>
<td>Final Cumulative Errors Escaping Detection</td>
</tr>
<tr>
<td>FNPRDT</td>
<td>Final Percentage of Errors Detected</td>
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<tr>
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Format explanation of PROCESS.DAT

One line containing 6 identifiers, 26 output variables, then 4 decision variables captured at project start and every 40 workdays until project completion:

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APPENDIX P. PERFORMANCE/DEMOGRAPHIC DATA SETS

Performance and Demographic data for all subjects

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NAME SMC# A 2 1 40 G5 12
NAME SMC# A 2 1 40 R1 317
NAME SMC# A 2 1 80 R1 51
NAME SMC# A 2 1 80 R2 23
NAME SMC# A 2 1 80 R3 55
NAME SMC# A 2 1 80 G4 22
NAME SMC# A 2 1 80 G5 10
NAME SMC# A 2 1 80 G6 13
NAME SMC# A 2 1 80 R1 332
NAME SMC# A 2 1 80 R1 320
NAME SMC# A 2 1 120 R1 36
NAME SMC# A 2 1 120 R2 29
NAME SMC# A 2 1 120 R3 60
NAME SMC# A 2 1 120 G6 15
NAME SMC# A 2 1 120 G5 5
NAME SMC# A 2 1 120 G4 31
NAME SMC# A 2 1 120 R1 218
NAME SMC# A 2 1 160 R1 15
NAME SMC# A 2 1 160 G6 10
NAME SMC# A 2 1 160 R3 4
NAME SMC# A 2 1 160 R2 20
NAME SMC# A 2 1 160 R3 25
NAME SMC# A 2 1 160 G6 11
NAME SMC# A 2 1 160 R1 93
NAME SMC# A 2 1 200 R1 24
NAME SMC# A 2 1 200 R2 25
NAME SMC# A 2 1 200 R3 20
NAME SMC# A 2 1 200 G6 45
NAME SMC# A 2 1 200 G5 6
NAME SMC# A 2 1 200 R1 124
NAME SMC# A 2 1 240 R1 18
NAME SMC# A 2 1 240 R2 20
NAME SMC# A 2 1 240 R3 43
NAME SMC# A 2 1 240 G4 16
NAME SMC# A 2 1 240 G6 90
NAME SMC# A 2 1 240 R1 203
NAME SMC# A 2 1 280 R1 30
NAME SMC# A 2 1 280 R2 31
NAME SMC# A 2 1 280 R3 14
NAME SMC# A 2 1 280 G6 14
NAME SMC# A 2 1 280 G4 13
NAME SMC# A 2 1 280 R1 278
NAME SMC# A 2 1 320 R1 26
NAME SMC# A 2 1 320 G5 7
NAME SMC# A 2 1 320 R3 8
NAME SMC# A 2 1 320 R1 13
APPENDIX S. SAS PROGRAM FILES

PERFDemo.SAS:

libname dataname "/tmp_mnt/h/sagan_u0/clswett/sas/";
options pagesize=58 linesize=80;
title "Performance and Demographic data for all subjects";
data dataname.dat;
infile "-clswett/sas/perfdemo.dat";
input Iname $ smc $ project $ goals $ order $ fncost fnsked fnerr
   fnerg fnerd fneres fnprdt fnqamd fntrmd fnrwmd #2
   smc $ project $ goals $ order $ Q1S Q1Q Q1C Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 curric $ age sex $ wkexp edago cfaqm chrswk grade;

/*
if (project='B') then delete;
if (project='A') then delete;
*/

/*
if (iname='Callagha') then delete;
*/

proc sort;
   by project goals ;
proc print;
proc means; by project goals ;
proc glm;
   class goals ;
   model fncost fnsked fnerr fnerg fnerd fneres fnprdt fnqamd fntrmd fnrwmd Q1S Q1Q Q1C Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 age wkexp edago cfaqm chrswk grade = goals ;
run;
DEMOCORR.SAS:

libname dataname "/tmp_mnt/h/sagan_u0/clswett/sas/";
options pagesize=58 linesize=80;
title "Correlation of all Demographics with Final outcomes for all subjects";
data dataname.dat;
infile "~clswett/sas/perfdemo.dat";
input lname $ smc $ project $ goals $ order $ fn cost fn sked fn err
    fn erg fn erd fner es fnpr dt fnq amd fntr md fnrw md
    Q2 smc $ project $ goals $ order $ Q1S Q1Q Q1C Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12
    Q13 Q14 Q15 Q16 Q17 Q18 curric $ age sex $ wkexp edago cfam chrswk grade;

/*
  if (project='B') then delete;
  if (project='A') then delete;
*/

/*
  if (lname='Callagh') then delete;
*/

proc sort;
   by project goals ;

proc corr; by project goals ;
   var fn cost fn sked fnerr grade;

proc corr; by project goals ;
   var fn cost fn sked fnerr edago;

proc corr; by project goals ;
   var fn cost fn sked fnerr wkexp;

proc corr; by project goals ;
   var fn cost fn sked fnerr chrswk;

proc corr; by project goals ;
   var fn cost fn sked fnerr age;

run;
PROCCESS.SAS:

libname dataname "/tmp_mnt/h/sagan_u0/clswett/sas/";
options pagesize=58 linesize=80;
title "Repeated measures analysis on Process data.";
title2 "Staffing Level for Group A";
/* This is run four times keeping the variables staff, qc, cost, duration*/

data dataname.dat (keep= lname $ smc $ project $ goals $ order $ time $ staff $);
infile "/tmp_mnt/h/sagan_u0/clswett/sas/process.dat";
input lname $ smc $ project $ goals $ order $ time $ var1-var26 staff
   qc cost duration;
/*Run all variables for Project A then for Project B*/
/*
if (project='B') then delete;
*/
if (project='A') then initcost=944;
if (project='A') then initsked=272;

proc sort data=dataname.dat out=dataname.sort;
   by project goals lname time;

proc transpose data=dataname.sort out=dataname.trans
   /* (rename=(.000=y1 _40.00=y2 _80.00=y3 _120.00=y4 _160.00=y5 _200.00=y6
        _240.00=y7))*/;
   by goals lname;
   id time;

proc glm data=dataname.trans;
   class goals ;
   model _0D00 _40D00 _80D00 _120D00 _160D00 _200D00 _240D00
     = goals/nouni;

   means goals /schefee;
   repeated period /*polynomial /short summary*/;
   proc means;
      var _0D00 _40D00 _80D00 _120D00 _160D00 _200D00 _240D00;
      by goals;
run;
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