

NAVAL POSTGRADUATE SCHOOL MONTEREY, CALIFORNIA



THESIS

**AN EXPERIMENTAL INVESTIGATION OF THE
INTERACTION BETWEEN FEEDBACK AND
GOALS ON STAFF RESOURCE ALLOCATION**

by

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June, 1996

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**AN EXPERIMENTAL INVESTIGATION OF THE INTERACTION
BETWEEN FEEDBACK AND GOALS
ON STAFF RESOURCE ALLOCATION**

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Submitted in partial fulfillment
of the requirements for the degree of

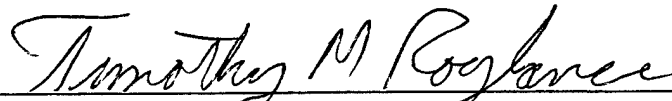
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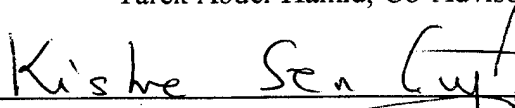


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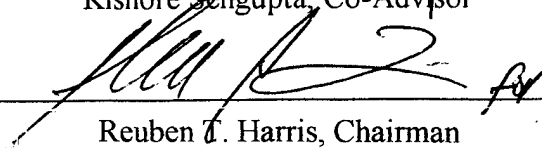
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ABSTRACT

The Department of Defense Information Technology budget stands at nine billion dollars 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. This thesis uses the Systems Dynamic Model of Software Project Management to investigate the effects of stated goals and project feedback on project manager behavior. Specifically, the experiment focuses on how software project managers allocate resources in both factual and erroneous feedback environments. The effect of goals and feedback on manager performance are measured in terms of staffing level decisions, percent of staff allocated to quality assurance activities, estimated schedule, estimated programmer productivity, and estimated cost. The results show that manager performance is highly sensitive to stated goals.

TABLE OF CONTENTS

| | |
|---|----|
| I. INTRODUCTION | 1 |
| A. BACKGROUND | 1 |
| B. PURPOSE OF RESEARCH | 2 |
| C. SCOPE OF RESEARCH | 2 |
| D. LIMITATIONS | 3 |
| E. THESIS ORGANIZATION | 3 |
| II. PREPARATION OF THE EXPERIMENTAL INTERFACE | 5 |
| A. EXPERIMENTAL DESIGN | 5 |
| 1. Cost and Schedule Goal Set | 6 |
| 2. Quality and Schedule Goal Set | 6 |
| 3. Feedback Treatment | 7 |
| 4. Experimental Groups | 8 |
| 5. Independent and Dependent Variables | 9 |
| B. SOFTWARE AND DOCUMENTATION | 10 |
| 1. Documentation | 10 |
| 2. Instruction Set | 10 |
| 3. Description of the Simulation Interface | 11 |
| 4. Project Questionnaire | 11 |
| C. INTERFACE VALIDATION | 11 |
| D. FINAL PREPARATIONS | 12 |
| III. CONDUCT OF THE EXPERIMENT | 13 |
| A. TASKS AND PROJECT CHARACTERISTICS | 13 |
| B. ORGANIZATION OF THE EXPERIMENT | 13 |
| C. THE EXPERIMENTAL SUBJECTS | 14 |
| 1. Random Number Assignment | 14 |

| | |
|--|----|
| 2. Project Assignment | 14 |
| D. DEPENDENT MEASURES | 15 |
| | |
| IV. EXPERIMENTAL RESULTS AND ANALYSIS | 17 |
| A. MODEL OF ANALYSIS | 17 |
| B. PERFORMANCE DATA | 17 |
| 1. Means | 19 |
| a. Evaluation of Variables | 19 |
| b. Cost | 19 |
| c. Schedule | 19 |
| d. Quality | 20 |
| C. PROCESS DATA | 20 |
| a. Total Staff | 22 |
| b. Quality Assurance | 23 |
| c. Cost Estimates | 24 |
| d. Schedule Estimates | 25 |
| e. Productivity Estimates | 26 |
| D. QUESTIONNAIRE AND DEMOGRAPHIC DATA | 27 |
| | |
| V. CONCLUSIONS | 29 |
| A. FINDINGS AND IMPLICATIONS | 29 |
| B. FURTHER RESEARCH | 29 |
| | |
| APPENDIX A. PROJECT@.BAT | 31 |
| | |
| APPENDIX B. PROJ@.DNX | 39 |
| | |
| APPENDIX C. TOY.BAT | 45 |

| | |
|---|-----|
| APPENDIX D. STATUS.DRS | 53 |
| APPENDIX E. STAFFING.DRS | 55 |
| APPENDIX F. DEF.DRS | 57 |
| APPENDIX G. *PLOT.DRS FILES | 59 |
| APPENDIX H. START/FINISH.BAT | 61 |
| APPENDIX I. A11 INSTRUCTION SET | 63 |
| APPENDIX J. B11 INSTRUCTION SET | 67 |
| APPENDIX K. DESCRIPTION OF THE SIMULATION INTERFACE | 71 |
| APPENDIX L. MASTER PROJECT QUESTIONNAIRE | 81 |
| APPENDIX M. WINDOWS 95 INSTRUCTIONS | 87 |
| APPENDIX N. SEATING CHARTS | 89 |
| APPENDIX O. KEY TO DATA FILE VARIABLES | 91 |
| APPENDIX P. PROCESS DATA | 95 |
| APPENDIX Q. PERFORMANCE DATA | 121 |
| APPENDIX R. SAMPLE CAPTURE.DAT | 127 |

| | |
|-------------------------------------|-----|
| APPENDIX S. SAS PROGRAM FILES | 129 |
| LIST OF REFERENCES | 133 |
| INITIAL DISTRIBUTION LIST | 135 |

I. INTRODUCTION

A. BACKGROUND

Department of Defense (DOD) software development costs have outstripped hardware costs and are continuing to grow. The major factors contributing to this growth of software costs are the continuing increase in the size and complexity of software systems and an international climate that calls for rapid adaptation to new situations. While at the same time, DOD and the Congress have stressed the importance of reducing the cost, time, and effort required to build and maintain software systems. Currently, the DOD 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. Further research suggests that software managers are also highly sensitive to stated goals. In a 1995 paper, (Swett, 1995) demonstrated using graduate students in an Information Technology Management curriculum that software managers are highly sensitive to goals and perform best in the goals they are given. Two important conclusions have been drawn from this research. First, that managers/programmers have very high achievement motivation toward their goals. Second, that different software goals are in conflict with each other.

Recently, the interaction between goals and feedback have been the subject of scrutiny by several researchers. Information about ones performance (feedback) has been hypothesized to enter into the goal-setting process by serving to evaluate assigned goals to both determine goal acceptance and to form personal goals. A study using graduate students focused on feedback as a necessary condition for goals to effect performance. It was predicted that feedback and goals would interactively relate to performance. Results supported the hypothesis by indicating that the individual differences in the self-set goals were

significantly higher in the feedback group than in the no-feedback group, and that it was in the feedback condition that the relationship between goals and performance was significantly higher than in the no-feedback condition. Ref. 10

Research seems to suggest that feedback is a necessary condition for goals to effect performance, and although there has been past research on the effects of goals on the software management process, there has never been a past experiment focused on the interaction between feedback and goals to evaluate the performance of the software management process.

B. PURPOSE OF RESEARCH

The purpose of this thesis is to design, develop, and conduct an experiment using the System Dynamics Model (SDM) of Software Project Management developed in Ref. 2 to investigate whether managerial goals (i.e. schedule, cost, and quality) and project feedback will 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 under the conditions of both accurate and erroneous feedback in allocating staff resources, and whether this leads to significant differences in project outcomes. Further, this research will examine the effects of Goal-discrepancy feedback (GDF) on project performance. GDF indicates whether subjects were performing above or below assigned goals, and by how much. Ref. 9 Even though research has been conducted into the affect of goals on software managers, no study on the interaction between feedback and 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 System Dynamics Model of Software Project Management to analyze the interaction between feedback and conflicting goals on software project managers. The System 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 several decisions for

their project every 40 days throughout the programming phase of the project life cycle.

The four groups represent different combinations of projects 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 have accurate feedback throughout the programming phase. Project B will have erroneous feedback over estimating project completion until day 120. 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 and independent 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 feedback and goals have on a software project manager's staffing decisions? 2. How will project feedback and goals effect project outcome?

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. It is assumed that these students will perform comparable to professional software managers. This assumption is further supported by the findings of William Remus. [Ref. 5]

E. THESIS ORGANIZATION

Chapter II describes the software, 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 System Dynamics 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. 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 set that includes a specific goal set.

Two separate project scenarios were constructed to investigate decisions under both accurate feedback and erroneous feedback. Project A provided accurate real time feedback through out the experiment, while project B provided an overestimation of project completion until day 120 to the subject, and then provided accurate feedback. Project B's subjects were shown reports and graphs reflecting that they were further along in the project than they actually were. 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 most likely occur. Figure 2-1 is a chart that depicts the goal and project combinations.

| | Cost and Schedule | | Quality and Schedule | |
|-----------|-------------------|-----|----------------------|-----|
| Project A | A11 | A12 | A21 | A22 |
| Project B | B11 | B12 | B21 | B22 |

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."

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 has erroneous feedback, Goal set 1 of Cost and Schedule, and Order 2 that changes the ordering of the goal set to Schedule and Cost.

3. Feedback Treatment

Figure 2-2 is an example of a completed project A Progress Report Graph. During project A, accurate feedback was displayed to the manager about the percent of Delivered Source Instructions (DSI) that were complete. The forty-five degree angle line is the Planned Percent Completion Rate, which the manager could use to judge if they were either ahead or behind schedule by comparing their DSI reported complete to it. In this example the manager could tell early in the simulation that they were behind in the project, and could make their resource allocation decisions based on that knowledge.

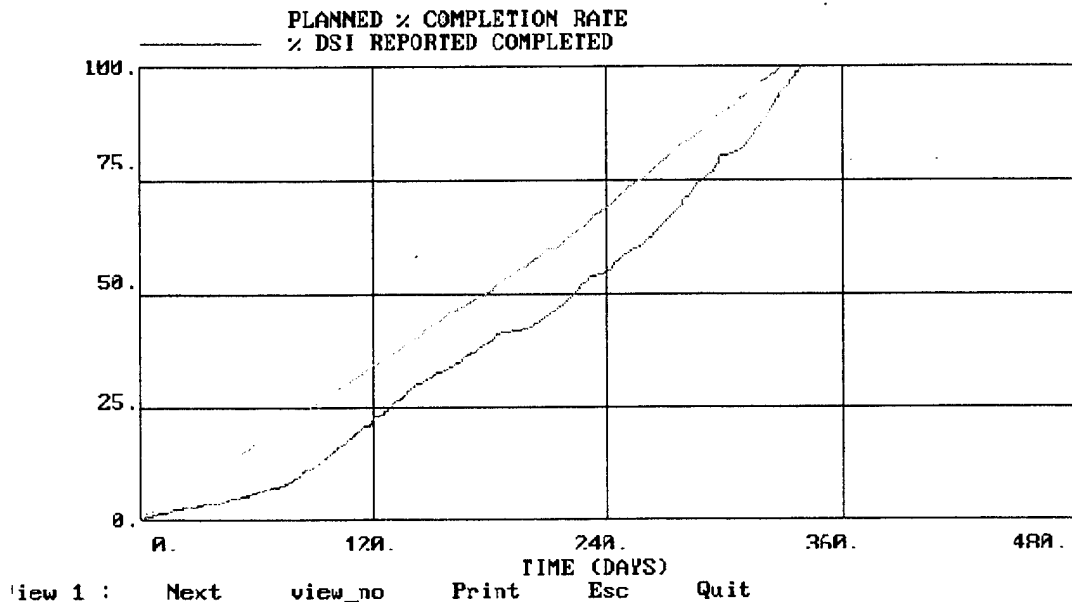


Figure 2-2 Accurate Feedback Example

Figure 2-3 is an example of a completed project B Project Report Graph. During Project B, erroneous feedback was displayed to the manager overestimating their projects DSI reported complete through day 120. In this example, the project manager was

unaware until day 120 that his project was significantly behind in completion. Because of this, he was much further along in the project when he realized that his critical staffing decisions and cost estimates were too low, and he had to begin making major adjustments to resource allocations in the middle of the project.

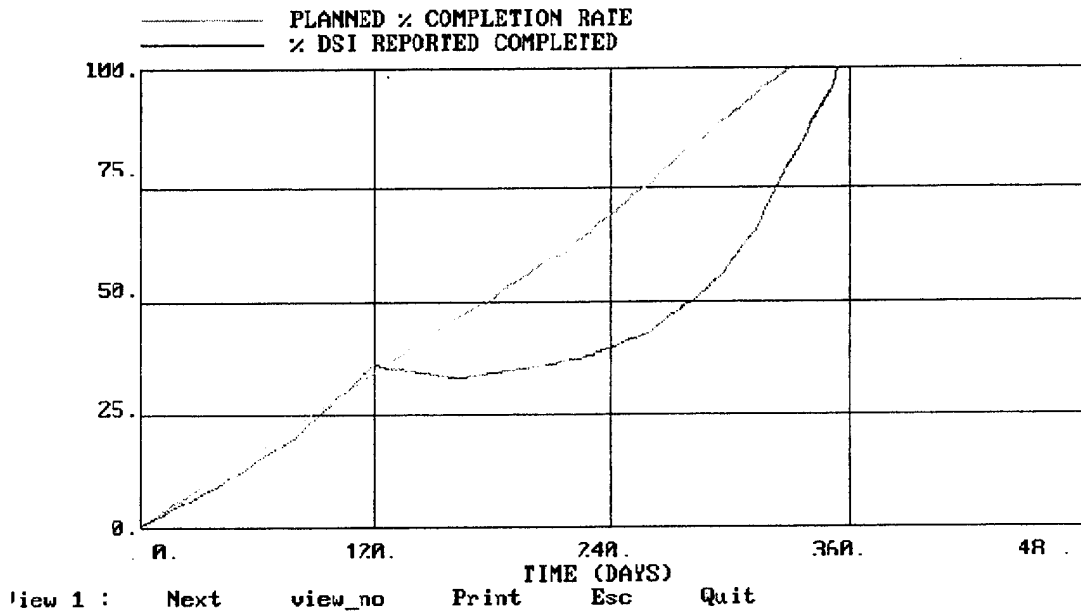


Figure 2-3 Erroneous Feedback Example

4. 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 called the "TOY". Toy was a project that had no specific goal other than to familiarize the subject with the experiment. TOY remained constant in size. The purpose of the training session was familiarity with the gaming interface and to provide a constant level of experience across the experimental groups.

5. Independent and Dependent Variables

Each subject made five inputs at each interval throughout the experiment. They were the estimated programmer productivity, total workforce requested, the percent of this workforce dedicated to quality assurance, the estimated cost to complete the programming phase, and the estimated programming phase duration. The ten project outcome variables shown in Figure 2-4 were captured at the end of the project simulation.

| VARIABLE | DESCRIPTION |
|----------|---|
| FNCOST | Final Cost (in Man Days) |
| FNTIME | Final Cumulative Time (Days) |
| FNERR | Final Errors Remaining Undetected |
| FNERG | Final Cumulative Errors Generated |
| FNERD | Final Cumulative Errors Detected |
| FNERES | Final Cumulative Errors Escaping Detection |
| FNPRDT | Final Percentage of Errors Detected |
| FNQAMD | Final Cumulative Quality Assurance Man Days |
| FNTRMD | Final Cumulative Training Man Days |
| FNRWMD | Final Cumulative Rework Man Days |

Figure 2-4 Project Outcome Variables

In addition, at each decision point in the simulation (i.e. every 40 days) 31

variables were automatically captured by the software. A detailed explanation of these variable is available in Ref. 7. These variables include the five 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. A detailed description of these variables in available in Ref. 7.

B. SOFTWARE AND DOCUMENTATION

In order to conduct the experiment, three distinct areas of components needed to be designed. The software interface for the experiment, the instructions for its use, and the questionnaire to be completed at the end of the experiment. Ref 7 provides a detailed explanation of how the software actually works.

1. 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 of the eight experimental groups. The Instruction Set also contained a documentation page so that subjects could record their inputs incase of computer malfunction. Each subject also received a copy of the "Description of the Simulation Interface." This document contained general instructions on the meaning of reports and graphs, and how 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.

2. Instruction Set

An example instruction set distributed to the subjects with project/goal/order All appears as Appendix I. 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.

3. 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 TOY and actual experiments in the manilla folder.

4. Project Questionnaire

Four versions of the Project Questionnaire were developed. An example version of the master appears as Appendix K. Each questionnaire had an X followed by the goal set/order combinations. For example X11 referred to either project A or B, goal set 1, order 1. X11 or X12 denotes that Question 1 would ask for the percentages concerning cost and schedule. X21 or X22 asked for percentages concerning quality and schedule. The order of the goal sets was added into the questionnaire to evaluate if goal order and demographics effected the experiment. 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 gather demographic data on the subjects, and to collect feedback concerning the conduct and performance of the experiment.

C. INTERFACE VALIDATION

In order to validate the user interface, pilot experiments were conducted using the lab attendants. The pilots were conducted at four separate sittings, allowing time to incorporate their suggestions between the sessions. Several 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 not to influence subject's decisions by exaggerated scales on a graph.

D. FINAL PREPARATIONS

Having completed the interface design, documentation, and follow-up questionnaire, seven copies of each of the eight project disks were made. 15 copies of each of the four separate follow-up questionnaires were made. 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 both days of experimentation 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 subjects were given an additional opportunity to ask questions prior to taking the actual experiment. Some questions were asked concerning whether there was any incentive to finish ahead of schedule. In response to these questions, the subjects were told the project that they were managing was a portion of a larger project. Finishing their portion early would only result in dead time for their staff. This left no questions that there was no reward for finishing early.

The subjects 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. None of the students with similar goals were seated next to each other. Prior to the experiment, all of the computers were checked to ensure the software would properly run. As noted in the Appendix N, several machines could not run the software and were not used. A final 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 with an hour in between to allow for separate group briefings. 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 and goal set

of each subject. This was done in the event that any subject's computer might malfunction creating the need for reassignment. Reassignment could then be done ensuring subjects with similar goal sets were not seated side by side. 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 Wednesday and Thursday sessions. Experimental groups were started an hour apart to allow for more individualized subject briefing. No information was given to the subjects on how to calculate staffing levels or how to interpret the reports. Both lab assistants had spare disks for each of the eight project configurations, and had back-up copies of all of the documentation. The entire experiment was conducted over two days. All subjects were completed with the experiment within two hours.

C. THE EXPERIMENTAL SUBJECTS

The subjects that participated 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 31 students and section two had 24 students. The subjects were randomized and assigned to each of the eight group 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. A standard list of random numbers was chosen (Daniel, 1975). The last three digits were used. Random numbers were assigned sequentially to each subject.

2. Project Assignment

The subjects were then sorted by their random number. 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.

D. DEPENDENT MEASURES

Ten performance variables were captured at the completion of the experiment. Of these, three were the most indicative of performance and were used to evaluate project performance 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.

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 indicated a higher quality product.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

A. MODEL OF ANALYSIS

For each subject, there were three sets of data captured during the simulation. Performance data measuring the project outcome was captured in the file PERFORM.DAT. Data was also captured on the five decisions made by a subject in each interval, and was stored in the file PROCESS.DAT. During each interval, data was captured on which report or graph subjects viewed and the length of time they viewed it. This data was written to the file named CAPTURE.DAT. The three data sets appear as Appendices A,B,C, respectively. Also, demographic data on each participant in the simulation was obtained through the use of a questionnaire contained in Appendix X.

Analysis of this data was conducted using Statistical Analysis System (SAS) software. Procedure MEANS, was used to determine the means and significance. Procedure General Linear Model (GLM) was used for multi variate analyses. Procedure Correlation was used to detect any correlation between independent and dependent variables. The SAS program files appear in Appendix P.

B. PERFORMANCE DATA

The analysis of each participants final performance focused on three dependent variables final cost, final schedule, and final errors. Figure 4-1 depicts the means and standard deviations of the performance variables for the different experimental groups.

| | FNSKED, Mean and (Std. Dev) | FNCOST, Mean and (Std. Dev) | FNERR, Mean and (Std. Dev) |
|-------------------------------------|--------------------------------|--------------------------------|-------------------------------|
| Project A - Cost and Schedule | 302 (41) | 1518 (355) | 2863 (3324) |
| Project A - Quality and Schedule | 292 (43) | 1737 (319) | 1190 (648) |
| Project B - Cost and Schedule | 295 (47) | 1451 (257) | 1463 (581) |
| Project B - Quality and Schedule | 347 (65) | 2006 (278) | 847 (386) |

Figure 4-1 Performance Means and Standard Deviations for the Groups

| | FNSKED, Mean and (Std. Dev) | FNCOST, Mean and (Std. Dev) | FNERR, Mean and (Std. Dev) |
|---|--------------------------------|--------------------------------|-------------------------------|
| Cost and Schedule All Projects | 298.3 (42.9) | 1483.0 (300.0) | 2126.2 (2365.2) |
| Quality and Schedule All Projects | 320.7 (60.7) | 1878.3 (321.0) | 1009.7 (540.6) |
| Project A both goal sets | 296.9 (346.1) | 1627.6 (346.1) | 2026.4 (2477.4) |
| Project B both goal sets | 320.9 (60.9) | 1728.5 (385.9) | 1155.4 (574.8) |

Figure 4-1a Performance Means and Standard Deviations by goals and projects

1. Means

The analysis of the above means from Figure 4-1 reveals that all goals were important to the subjects. The mean of the groups that had quality as a goal had fewer errors than those groups that did not. The same holds true for those subjects that had cost as a goal, those groups had lower mean costs than the groups without cost as a goal. Everyone had minimizing schedule as a goal, so it is not surprising there was not a substantial difference between groups with respect to schedule. The data in figure 4-1a showed that the bad feed back of project B definitely increased the mean project schedule and cost, as compared to project A. Peculiarly, though, the bad feedback of project B led to a better quality product, this was because as subjects with quality as a goal felt they were on or ahead of schedule due to erroneous feed back, they put more staff into quality assurance to attain a quality product.

a. Evaluation of variables

The GLM procedure was used for comparison of the groups performance to determine if there were significant differences between the groups. Each group's cost, schedule and quality variables were analyzed to determine if they were significant. Then the effects of goals and feedback were analyzed on the above variables.

b. Cost

For final cost, the GLM procedure yielded ($F(4,33)=7.00$; $P<0.0003$). This rejects the null hypothesis, thereby that indicating there were significant differences among the four experimental groups in terms of cost. Also, there was a strong goals effect ($F(4,33)=17.39$; $P<0.0002$) on cost. Subjects that had minimizing cost as a goal had significantly lower costs compared to subjects that did not have cost as a goal. There was not, however, a feedback effect ($F(4,33)=1.48$; $P<.2839$), the erroneous feedback given to a subject working on project B did not significantly effect his/her cost.

c. Schedule

For final schedule the GLM procedure produced ($F(4,33)=3.24$; $P<.0239$). This rejects the null hypothesis thereby indicating that there were significant differences

between groups in terms of schedule. All subjects had the goal of minimizing schedule, so there was not a goals effect between groups. However, the order of the goals on the subjects instruction sets seemed to have an effect, ($F(4,33)=3.24$; $P<.040$) this was probably due to the small number of subjects in each experimental group. The erroneous feedback given to a subject working on project B, though, did not significantly effect his/her final schedule ($F(4,33)=2.77$; $P<.1058$).

d. Quality

The GLM procedure for final errors revealed ($F(4,33)=3.26$; $P<0.0233$) rejecting the null hypothesis thereby indicating significance. There was a significant difference between groups in terms of quality. Again, there was a strong goals effect ($F(4,33)=4.85$; $P<0.0348$). Subjects that had maximizing quality as a goal delivered a product with fewer errors than subjects who did not have maximizing quality as a goal. The order of the goals was also significant ($F(4,33)=4.57$; $P<0.0401$), but again, this was probably due to the small number of subjects in each experimental group. However, the erroneous feedback of project B did not significantly effect it in terms of quality ($F(4,33)=3.21$; $P<.0823$), although, the group with erroneous feed back and quality as a goal did have the best quality product.

C. PROCESS DATA

The subjects were required to make five decisions at each 40 day interval. The first decision was to estimate the productivity of the team (lines of code produced per programmer per day). Then each subject selected his/her total staff, percentage of staff allocated to quality assurance, and estimates of the projects' final cost and schedule. 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 obtained, the last interval used is day 200. This is the last interval in which all of the subjects had not completed the project and were still making decisions. An analysis using the SAS GLM procedure was used to determine if there was a period effect, second to determine if there was a time effect between the four groups, and also to determine if there was significant difference

between the subjects of the four groups.

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 over time. Lastly, analysis was conducted to determine if there was significant difference between subjects.

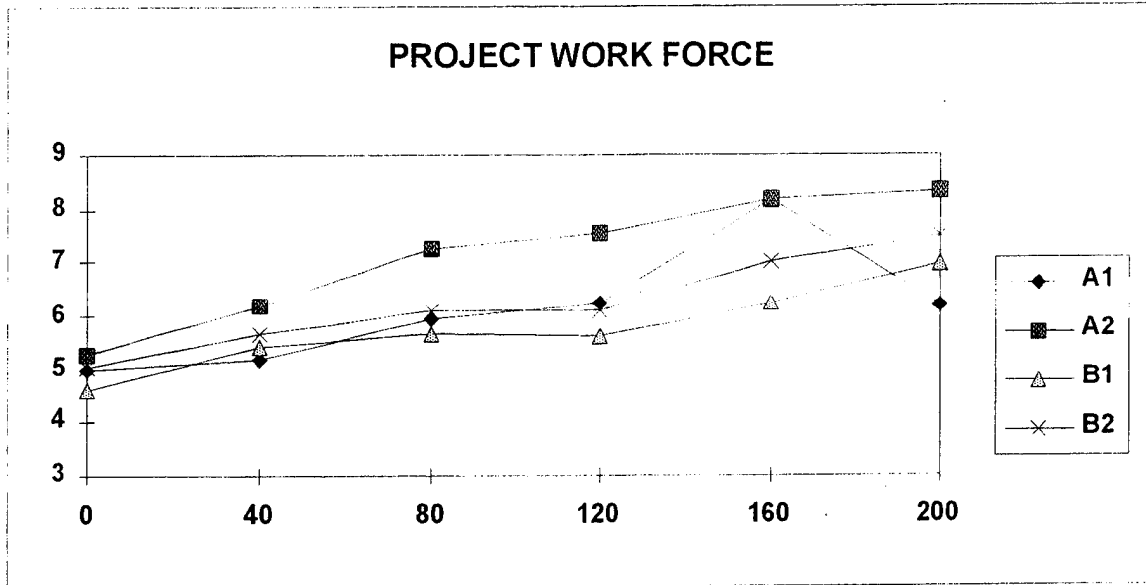


Figure 4-2 Total Staff Requested for Project.

a. Total Staff

Figure 4-2 is a graph of the group means for total staff requested by participants in the Project. 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 staff ($F(5,31)=5.84$; $P<0.0007$). The null hypothesis for interaction however, cannot be rejected ($F(5,31)=1.52$; $P<0.2211$). The test for difference between subjects indicates that the null hypothesis cannot be rejected, there is no significant difference between subjects with different goals ($F(1,35)=4.05$; $P<0.052$), or feed back ($F(1,35)=1.14$; $P<0.290$).

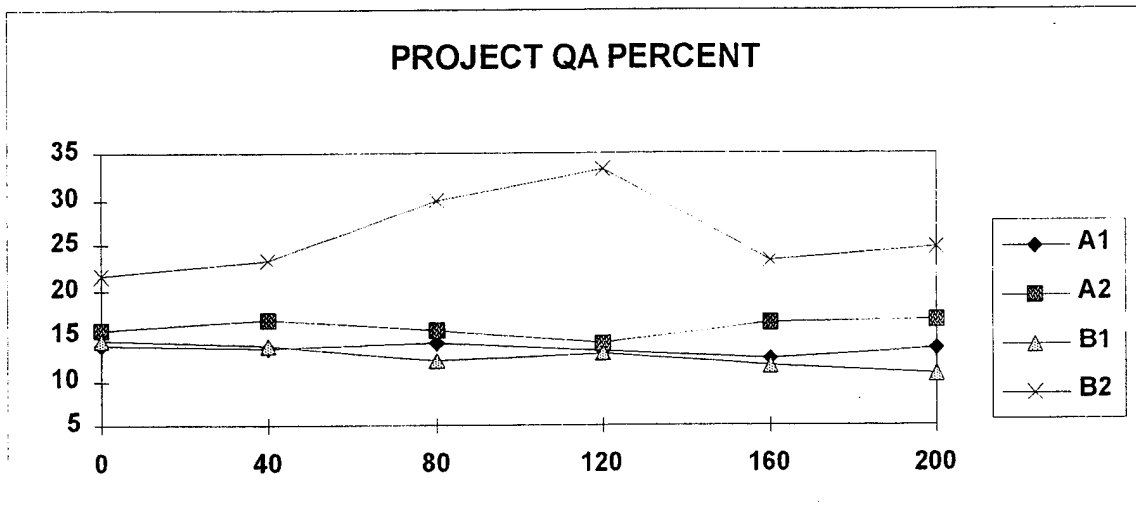


Figure 4-3 Percent of Requested Staff Allocated to QA for Project

b. Quality Assurance

Figure 4-3 is a graph of the percent of the total staff allocated to quality assurance activities. The analysis of the means as shown in the graph indicates that there is no period effect with respect to quality assurance. The null hypothesis for no period effect is accepted with respect to quality assurance ($F(5,31)=5.84$; $P<0.336$). Also, the null hypothesis for interaction between groups over time cannot be rejected ($F(5,31)=1.41$; $P<0.249$). The test for difference between subjects indicates that the null hypothesis can be rejected, there is significant difference between subjects with different goals ($F(1,35)=8.35$; $P<0.052$). For between subjects effects on feed back, however the null hypothesis cannot be rejected ($F(1,35)=2.71$; $P<0.111$). Feedback was not significant with respect to quality assurance.

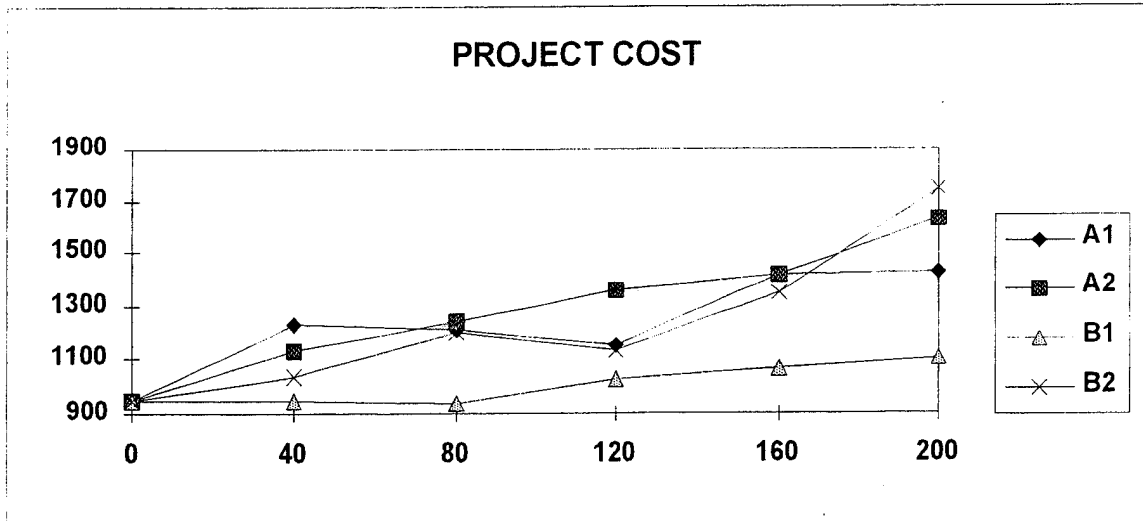


Figure 4-4 Estimated Completion Cost for Project

c. Cost Estimates

Figure 4-4 depicts the estimate for total project cost for the subjects that managed Project. The analysis of the means as shown in the graph indicates that there is a period effect with respect to cost. The null hypothesis for no period effect is rejected with respect to cost estimates ($F(5,31)=8.11$; $P<0.0001$). However, the null hypothesis for interaction between groups cannot be rejected ($F(5,31)=1.74$; $P<0.155$). The test for difference between subjects indicates that the null hypothesis can not be rejected, indicating that there is no significant difference between subjects with different goals ($F(1,35)=2.70$; $P<0.110$) or feed back ($F(1,35)=2.36$; $P<0.133$).

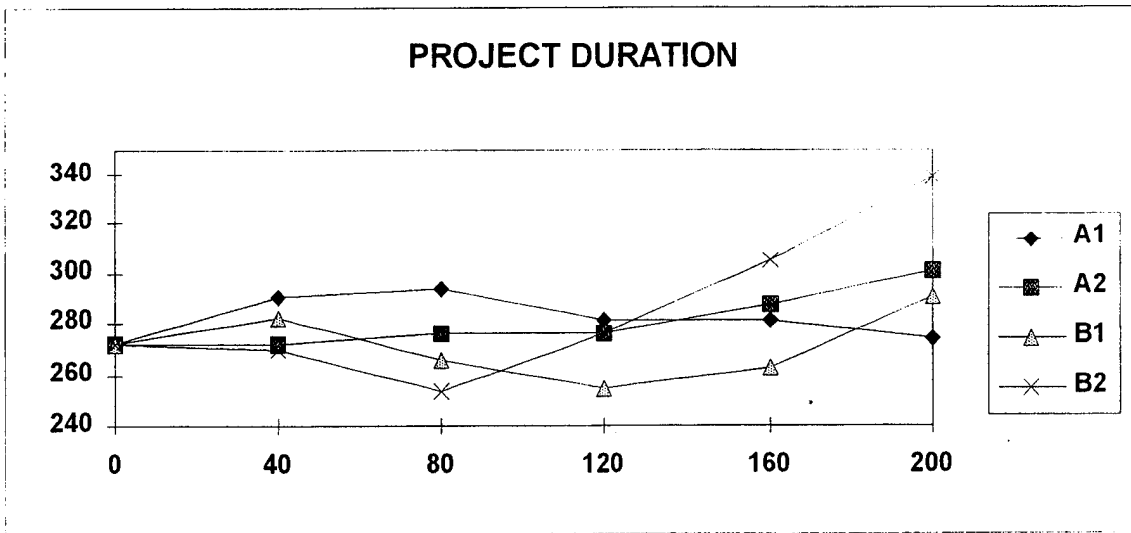


Figure 4-5 Estimated Schedule for Project.

d. Schedule Estimates

Figure 4-5 illustrates the subject's estimated project schedule as the project progressed. The analysis of the means as shown in the graph indicates that there is no period effect. The null hypothesis for no period effect can not be rejected with respect to schedule estimates ($F(5,31)=2.13$; $P<0.089$). Also, the null hypothesis for interaction between groups cannot be rejected ($F(5,31)=1.52$; $P<0.214$). The test for difference between subjects indicates that the null hypothesis can not be rejected, indicating that there is no significant difference between subjects with different goals ($F(1,35)=.74$; $P<0.396$) or feed back ($F(1,35)=0.11$; $P<0.739$).

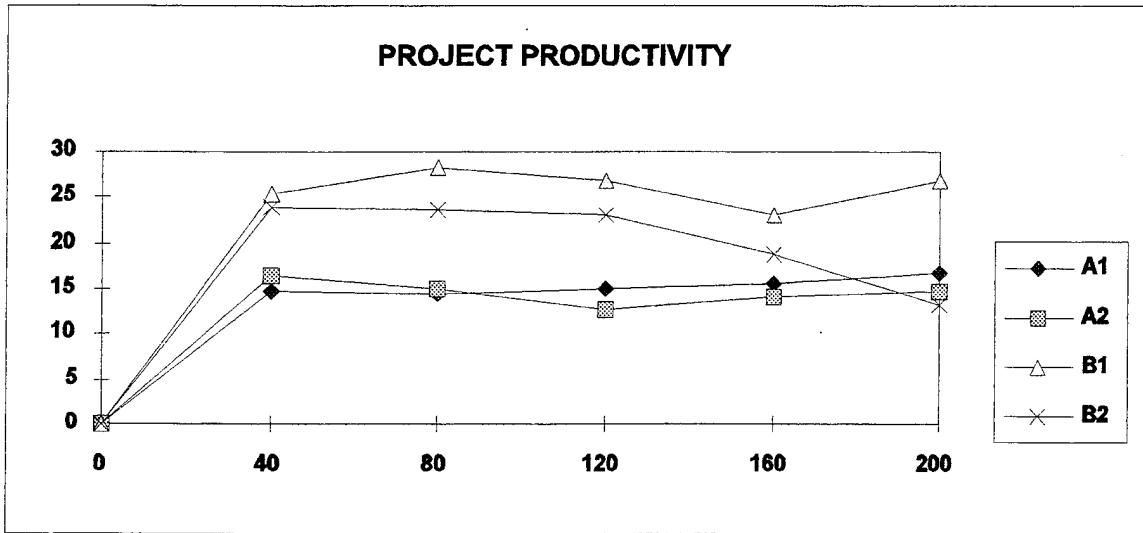


Figure 4-6 Estimated Productivity for Project.

e. Productivity Estimates

Figure 4-6 is a graph of the group means for individual staff productivity estimated by participants in the Project. 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 staff productivity ($F(5,31)=320$; $P<0.0001$). The null hypothesis for interaction between groups however, cannot be rejected ($F(5,31)=2.22$; $P<0.077$). The test for between subjects effects with different goals indicates that the null hypothesis cannot be rejected ($F(1,35)=3.31$; $P<0.078$). However, the between subjects effects for different feed back were significant rejecting the null hypothesis ($F(1,35)=21.23$; $P<0.0001$).

D. QUESTIONNAIRE AND DEMOGRAPHIC DATA

After completion of the project, each participant filled out a questionnaire. The last page of the questionnaire was devoted entirely to demographics. The data format can be found in Appendix Q.

| Group | AGE | CHRSWK | WKEXP | EDAGO |
|-------|---------------|----------------|---------------|---------------|
| A1 | 33.0 (2.8) | 23.4 (9.7) | 13.0 (5.5) | 11.9 (6.3) |
| A2 | 31.9 (3.1) | 15 (6.9) | 10.8 (4.8) | 8.3 (4.0) |
| B1 | 31.6 (4.1) | 13.6 (7.0) | 11.5 (4.7) | 7.4 (5.1) |
| B2 | 30.2 (3.7) | 19.9 (13.0) | 8.4 (4.9) | 7.4 (3.8) |

Figure 4-7 Group means and standard deviation demographics

Figure 4.7 represents the sample demographics profile by group. Age represents the average age of the participant, CHRSWK represents the mean number of hours spent using a computer per week, WKEXP represents work experience in years, and EDAGO is the number of years since the subject completed his undergraduate education. Group A1 was the oldest, had the most work experience, spent the most time on a computer per week, and had completed their undergraduate education the longest ago. Group B2 was the youngest spent the second greatest time on a computer per week and tied with group B2 for having the most recent undergraduate experience.

V. CONCLUSIONS

A. FINDINGS AND IMPLICATIONS

The objective of this thesis was to conduct a controlled experiment focused on gaining insight into the interaction between feedback and stated goals on software project management. This thesis provides significant findings regarding the software project managers's behavior in both accurate and erroneous feedback environments.

The experimental results confirm that goals do matter to software development managers. Managers perform best in the goals that they are given. Additionally, it confirms that different software development goals, i.e. quality, cost, and schedule are indeed in conflict with each other.

The experimental results did not, however, find any significant differences between the groups given different feedback. Only two reasons for this exist, either goals overwhelm feedback, or more than likely, the small group size of this experiment caused the feedback results to be insignificant.

B. FURTHER RESEARCH

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

Another area to be researched concerns goal commitment. In this thesis goals were given to the manager and no attempt was made to analyze the level of commitment. Further research could be conducted to measure both the initial commitment to the goals and whether this commitment was maintained over time.

Lastly, interaction between feedback and goal commitment could be researched using more subjects. In this thesis, there were differences in performance that occurred due to feedback, but the group size was too small for them to be significant.

APPENDIX A. PROJECT@.BAT

```
@echo off
rem PROJA initially underestimated project

cls
rem init.exe requires 3 parameters i.e. [project,group,ins.set]
init A 1 2
graphics
bat /n /p /s
ram
smlt PROJA -go = -prs = -ls -ns -plm 16
rep PROJA.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
rep PROJA.RSL PROCESS.DRS -outf .PROCESSSS.OUT -t >NUL

-top    dynex PROJA -in PROJA.STT -sc -ls -plm 16
        smlt PROJA -gm = -ns -plm 16

        copy process.out process.old >NUL
        rep PROJA.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
        rep PROJA.RSL PROCESS.DRS -outf PROCESSSS.OUT >NUL
        rep PROJA.RSL INTERVAL.DRS -outf INTERVAL.OUT -t >NUL
        process

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

-top1   cls

-PROGREP **** VIEW PROGRESS *****
        timestmp
        rep PROJA PROGRESS.DRS -outf PROGRESS.OUT -t -sc -ls -plm 16
        inkey
        capture R5 >NUL
        cls
        color \1F

-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
```

```
             \1E 4  \1F CUMULATIVE \1EREPORT\1F
```

```
\1BGRAPHS:  \1F
```

```
             \1B 5  \1F PROJECT PROGRESS \1BGRAPH\1F
```

```
             \1B 6  \1F STAFFING \1BGRAPH\1F
```

```
             \1B 7  \1F COST AND DURATION \1BGRAPH\1F
```

```
             \1B 8  \1F DEFECT STATUS \1BGRAPH\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 -CUMREP
  if %2 = 5 goto -FEEDPLOT
  if %2 = 6 goto -STAFPLOT
  if %2 = 8 goto -DEFPLOT
```

```
if %2 = 7 goto -COSTPLOT
if %2 = P goto -proceed
if %2 = KEY011 return
beep goto -menu
```

```
-STATREP **** VIEW PROJECT STATUS REPORT *****
timestamp
rep PROJA 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 PROJA 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 PROJA DEF.DRS -outf DEF.OUT -t -sc -ls -plm 16
inkey
capture R3 >NUL
cls
color \1F
goto -menu
```

```
-CUMREP **** VIEW PROJECT CUMULATIVE REPORT *****
timestamp
rep PROJA CUM.DRS -outf CUM.OUT -t -sc -ls -plm 16
inkey
capture R4 >NUL
cls
color \1F
goto -menu
```

```
-COSTPLOT **** VIEW PROJECT STATUS PLOT ****
  timestmp
  cls
  color \1F
  begtype
```

```
*****
\1A          PROJECT COST VARIABLES          \1F
*****
```

THE FOLLOWING PROJECT STATUS VARIABLES WILL BE PLOTTED:

```
EST OF PROGRAMMING PHASE COST. . . . . PERSON DAYS
EST OF PROGRAMMING PHASE DURATION . . . . . DAYS
```

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

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

```
end
  inkey
  cls
  rep PROJA STATPLOT.DRS
  capture G8 >NUL
  color \1F
  cls
  goto -menu
```

```
-STAFPLOT **** VIEW GRAPHIC STAFFING PLOT ****
  timestmp
  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 PROJA STAFFPLOT.DRS
capture G6 >NUL
color \1F
cls
goto -menu
```

```
-DEFPLOT **** VIEW DEFECT PLOT ****
  timestmp
  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 PROJA DEF PLOT.DRS
capture G7 >NUL
color \1F
cls
goto -menu

-FEEDPLOT **** VIEW DEFECT PLOT ****
timestmp
cls
color \1F
begtype

\1A PERCENT COMPLETION VARIABLES \1F

THE FOLLOWING VARIABLES WILL BE PLOTTED:

PLANNED PERCENTAGE COMPLETION RATE . . . PERCENT KDSI
PERCENT DSI REPORTED COMPLETE PERCENT KDSI

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

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

```
END
```

```
inkey  
cls  
rep PROJA FEEDPLOT.DRS  
capture G5 >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 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                24400. 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
cend 1/1
display clear

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

Your updated estimate for productivity (DSI/person days) =
dendq
dq PRODTY=0<

display
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 productivity =           #PRODTY DSI/person-day
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
Your updated estimate for productivity (DSI/person days) =
dendq
dq PRODTY=0<

```

```

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 clear

```

```
*****
*
*   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 PROJA initially underestimated project

cls
rem init.exe requires 3 parameters i.e. [project,group,ins.set]
init A 1 2
graphics
bat /n /p /s
ram
smlt PROJA -go = -prs = -ls -ns -plm 16
rep PROJA.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
rep PROJA.RSL PROCESS.DRS -outf PROCESSSS.OUT -t >NUL

-top    dynex PROJA -in PROJA.STT -sc -ls -plm 16
smlt PROJA -gm = -ns -plm 16

copy process.out process.old >NUL
rep PROJA.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
rep PROJA.RSL PROCESS.DRS -outf PROCESSSS.OUT >NUL
rep PROJA.RSL INTERVAL.DRS -outf INTERVAL.OUT -t >NUL
process

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

-top1   cls

-PROGREP **** VIEW PROGRESS *****
timestmp
rep PROJA PROGRESS.DRS -outf PROGRESS.OUT -t -sc -ls -plm 16
inkey
capture R5 >NUL
cls
color \1F

-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

 \1E 4 \1F CUMULATIVE \1EREPORT\1F

\1BGRAPHS: \1F

 \1B 5 \1F PROJECT PROGRESS \1BGRAPH\1F

 \1B 6 \1F STAFFING \1BGRAPH\1F

 \1B 7 \1F COST AND DURATION \1BGRAPH\1F

 \1B 8 \1F DEFECT STATUS \1BGRAPH\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 -CUMREP  
  if %2 = 5 goto -FEEDPLOT  
  if %2 = 6 goto -STAFPLOT  
  if %2 = 8 goto -DEFPLOT  
  if %2 = 7 goto -COSTPLOT
```

```
if %2 = P goto -proceed
if %2 = KEY011 return
beep goto -menu
```

```
-STATREP **** VIEW PROJECT STATUS REPORT *****
timestamp
rep PROJA 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 PROJA 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 PROJA DEF.DRS -outf DEF.OUT -t -sc -ls -plm 16
inkey
capture R3 >NUL
cls
color \1F
goto -menu
```

```
-CUMREP **** VIEW PROJECT CUMULATIVE REPORT *****
timestamp
rep PROJA CUM.DRS -outf CUM.OUT -t -sc -ls -plm 16
inkey
capture R4 >NUL
cls
color \1F
goto -menu
```

```
-COSTPLOT **** VIEW PROJECT STATUS PLOT ****
```

```
  timestmp  
  cls  
  color \1F  
  begtype
```

```
*****  
  \1A                PROJECT COST VARIABLES                \1F  
*****
```

THE FOLLOWING PROJECT STATUS VARIABLES WILL BE PLOTTED:

```
EST OF PROGRAMMING PHASE COST. . . . . PERSON DAYS  
EST OF PROGRAMMING PHASE DURATION . . . . . DAYS
```

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

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

```
end
```

```
  inkey  
  cls  
  rep PROJA STATPLOT.DRS  
  capture G8 >NUL  
  color \1F  
  cls  
  goto -menu
```

```
-STAFFPLOT **** VIEW GRAPHIC STAFFING PLOT ****
```

```
  timestmp  
  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 PROJA STAFFPLOT.DRS
capture G6 >NUL
color \1F
cls
goto -menu
```

```
-DEFPLOT **** VIEW DEFECT PLOT ****
timestmp
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 PROJA DEF PLOT.DRS
capture G7 >NUL
color \1F
cls
goto -menu
```

-FEEDPLOT **** VIEW DEFECT PLOT ****

```
timestmp
cls
color \1F
begtype
```

```
*****
\1A PERCENT COMPLETION VARIABLES \1F
*****
```

THE FOLLOWING VARIABLES WILL BE PLOTTED:

```
PLANNED PERCENTAGE COMPLETION RATE . . . PERCENT KDSI
PERCENT DSI REPORTED COMPLETE . . . . . PERCENT KDSI
```

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

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

```
END
```

```
inkey  
cls  
rep PROJA FEEDPLOT.DRS  
capture G5 >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 G. *PLOT.DRS FILES

STATPLOT.DRS:

plotxy <TM"TIME (DAYS) ",0,480>,
<SCHCDT"EST PROGRAMMING PHASE DURATION (START-END) ",0,440>,
<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) ",0,600>,<PRQAMD"QA PERSON DAYS PER PERIOD
",0,240>,<PRERD"DEFECTS DETECTED PER PERIOD ",0,240>

FEEDPLOT.DRS:

plotxy <TM"TIME (DAYS) ",0,480>,
<PLAN " PLANNED % COMPLETION RATE",0,100>,
<REPRT" % DSI REPORTED COMPLETED ",0,100>

APPENDIX H: START/FINISH.BAT

```
start.bat
cls
@echo off
@echo.
@echo.
@echo          Starting the Project Simulation.
@echo.
@echo Copying files...
@echo.
mkdir c:\proja21
copy *.* c:\proja21
c:
cd c:\proja21
cls
proja

finish.bat
echo off
cls
copy *.* b:
```


APPENDIX I. All INSTRUCTION SET

Your Name: _____
SMC No.: _____

All

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 total cost incurred and minimize schedule overrun.

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 you select may have fractions (e.g. 4.5 people).
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 Name: _____
 SMC No.: _____

YOUR GOAL IS:

Minimize total cost incurred and minimize schedule overrun.

INITIAL ESTIMATES:

| | |
|------------------------------|-----------------|
| Project Size | 24400 DSI |
| Project Cost | 944 Person Days |
| Project Duration (start-end) | 272 Days |

| TIME ELAPSED (DAYS) | ESTIMATED PRODUCTI- VITY (DSI/P-D) | ESTIMATED COST (PERS-DAYS) | ESTIMATED DURATION (DAYS) | STAFFING LEVEL (PERSONS) | QUALITY ASSURANC E (PERCENT) |
|-------------------------|---|----------------------------------|---------------------------------|--------------------------------|---------------------------------------|
| Initial Decision | | 944 | 272 | | |
| Time Elapsed - 40 Days | | | | | |
| Time Elapsed - 80 Days | | | | | |
| Time Elapsed - 120 Days | | | | | |
| Time Elapsed - 160 Days | | | | | |
| Time Elapsed - 200 Days | | | | | |
| Time Elapsed - 240 Days | | | | | |
| Time Elapsed - 280 Days | | | | | |
| Time Elapsed - 320 Days | | | | | |
| Time Elapsed - 360 Days | | | | | |
| Time Elapsed - 400 Days | | | | | |
| Time Elapsed - 440 Days | | | | | |
| Time Elapsed - 480 Days | | | | | |
| Time Elapsed - 520 Days | | | | | |

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

APPENDIX J: B11 INSTRUCTION SET

Your Name: _____
SMC No.: _____

B11

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:

| | |
|--|--|
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| 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 total cost incurred and minimize schedule overrun.

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 you select may have fractions (e.g. 4.5 people).
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 Name: _____
 SMC No.: _____

YOUR GOAL IS:

Minimize total cost incurred and minimize schedule overrun.

INITIAL ESTIMATES:

| | |
|------------------------------|-----------------|
| Project Size | 24400 DSI |
| Project Cost | 944 Person Days |
| Project Duration (start-end) | 272 Days |

| TIME ELAPSED (DAYS) | ESTIMATED PRODUCTI- VITY (DSI/P-D) | ESTIMATED COST (PERS-DAYS) | ESTIMATED DURATION (DAYS) | STAFFING LEVEL (PERSONS) | QUALITY ASSURANC E (PERCENT) |
|-------------------------|---|----------------------------------|---------------------------------|--------------------------------|---------------------------------------|
| Initial Decision | | 944 | 272 | | |
| Time Elapsed - 40 Days | | | | | |
| Time Elapsed - 80 Days | | | | | |
| Time Elapsed - 120 Days | | | | | |
| Time Elapsed - 160 Days | | | | | |
| Time Elapsed - 200 Days | | | | | |
| Time Elapsed - 240 Days | | | | | |
| Time Elapsed - 280 Days | | | | | |
| Time Elapsed - 320 Days | | | | | |
| Time Elapsed - 360 Days | | | | | |
| Time Elapsed - 400 Days | | | | | |
| Time Elapsed - 440 Days | | | | | |
| Time Elapsed - 480 Days | | | | | |
| Time Elapsed - 520 Days | | | | | |

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

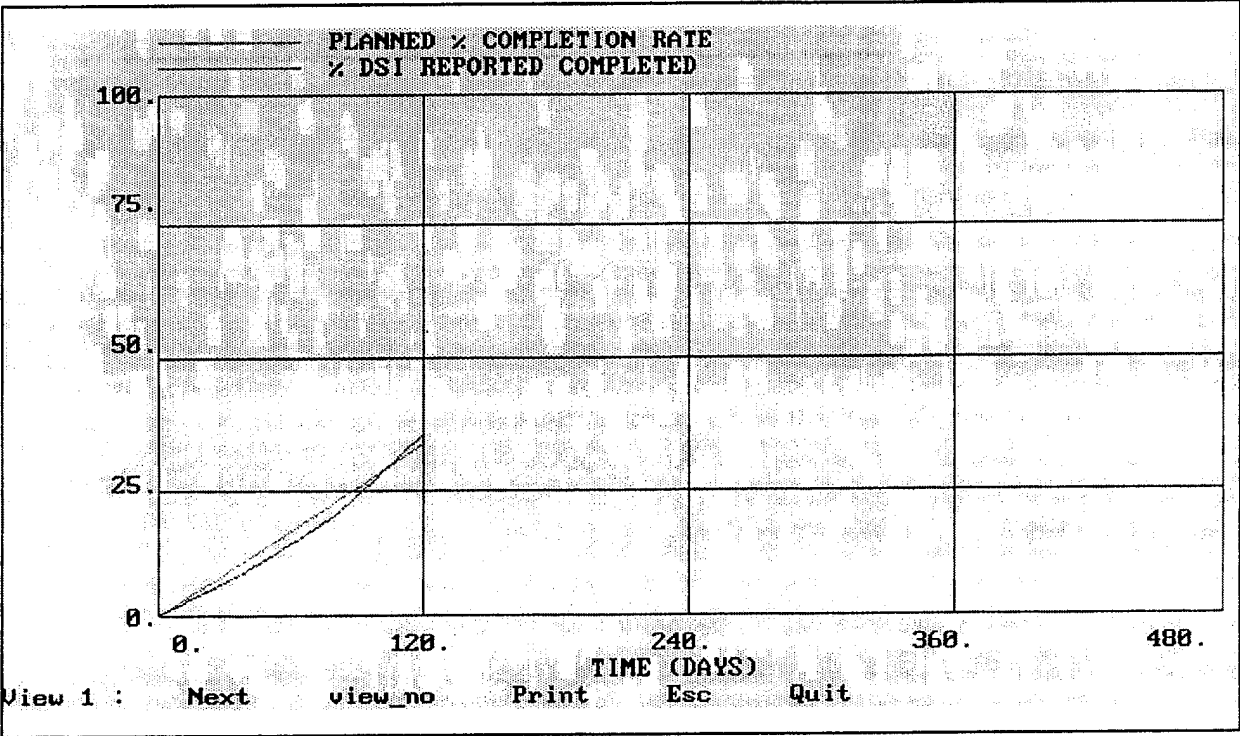
**APPENDIX K: DESCRIPTION OF THE SIMULATION INTERFACE
REPORTS AND GRAPHS MENU:**

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 STATUS REPORT |
| | 2 STAFFING REPORT |
| | 3 DEFECT REPORT |
| | 4 CUMULATIVE REPORT |
| GRAPHS: | 5 PROJECT PROGRESS GRAPH |
| | 6 STAFFING GRAPH |
| | 7 COST AND DURATION GRAPH |
| | 8 DEFECT STATUS GRAPH |
| PRESS P TO PROCEED TO ENTER DECISIONS FOR THE NEXT 40 DAYS | |
| Choose an option: <Do NOT hit <ENTER> after selection!!!>; | |

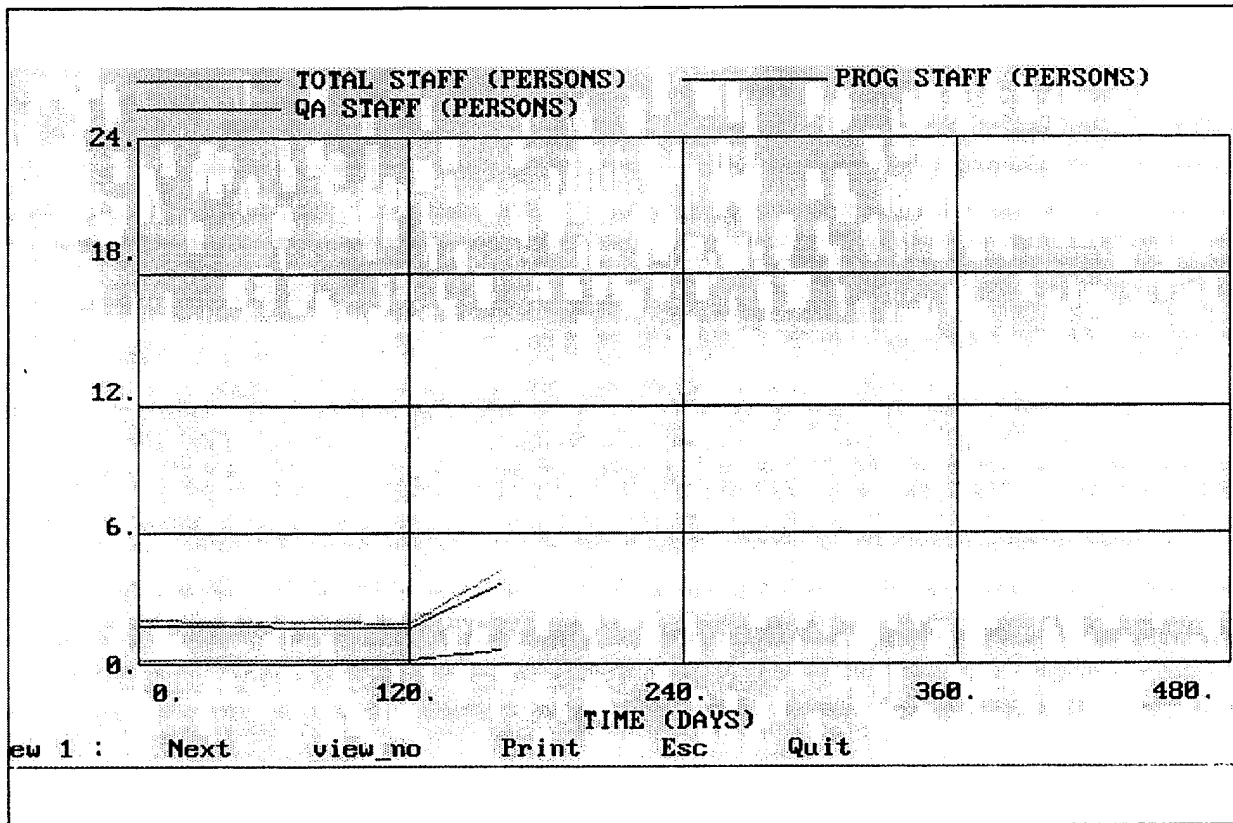
After viewing the pertinent information (you may view any report or graph more than once), use the "P" selection to proceed to enter your decisions for the next 40 day simulation period.

Graph 5 (PROJECT PROGRESS GRAPH)



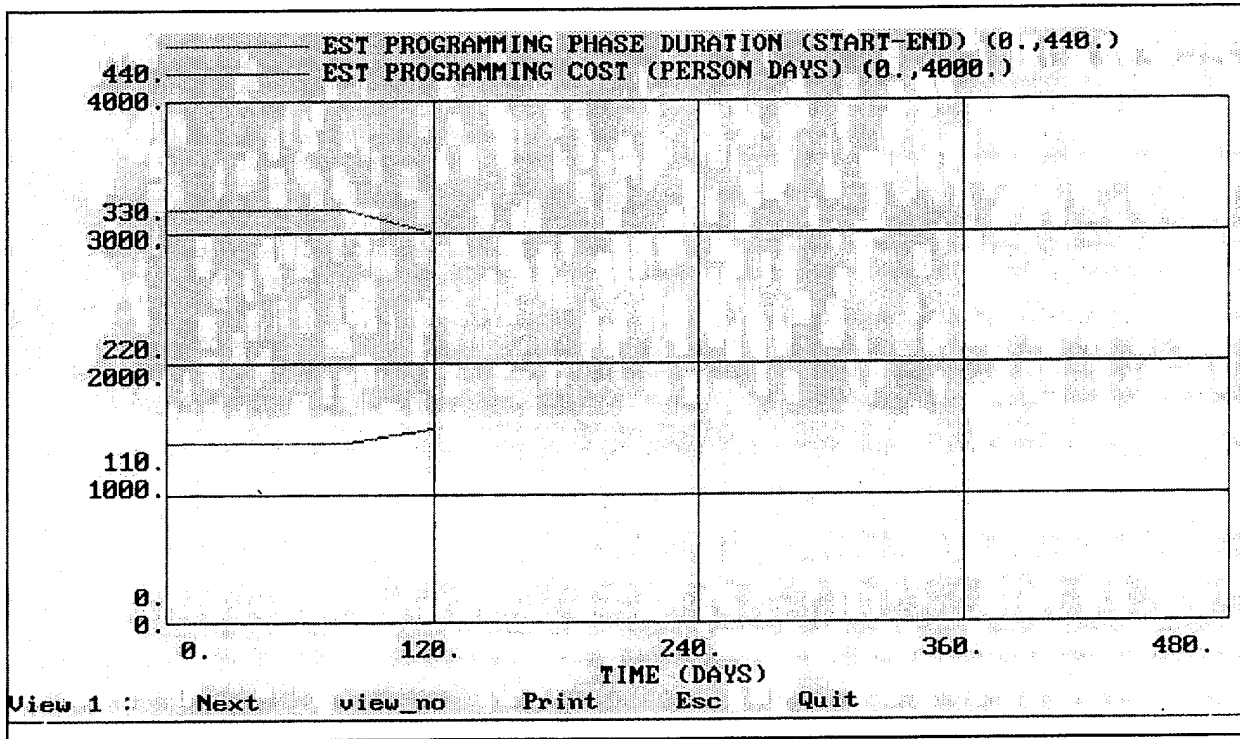
This graph compares the level of "planned % completion rate" and "%DSI reported complete" over time.

Graph 6 (STAFFING GRAPH)



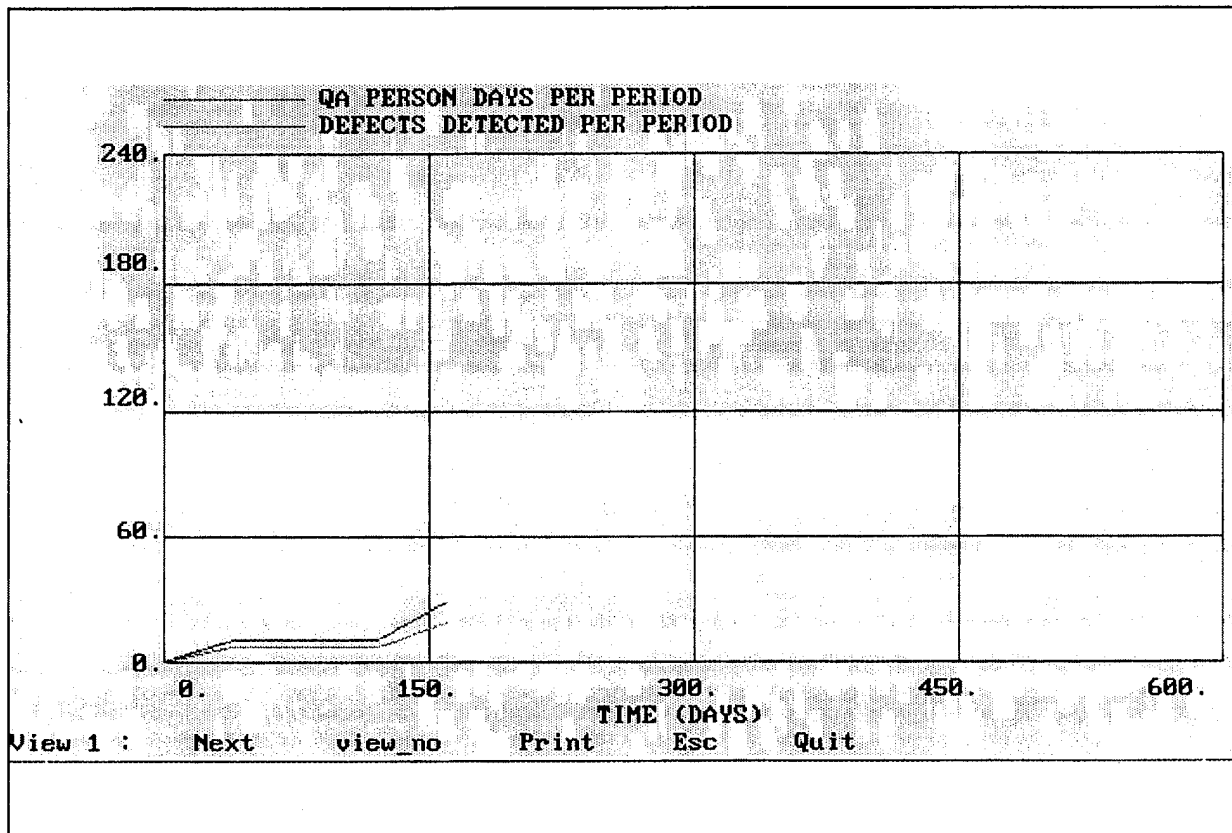
This graph shows how the level of the total staff, programming staff, and QA staff is changing over time.

Graph 7 (PROJECT COST AND DURATION GRAPH)



This graph shows how the estimates of programming phase duration and programming cost are changing over time.

Graph 8 (DEFECT GRAPH)



This graph shows how "QA person days expended per period" and the "number of defects detected per period" are changing over time.

APPENDIX L. MASTER PROJECT QUESTIONNAIRE

PROJECT QUESTIONNAIRE

XXX

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.

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?

| | | | | | | | | |
|------------|---|---|---|---|---|---|---|-------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 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?

| | | | | | | | | |
|------------|---|---|---|---|---|---|---|---------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 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?

| | | | | | | | | |
|------------|---|---|---|---|---|---|---|---------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 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.

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 | | | | | | | | Very |
| Similar | | | | | | | | Similar |

15. How interesting was the task you just performed?

| | | | | | | | | |
|-------------|---|---|---|---|---|---|---|-------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Not at all | | | | | | | | Very |
| Interesting | | | | | | | | 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 | | | | | | | | | Very 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: WINDOWS 95 INSTRUCTIONS

Since this simulation will be used in future experiments on computers running Windows 95, the simulation has been upgraded. To use the simulation in Windows 95, the following instructions are provided:

1. A new BAT.COM files has been provided which will work in Windows 95.
2. To operate the simulation in Windows 95, Push F8 when the "starting windows" dialogue appears, then select option 8.
3. Type "start"

APPENDIX N. SEATING CHARTS

Seating Chart
Monday Wednesday
27 and 29 Nov.

IN-224
1 - 3 PM

(Front)

| | | | | | |
|--------|-------|-------|--------|-------|--------|
| Craves | King | Magno | Margof | Shore | Morrow |
| Norris | Peber | Penn | Sauer | Sklar | Milbrn |
| | | Tiddy | West | | |

IN-250
12 - 2 PM

(Front)

| | | | | | | |
|---------|---------|---------|-----------|---------|--------|---------|
| Dennis | Kern | Kopper | Larkhurst | Leonard | Lucas | Mullis |
| Thovini | Schokki | Staifer | Smith | Sprague | Stuere | Tomphre |
| Ring | Tuner | X | | | | |
| | X | X | X | X | | |

Seating Chart
 Tuesday Thursday
 28 and 30 Nov.

IN-224
 1 - 3 PM

(Print)

| | | | | | |
|----------|---------|---------|-------|-------|----------|
| Amos | Brady | Cameron | Casey | Cebal | Cepak |
| Chalfant | Cherney | Coble | Erley | Flick | Geathard |
| | | Geberth | | | |

IN-250
 1 - 3 PM

(Print)

| | | | | | |
|--------|--------|--------|------|----------|---------|
| Callum | Hagle | Heaton | King | Jacobson | Johnson |
| Jones | Romano | Walker | Coms | James | |
| | | X | | | |
| | X | X | X | | X |

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:

| | |
|----------------|--|
| Name | Subject's name |
| SMC | Student Mail Center Box Number |
| Project | A initially underestimated, B initially overestimated |
| Goal | 1 = Cost and Schedule, 2 = Quality and Schedule |
| Order | The order that the goals were listed on the instructions (1 or 2) |
| FNCOST | Final Cost (in Man Days) |
| FNTIME | Final Cumulative Time (Days) |
| FNERR | Final Errors Remaining Undetected |
| FNERG | Final Cumulative Errors Generated |
| FNERD | Final Cumulative Errors Detected |
| FNERES | Final Cumulative Errors Escaping Detection |
| FNPRDT | Final Percentage of Errors Detected |
| FNQAMD | Final Cumulative Quality Assurance Man Days |
| FNTRMD | Final Cumulative Training Man Days |
| FNRWMD | Final Cumulative Rework Man Days |

Format explanation of PROCESS.DAT

One line containing 6 identifiers, 26 output variables, then 5 decision variables captured at project start and every 40 workdays until project completion:

| | |
|---------|---|
| Name | Subject's name |
| SMC | Student Mail Center Box Number |
| Project | A increased in size, B decreased in Size |
| Goal | 1 = Cost and Schedule, 2 = Quality and Schedule |
| Order | The order that the goals were listed on the instructions (1 or 2) |
| Day | The period that the decisions were made |
| IPRJSZ | Initial Project Size (in Delivered Source Instructions) |
| TOTMDO | Programming Phase Cost (in Man Days) |
| TDEV | Programming Phase Duration (Development Time in Days) |
| PJBSZT | Updated Est of System Size (in DSI) |
| FNERR | Final Errors Remaining Undetected |
| FNERG | Final Cumulative Errors Generated |
| TIMERM | Time Remaining |
| PRCMPL | Percent DSI Reported Complete |
| CMDSI | Total DSI Completed to Date |
| CUMMD | Total Person Days Expended to Date |
| RPPROD | Reported Productivity (in DSI/Person Day) |
| FTEQWF | Current Total Staff Size (in People) |
| CRDVWF | Staff Allocated to Programming (in People) |
| CRQAWF | Staff Allocated to QA (in People) |
| FRWFEX | Percent of Workforce that is Experienced |
| CMQAMD | QA Person Days Expended to Date |
| CMERD | Total Defects Detected |
| PRQAMD | QA Person Days Expended Last 40 Days |
| PRERD | Defects Detected Last 40 Days |
| PRDFDS | Defect Density Observed Last 40 Days |
| PRTKDV | DSI Developed Last 40 Days |
| TOTMD1 | Programming Phase Cost (in Man Days) |
| WFS | Total Workforce Sought |
| CRRWWF | Current Rework Workforce (in People) |
| AFMDPJ | Actual Fraction of Man Days on Project |
| SCHPR | Schedule Pressure |
| PRODTY | Estimated programmer productivity |
| WFS2 | Total Workforce Requested |
| FRMPQ1 | Fraction of Workforce devoted to Quality Assurance (Percent) |
| JBSZMD | Last Est of Programming Phase Cost (in Person Days) |
| SCHCDT | Last Est of Prog Phase Duration (start-end in Days) |

Format explanation of Questionnaire/Demographic Data:

| | |
|---------------|--|
| Q1S | Question 1 Schedule Percent (All subjects) |
| Q1Q | Question 1 Quality Percent (value only for Goal 2) |
| Q1C | Question 1 Cost Percent (value only for Goal 1) |
| Q5 | Question 5 Response (1-9) |
| Q6 | Question 6 Response (1-9) |
| Q7 | Question 7 Response (1-9) |
| Q8 | Question 8 Response (0/1 1=Yes 0=No) |
| Q9 | Question 9 Response (0/1 1=Yes 0=No) |
| Q10 | Question 10 Response (0/1 1=Yes 0=No) |
| Q11 | Question 11 Response (0/1 1=Yes 0=No) |
| Q12 | Question 12 Response (0/1 1=Yes 0=No) |
| Q13 | Question 13 Response (0/1 1=Yes 0=No) |
| Q14 | Question 14 Response (0-9 0=No, 1-9 indicate yes and the value) |
| Q15 | Question 15 Response (1-9) |
| Q16 | Question 16 Response (1-9) |
| Q17 | Question 17 Response (1-9) |
| Q18 | Question 18 Response (1-9) |
| CURRIC | Curriculum number or abbreviation |
| AGE | Age (years) |
| SEX | M=Male, F=Female |
| WKEXP | Work Experience (Years) |
| EDAGO | Years since undergraduate education was completed |
| CFAM | Computer familiarity (1-9) |
| CHRSWK | Computer hours per week |
| GRADE | Numeric grade received in IS-4300 course |

APPENDIX P PROCESS DATA

Repeated measures on process data.

09:37 Sunday, March 3, 1996

| OBS | GOALS | PROJECT | LNAME | _NAME_ | _0D00 | _120D00 | _160D00 | _200D00 | _240D00 |
|-----|-------|---------|----------|--------|-------|---------|---------|---------|---------|
| 1 | 1 | A | Asmus | COST | 944 | 950 | 950.0 | 950.0 | 950.0 |
| 2 | 1 | A | Stueve | COST | 944 | 1000 | 1000.0 | 1000.0 | 1300.0 |
| 3 | 1 | A | gearhard | COST | 944 | 944 | 1200.0 | 1200.0 | 1212.0 |
| 4 | 1 | A | johnson | COST | 944 | 1743 | 1743.0 | 1627.0 | 1627.0 |
| 5 | 1 | A | jones | COST | 944 | 1500 | 1500.0 | 1000.0 | 1000.0 |
| 6 | 1 | A | leonard | COST | 944 | 944 | 2200.0 | 2200.0 | 2200.0 |
| 7 | 1 | A | norris | COST | 944 | 1400 | 1400.0 | 1600.0 | 1850.0 |
| 8 | 1 | A | stone | COST | 944 | 944 | 1800.0 | 1800.0 | 1800.0 |
| 9 | 1 | A | west | COST | 944 | 944 | 944.0 | 1400.0 | 1400.0 |
| 10 | 1 | B | CELEBI | COST | 944 | 900 | 930.0 | 940.0 | 940.0 |
| 11 | 1 | B | Cooke | COST | 944 | 944 | 1000.0 | 1000.0 | 1000.0 |
| 12 | 1 | B | Jacobson | COST | 944 | 994 | 1340.6 | 1967.7 | 1930.0 |
| 13 | 1 | B | brady | COST | 944 | 1900 | 1900.0 | 620.0 | . |
| 14 | 1 | B | casey | COST | 944 | 944 | 944.0 | 1500.0 | 1400.0 |
| 15 | 1 | B | flick | COST | 944 | 834 | 794.0 | 754.0 | 714.0 |
| 16 | 1 | B | gillum | COST | 944 | 944 | 944.0 | 944.0 | 944.0 |
| 17 | 1 | B | hague | COST | 944 | 944 | 950.0 | 1400.0 | 1500.0 |
| 18 | 1 | B | hsing | COST | 944 | 900 | 920.0 | 940.0 | 944.0 |
| 19 | 1 | B | romano | COST | 944 | 944 | 944.0 | 944.0 | 1034.0 |
| 20 | 2 | A | Dennis | COST | 944 | 1267 | 1267.0 | 2018.0 | 2018.0 |
| 21 | 2 | A | Lankhors | COST | 944 | 944 | 944.0 | 944.0 | 944.0 |
| 22 | 2 | A | Shaffer | COST | 944 | 1000 | 1400.0 | 1400.0 | 2068.0 |
| 23 | 2 | A | TURNER | COST | 944 | 2000 | 2000.0 | 2200.0 | 2300.0 |
| 24 | 2 | A | king | COST | 944 | 944 | 1000.0 | 1500.0 | 1500.0 |
| 25 | 2 | A | kopper | COST | 944 | 980 | 1000.0 | 1000.0 | 1200.0 |
| 26 | 2 | A | mihlon | COST | 944 | 944 | 1000.0 | 1250.0 | 1300.0 |
| 27 | 2 | A | ring | COST | 944 | 1904 | 1904.0 | 2176.0 | 2720.0 |
| 28 | 2 | A | staier | COST | 944 | 2200 | 2200.0 | 2200.0 | 2200.0 |
| 29 | 2 | B | Cameron | COST | 944 | 1050 | 1150.0 | 1848.0 | 1763.5 |
| 30 | 2 | B | Cepek | COST | 944 | 1060 | 1620.0 | 1620.0 | 1440.0 |
| 31 | 2 | B | Chalfant | COST | 944 | 1400 | 1626.0 | 2440.0 | 2033.0 |
| 32 | 2 | B | Chaney | COST | 944 | 944 | 944.0 | 1570.0 | 2000.0 |
| 33 | 2 | B | Earley | COST | 944 | 1000 | 1632.0 | 1632.0 | 1800.0 |
| 34 | 2 | B | Geberth | COST | 944 | 938 | 942.0 | 950.0 | 948.0 |
| 35 | 2 | B | Heaton | COST | 944 | 2000 | 2200.0 | 3200.0 | 3200.0 |
| 36 | 2 | B | James | COST | 944 | 944 | 944.0 | 1000.0 | 2000.0 |
| 37 | 2 | B | coats | COST | 944 | 1040 | 1420.0 | 2204.0 | 2077.0 |
| 38 | 2 | B | waller | COST | 944 | 944 | 944.0 | 944.0 | 1300.0 |

| OBS | _280D00 | _320D00 | _360D00 | _40D00 | _80D00 | _400D00 | _440D00 | _480D00 |
|-----|---------|---------|---------|--------|--------|---------|---------|---------|
| 1 | 950 | 950 | 950 | 944 | 944 | . | . | . |
| 2 | . | . | . | 1000 | 1000 | . | . | . |
| 3 | . | . | . | 944 | 944 | . | . | . |
| 4 | 1525 | . | . | 1627 | 1743 | . | . | . |
| 5 | 2000 | . | . | 2312 | 2000 | . | . | . |
| 6 | 2200 | 2200 | 2040 | 944 | 944 | . | . | . |
| 7 | . | . | . | 1400 | 1400 | . | . | . |
| 8 | 1800 | . | . | 944 | 944 | . | . | . |
| 9 | . | . | . | 944 | 944 | . | . | . |
| 10 | 940 | 940 | . | 940 | 940 | . | . | . |
| 11 | . | . | . | 944 | 944 | . | . | . |
| 12 | 1872 | 1789 | 1700 | 968 | 984 | . | . | . |
| 13 | . | . | . | 1000 | 950 | . | . | . |
| 14 | 1400 | . | . | 944 | 944 | . | . | . |
| 15 | 674 | . | . | 944 | 874 | . | . | . |
| 16 | . | . | . | 944 | 944 | . | . | . |
| 17 | 1500 | . | . | 944 | 944 | . | . | . |
| 18 | 944 | . | . | 900 | 900 | . | . | . |
| 19 | 1400 | 1500 | . | 944 | 944 | . | . | . |
| 20 | 2018 | . | . | 1267 | 1267 | . | . | . |
| 21 | 944 | 944 | 944 | 944 | 944 | . | . | . |
| 22 | . | . | . | 944 | 1000 | . | . | . |
| 23 | 2300 | 2300 | . | 1200 | 1200 | . | . | . |
| 24 | . | . | . | 944 | 944 | . | . | . |
| 25 | . | . | . | 950 | 950 | . | . | . |
| 26 | . | . | . | 944 | 944 | . | . | . |
| 27 | 2720 | 2720 | . | 1150 | 1904 | . | . | . |
| 28 | . | . | . | 1888 | 2000 | . | . | . |
| 29 | . | . | . | 1054 | 1073 | . | . | . |
| 30 | 2218 | 2218 | . | 1017 | 1060 | . | . | . |
| 31 | 1931 | . | . | 944 | 1572 | . | . | . |
| 32 | 1950 | . | . | 944 | 944 | . | . | . |
| 33 | 2300 | 2300 | 2300 | 944 | 1000 | . | . | . |
| 34 | 1100 | 1300 | . | 940 | 940 | . | . | . |
| 35 | 3200 | . | . | 1632 | 2400 | . | . | . |
| 36 | 2000 | 3000 | 3000 | 944 | 944 | 3000 | 3000 | 3000 |
| 37 | 2018 | 1913 | . | 1016 | 1120 | . | . | . |
| 38 | 1400 | 2000 | 2300 | 944 | 944 | . | . | . |

Repeated measures on process data.

8

09:37 Sunday, March 3, 1996

General Linear Models Procedure
Class Level Information

| | | |
|---------|--------|--------|
| Class | Levels | Values |
| GOALS | 2 | 1 2 |
| PROJECT | 2 | A B |

Number of observations in data set = 38

Repeated measures on process data. 9
09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

| | | | | | | |
|--------------------|-------|--------|--------|---------|---------|---------|
| Dependent Variable | _0D00 | _40D00 | _80D00 | _120D00 | _160D00 | _200D00 |
| Level of PERIOD | 1 | 2 | 3 | 4 | 5 | 6 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect
H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.43330173 | 8.1087 | 5 | 31 | 0.0001 |
| Pillai's Trace | 0.56669827 | 8.1087 | 5 | 31 | 0.0001 |
| Hotelling-Lawley Trace | 1.30786062 | 8.1087 | 5 | 31 | 0.0001 |
| Roy's Greatest Root | 1.30786062 | 8.1087 | 5 | 31 | 0.0001 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect

H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|----------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.78079533 | 1.7406 | 5 | 31 | 0.1547 |
| Pillai's Trace | 0.21920467 | 1.7406 | 5 | 31 | 0.1547 |

| | | | | | |
|------------------------|------------|--------|---|----|--------|
| Hotelling-Lawley Trace | 0.28074536 | 1.7406 | 5 | 31 | 0.1547 |
| Roy's Greatest Root | 0.28074536 | 1.7406 | 5 | 31 | 0.1547 |

Manova Test Criteria and Exact F Statistics for
the Hypothesis of no PERIOD*PROJECT Effect
H = Type III SS&CP Matrix for PERIOD*PROJECT E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.85616720 | 1.0416 | 5 | 31 | 0.4111 |
| Pillai's Trace | 0.14383280 | 1.0416 | 5 | 31 | 0.4111 |
| Hotelling-Lawley Trace | 0.16799616 | 1.0416 | 5 | 31 | 0.4111 |
| Roy's Greatest Root | 0.16799616 | 1.0416 | 5 | 31 | 0.4111 |

Repeated measures on process data. 10

09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---------|----|-------------------|------------------|---------|--------|
| GOALS | 1 | 1256636.72320175 | 1256636.72320175 | 2.70 | 0.1092 |
| PROJECT | 1 | 1098499.45669055 | 1098499.45669055 | 2.36 | 0.1333 |
| Error | 35 | 16277870.78734450 | 465082.02249556 | | |

Repeated measures on process data. 11

09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

| DF | Type III SS | Mean Square | F Value | Adj Pr > F | Pr > F | G - G | H - F |
|----|---------------|---------------|---------|------------|--------|--------|--------|
| 5 | 6366921.41853 | 1273384.28371 | 17.11 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

Source: PERIOD*GOALS

| DF | Type III SS | Mean Square | F Value | Adj Pr > F | Pr > F | G - G | H - F |
|----|-------------|-------------|---------|------------|--------|-------|-------|
| | | | | | | | |

5 1200514.33075 240102.86615 3.23 0.0082 0.0278 0.0214

Source: PERIOD*PROJECT

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|--------------|-------------|---------|--------|------------|--------|-------|
| 5 | 280382.78520 | 56076.55704 | 0.75 | 0.5845 | 0.5166 | 0.5344 | |

Source: Error(PERIOD)

| DF | Type III SS | Mean Square |
|-----|----------------|-------------|
| 175 | 13021182.31287 | 74406.75607 |

Greenhouse-Geisser Epsilon = 0.5704

Huynh-Feldt Epsilon = 0.6618

Repeated measures on process data. 12

09:37 Sunday, March 3, 1996

----- GOALS=1 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|-------------|-------------|-------------|-------------|
| 0D00 | 9 | 944.0000000 | 0 | 944.0000000 | 944.0000000 |
| 40D00 | 9 | 1228.78 | 476.8515958 | 944.0000000 | 2312.00 |
| 80D00 | 9 | 1207.00 | 409.5863767 | 944.0000000 | 2000.00 |
| 120D00 | 9 | 1152.11 | 310.0106629 | 944.0000000 | 1743.00 |
| 160D00 | 9 | 1415.22 | 438.1779826 | 944.0000000 | 2200.00 |
| 200D00 | 9 | 1419.67 | 425.8151007 | 950.0000000 | 2200.00 |

----- GOALS=1 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|-------------|-------------|-------------|-------------|
| 0D00 | 10 | 944.0000000 | 0 | 944.0000000 | 944.0000000 |
| 40D00 | 10 | 947.2000000 | 24.8587119 | 900.0000000 | 1000.00 |
| 80D00 | 10 | 936.8000000 | 29.7575387 | 874.0000000 | 984.0000000 |
| 120D00 | 10 | 1024.80 | 310.3978809 | 834.0000000 | 1900.00 |
| 160D00 | 10 | 1066.66 | 324.4168793 | 794.0000000 | 1900.00 |
| 200D00 | 10 | 1100.97 | 403.1655134 | 620.0000000 | 1967.70 |

----- GOALS=2 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|-------------|-------------|-------------|-------------|
| _0D00 | 9 | 944.0000000 | 0 | 944.0000000 | 944.0000000 |
| _40D00 | 9 | 1136.78 | 310.0410367 | 944.0000000 | 1888.00 |
| _80D00 | 9 | 1239.22 | 422.1030022 | 944.0000000 | 2000.00 |
| _120D00 | 9 | 1353.67 | 525.9030329 | 944.0000000 | 2200.00 |
| _160D00 | 9 | 1412.78 | 494.7438170 | 944.0000000 | 2200.00 |
| _200D00 | 9 | 1632.00 | 522.0296926 | 944.0000000 | 2200.00 |

----- GOALS=2 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|-------------|-------------|-------------|-------------|
| _0D00 | 10 | 944.0000000 | 0 | 944.0000000 | 944.0000000 |
| _40D00 | 10 | 1037.90 | 212.8643021 | 940.0000000 | 1632.00 |
| _80D00 | 10 | 1199.70 | 462.4476066 | 940.0000000 | 2400.00 |
| _120D00 | 10 | 1132.00 | 334.4501292 | 938.0000000 | 2000.00 |
| _160D00 | 10 | 1342.20 | 428.9993007 | 942.0000000 | 2200.00 |
| _200D00 | 10 | 1740.80 | 723.3282335 | 944.0000000 | 3200.00 |

Repeated measures on process data. 19
09:37 Sunday, March 3, 1996

| OBS | GOALS | PROJECT | LNAME | _NAME_ | _0D00 | _120D00 | _160D00 | _200D00 |
|-----|-------|---------|----------|----------|-------|---------|---------|---------|
| 1 | 1 | A | Asmus | DURATION | 272 | 250.0 | 250.0 | 280.0 |
| 2 | 1 | A | Stueve | DURATION | 272 | 300.0 | 300.0 | 300.0 |
| 3 | 1 | A | gearhard | DURATION | 272 | 272.0 | 272.0 | 280.0 |
| 4 | 1 | A | johnson | DURATION | 272 | 349.0 | 349.0 | 271.0 |
| 5 | 1 | A | jones | DURATION | 272 | 272.0 | 272.0 | 300.0 |
| 6 | 1 | A | leonard | DURATION | 272 | 272.0 | 272.0 | 302.0 |
| 7 | 1 | A | norris | DURATION | 272 | 272.0 | 272.0 | 272.0 |
| 8 | 1 | A | stone | DURATION | 272 | 272.0 | 272.0 | 300.0 |
| 9 | 1 | A | west | DURATION | 272 | 272.0 | 272.0 | 272.0 |
| 10 | 1 | B | CELEBI | DURATION | 272 | 272.0 | 272.0 | 272.0 |
| 11 | 1 | B | Cooke | DURATION | 272 | 272.0 | 272.0 | 280.0 |
| 12 | 1 | B | Jacobson | DURATION | 272 | 261.6 | 343.7 | 491.9 |
| 13 | 1 | B | brady | DURATION | 272 | 250.0 | 300.0 | 300.0 |
| 14 | 1 | B | casey | DURATION | 272 | 250.0 | 272.0 | 360.0 |
| 15 | 1 | B | flick | DURATION | 272 | 152.0 | 112.0 | 72.0 |
| 16 | 1 | B | gillum | DURATION | 272 | 272.0 | 272.0 | 272.0 |
| 17 | 1 | B | hague | DURATION | 272 | 272.0 | 238.0 | 300.0 |
| 18 | 1 | B | hsing | DURATION | 272 | 270.0 | 272.0 | 276.0 |

| | | | | | | | | | |
|----|---|---|----------|----------|-----|-------|-------|-------|-------|
| 19 | 1 | B | romano | DURATION | 272 | 272.0 | 272.0 | 272.0 | 272.0 |
| 20 | 2 | A | Dennis | DURATION | 272 | 272.0 | 272.0 | 272.0 | 272.0 |
| 21 | 2 | A | Lankhors | DURATION | 272 | 272.0 | 272.0 | 272.0 | 272.0 |
| 22 | 2 | A | Shaffer | DURATION | 272 | 300.0 | 400.0 | 400.0 | 272.0 |
| 23 | 2 | A | TURNER | DURATION | 272 | 272.0 | 272.0 | 400.0 | 400.0 |
| 24 | 2 | A | king | DURATION | 272 | 272.0 | 272.0 | 272.0 | 255.0 |
| 25 | 2 | A | kopper | DURATION | 272 | 272.0 | 280.0 | 280.0 | 280.0 |
| 26 | 2 | A | mihlon | DURATION | 272 | 272.0 | 272.0 | 272.0 | 272.0 |
| 27 | 2 | A | ring | DURATION | 272 | 272.0 | 272.0 | 272.0 | 280.0 |
| 28 | 2 | A | staier | DURATION | 272 | 280.0 | 272.0 | 272.0 | 260.0 |
| 29 | 2 | B | Cameron | DURATION | 272 | 272.0 | 272.0 | 314.0 | 315.0 |
| 30 | 2 | B | Cepek | DURATION | 272 | 271.0 | 406.0 | 280.0 | 280.0 |
| 31 | 2 | B | Chalfant | DURATION | 272 | 292.0 | 313.0 | 406.0 | 359.0 |
| 32 | 2 | B | Chaney | DURATION | 272 | 272.0 | 272.0 | 272.0 | 272.0 |
| 33 | 2 | B | Earley | DURATION | 272 | 272.0 | 272.0 | 272.0 | 300.0 |
| 34 | 2 | B | Geberth | DURATION | 272 | 268.0 | 270.0 | 278.0 | 275.0 |
| 35 | 2 | B | Heaton | DURATION | 272 | 300.0 | 320.0 | 320.0 | 320.0 |
| 36 | 2 | B | James | DURATION | 272 | 272.0 | 300.0 | 300.0 | 325.0 |
| 37 | 2 | B | coats | DURATION | 272 | 273.0 | 348.0 | 680.0 | 405.0 |
| 38 | 2 | B | waller | DURATION | 272 | 272.0 | 272.0 | 272.0 | 300.0 |

OBS _280D00 _320D00 _360D00 _40D00 _80D00 _400D00 _440D00 _480D00

| | | | | | | | | |
|----|-------|-----|-----|-------|-------|---|---|---|
| 1 | 290.0 | 360 | 360 | 272.0 | 272.0 | . | . | . |
| 2 | . | . | . | 300.0 | 300.0 | . | . | . |
| 3 | . | . | . | 272.0 | 272.0 | . | . | . |
| 4 | 254.0 | . | . | 407.0 | 436.0 | . | . | . |
| 5 | 300.0 | . | . | 272.0 | 272.0 | . | . | . |
| 6 | 302.0 | 302 | 302 | 272.0 | 272.0 | . | . | . |
| 7 | . | . | . | 272.0 | 272.0 | . | . | . |
| 8 | 300.0 | . | . | 272.0 | 272.0 | . | . | . |
| 9 | . | . | . | 272.0 | 272.0 | . | . | . |
| 10 | 272.0 | 272 | . | 270.0 | 272.0 | . | . | . |
| 11 | . | . | . | 272.0 | 272.0 | . | . | . |
| 12 | 340.5 | 313 | 298 | 242.0 | 246.0 | . | . | . |
| 13 | . | . | . | 400.0 | 320.0 | . | . | . |
| 14 | 320.0 | . | . | 272.0 | 272.0 | . | . | . |
| 15 | 12.0 | . | . | 272.0 | 192.0 | . | . | . |
| 16 | . | . | . | 272.0 | 272.0 | . | . | . |
| 17 | 285.0 | . | . | 272.0 | 272.0 | . | . | . |
| 18 | 276.0 | . | . | 272.0 | 272.0 | . | . | . |
| 19 | 272.0 | 290 | . | 272.0 | 272.0 | . | . | . |
| 20 | 290.0 | . | . | 272.0 | 272.0 | . | . | . |
| 21 | 272.0 | 272 | 272 | 272.0 | 272.0 | . | . | . |
| 22 | . | . | . | 272.0 | 300.0 | . | . | . |
| 23 | 350.0 | 350 | . | 272.0 | 272.0 | . | . | . |

| | | | | | | | | |
|----|-------|-----|-----|-------|-------|-----|-----|-----|
| 24 | . | . | . | 272.0 | 272.0 | . | . | . |
| 25 | . | . | . | 272.0 | 272.0 | . | . | . |
| 26 | . | . | . | 272.0 | 272.0 | . | . | . |
| 27 | 290.0 | 294 | . | 272.0 | 272.0 | . | . | . |
| 28 | . | . | . | 272.0 | 280.0 | . | . | . |
| 29 | . | . | . | 310.1 | 233.7 | . | . | . |
| 30 | 320.0 | 360 | . | 282.0 | 151.0 | . | . | . |
| 31 | 320.0 | . | . | 272.0 | 262.0 | . | . | . |
| 32 | 290.0 | . | . | 272.0 | 272.0 | . | . | . |
| 33 | 360.0 | 360 | 375 | 272.0 | 272.0 | . | . | . |
| 34 | 275.0 | 360 | . | 270.0 | 268.0 | . | . | . |
| 35 | 320.0 | . | . | 272.0 | 300.0 | . | . | . |
| 36 | 360.0 | 500 | 500 | 272.0 | 272.0 | 500 | 500 | 500 |
| 37 | 377.0 | 348 | . | 210.0 | 226.0 | . | . | . |
| 38 | 320.0 | 440 | 400 | 272.0 | 272.0 | . | . | . |

Repeated measures on process data. 20
09:37 Sunday, March 3, 1996

General Linear Models Procedure
Class Level Information

Class Levels Values

GOALS 2 1 2

PROJECT 2 A B

Number of observations in data set = 38

Repeated measures on process data. 21
09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

| | | | | | | |
|--------------------|-------|--------|--------|---------|---------|---------|
| Dependent Variable | _0D00 | _40D00 | _80D00 | _120D00 | _160D00 | _200D00 |
| Level of PERIOD | 1 | 2 | 3 | 4 | 5 | 6 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect

H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.74468985 | 2.1256 | 5 | 31 | 0.0886 |
| Pillai's Trace | 0.25531015 | 2.1256 | 5 | 31 | 0.0886 |
| Hotelling-Lawley Trace | 0.34284092 | 2.1256 | 5 | 31 | 0.0886 |
| Roy's Greatest Root | 0.34284092 | 2.1256 | 5 | 31 | 0.0886 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect

H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.80359118 | 1.5154 | 5 | 31 | 0.2137 |
| Pillai's Trace | 0.19640882 | 1.5154 | 5 | 31 | 0.2137 |
| Hotelling-Lawley Trace | 0.24441385 | 1.5154 | 5 | 31 | 0.2137 |
| Roy's Greatest Root | 0.24441385 | 1.5154 | 5 | 31 | 0.2137 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*PROJECT Effect

H = Type III SS&CP Matrix for PERIOD*PROJECT E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.79561946 | 1.5927 | 5 | 31 | 0.1914 |
| Pillai's Trace | 0.20438054 | 1.5927 | 5 | 31 | 0.1914 |
| Hotelling-Lawley Trace | 0.25688227 | 1.5927 | 5 | 31 | 0.1914 |
| Roy's Greatest Root | 0.25688227 | 1.5927 | 5 | 31 | 0.1914 |

Repeated measures on process data. 22
09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|--------|----|---------------|---------------|---------|--------|
| GOALS | 1 | 3011.30684211 | 3011.30684211 | 0.74 | 0.3955 |

| | | | | | |
|---------|----|-----------------|---------------|------|--------|
| PROJECT | 1 | 459.00394737 | 459.00394737 | 0.11 | 0.7390 |
| Error | 35 | 142429.73149123 | 4069.42089975 | | |

Repeated measures on process data. 23
09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|---------------|--------------|---------|--------|------------|--------|-------|
| 5 | 24567.3865673 | 4913.4773135 | 2.81 | 0.0181 | 0.0766 | 0.0708 | |

Source: PERIOD*GOALS

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|---------------|--------------|---------|--------|------------|--------|-------|
| 5 | 22529.6868421 | 4505.9373684 | 2.58 | 0.0281 | 0.0928 | 0.0870 | |

Source: PERIOD*PROJECT

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|---------------|--------------|---------|--------|------------|--------|-------|
| 5 | 14332.2602515 | 2866.4520503 | 1.64 | 0.1519 | 0.2056 | 0.2033 | |

Source: Error(PERIOD)

| DF | Type III SS | Mean Square |
|-----|----------------|--------------|
| 175 | 305974.6190468 | 1748.4263946 |

Greenhouse-Geisser Epsilon = 0.3394
Huynh-Feldt Epsilon = 0.3753

Repeated measures on process data. 24
09:37 Sunday, March 3, 1996

----- GOALS=1 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|-------------|------------|-------------|-------------|
| 0D00 | 9 | 272.0000000 | 0 | 272.0000000 | 272.0000000 |
| 40D00 | 9 | 290.1111111 | 44.8007936 | 272.0000000 | 407.0000000 |

| | | | | | |
|---------|---|-------------|------------|-------------|-------------|
| _80D00 | 9 | 293.3333333 | 54.2954878 | 272.0000000 | 436.0000000 |
| _120D00 | 9 | 281.2222222 | 28.3539141 | 250.0000000 | 349.0000000 |
| _160D00 | 9 | 281.2222222 | 28.3539141 | 250.0000000 | 349.0000000 |
| _200D00 | 9 | 273.6666667 | 10.6301458 | 260.0000000 | 300.0000000 |

----- GOALS=1 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|-------------|-------------|-------------|-------------|
| _0D00 | 10 | 272.0000000 | 0 | 272.0000000 | 272.0000000 |
| _40D00 | 10 | 281.6000000 | 42.6437438 | 242.0000000 | 400.0000000 |
| _80D00 | 10 | 266.2000000 | 31.6992814 | 192.0000000 | 320.0000000 |
| _120D00 | 10 | 254.3600000 | 37.0711988 | 152.0000000 | 272.0000000 |
| _160D00 | 10 | 262.5700000 | 59.4340353 | 112.0000000 | 343.7000000 |
| _200D00 | 10 | 289.5900000 | 102.5529289 | 72.0000000 | 491.9000000 |

----- GOALS=2 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|-------------|------------|-------------|-------------|
| _0D00 | 9 | 272.0000000 | 0 | 272.0000000 | 272.0000000 |
| _40D00 | 9 | 272.0000000 | 0 | 272.0000000 | 272.0000000 |
| _80D00 | 9 | 276.0000000 | 9.3808315 | 272.0000000 | 300.0000000 |
| _120D00 | 9 | 276.0000000 | 9.3808315 | 272.0000000 | 300.0000000 |
| _160D00 | 9 | 287.1111111 | 42.4159299 | 272.0000000 | 400.0000000 |
| _200D00 | 9 | 301.3333333 | 56.0000000 | 272.0000000 | 400.0000000 |

----- GOALS=2 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|-------------|-------------|-------------|-------------|
| _0D00 | 10 | 272.0000000 | 0 | 272.0000000 | 272.0000000 |
| _40D00 | 10 | 270.4100000 | 24.4366051 | 210.0000000 | 310.1000000 |
| _80D00 | 10 | 252.8700000 | 41.4518744 | 151.0000000 | 300.0000000 |
| _120D00 | 10 | 276.4000000 | 10.5851048 | 268.0000000 | 300.0000000 |
| _160D00 | 10 | 304.5000000 | 44.6498725 | 270.0000000 | 406.0000000 |
| _200D00 | 10 | 339.4000000 | 126.4666842 | 272.0000000 | 680.0000000 |

Repeated measures on process data. 1
09:37 Sunday, March 3, 1996

OBS GOALS PROJECT LNAME _NAME_ _0D00 _120D00 _160D00 _200D00
 _240D00

| | | | | | | | | | |
|----|---|---|----------|------|---|-------|-------|--------|--------|
| 1 | 1 | A | Asmus | PROD | 0 | 18.00 | 20.00 | 20.00 | 20.00 |
| 2 | 1 | A | Stueve | PROD | 0 | 20.00 | 20.00 | 20.00 | 20.00 |
| 3 | 1 | A | gearhard | PROD | 0 | 18.35 | 19.30 | 20.40 | 20.60 |
| 4 | 1 | A | johnson | PROD | 0 | 14.00 | 14.00 | 15.00 | 15.00 |
| 5 | 1 | A | jones | PROD | 0 | 9.00 | 9.00 | 15.00 | 15.00 |
| 6 | 1 | A | leonard | PROD | 0 | 10.00 | 9.00 | 10.00 | 10.00 |
| 7 | 1 | A | norris | PROD | 0 | 15.00 | 18.00 | 15.00 | 15.00 |
| 8 | 1 | A | stone | PROD | 0 | 14.00 | 14.00 | 16.00 | 16.00 |
| 9 | 1 | A | west | PROD | 0 | 16.00 | 17.00 | 19.00 | 19.00 |
| 10 | 1 | B | CELEBI | PROD | 0 | 27.00 | 25.00 | 20.00 | 26.00 |
| 11 | 1 | B | Cooke | PROD | 0 | 28.00 | 28.00 | 28.00 | 28.00 |
| 12 | 1 | B | Jacobson | PROD | 0 | 24.50 | 18.20 | 12.40 | 12.64 |
| 13 | 1 | B | brady | PROD | 0 | 25.00 | 25.00 | 15.00 | . |
| 14 | 1 | B | casey | PROD | 0 | 26.50 | 5.50 | 20.00 | 20.00 |
| 15 | 1 | B | flick | PROD | 0 | 30.00 | 50.00 | 100.00 | 100.00 |
| 16 | 1 | B | gillum | PROD | 0 | 26.00 | 20.00 | 16.00 | 18.00 |
| 17 | 1 | B | hague | PROD | 0 | 26.00 | 19.00 | 16.00 | 16.00 |
| 18 | 1 | B | hsing | PROD | 0 | 28.00 | 28.00 | 20.00 | 20.00 |
| 19 | 1 | B | romano | PROD | 0 | 26.00 | 13.00 | 20.00 | 30.00 |
| 20 | 2 | A | Dennis | PROD | 0 | 13.00 | 13.00 | 12.00 | 13.00 |
| 21 | 2 | A | Lankhors | PROD | 0 | 12.00 | 12.00 | 14.00 | 16.00 |
| 22 | 2 | A | Shaffer | PROD | 0 | 12.00 | 12.00 | 15.00 | 26.00 |
| 23 | 2 | A | TURNER | PROD | 0 | 9.00 | 9.00 | 9.00 | 10.00 |
| 24 | 2 | A | king | PROD | 0 | 13.00 | 20.00 | 20.00 | 20.00 |
| 25 | 2 | A | kopper | PROD | 0 | 13.00 | 15.00 | 15.50 | 17.00 |
| 26 | 2 | A | mihlon | PROD | 0 | 20.00 | 20.00 | 20.00 | 20.00 |
| 27 | 2 | A | ring | PROD | 0 | 13.00 | 13.00 | 12.00 | 12.00 |
| 28 | 2 | A | staier | PROD | 0 | 8.94 | 11.71 | 13.89 | 15.17 |
| 29 | 2 | B | Cameron | PROD | 0 | 29.00 | 18.00 | 13.00 | 14.00 |
| 30 | 2 | B | Cepek | PROD | 0 | 23.00 | 23.00 | 23.00 | 9.00 |
| 31 | 2 | B | Chalfant | PROD | 0 | 15.00 | 15.00 | 10.00 | 12.00 |
| 32 | 2 | B | Chaney | PROD | 0 | 25.40 | 20.00 | 15.00 | 15.00 |
| 33 | 2 | B | Earley | PROD | 0 | 24.00 | 15.00 | 15.00 | 10.00 |
| 34 | 2 | B | Geberth | PROD | 0 | 27.00 | 24.00 | 12.00 | 13.00 |
| 35 | 2 | B | Heaton | PROD | 0 | 13.00 | 13.00 | 11.00 | 11.00 |
| 36 | 2 | B | James | PROD | 0 | 25.56 | 15.68 | 6.54 | 7.54 |
| 37 | 2 | B | coats | PROD | 0 | 22.00 | 17.00 | 11.00 | 12.00 |
| 38 | 2 | B | waller | PROD | 0 | 26.00 | 26.00 | 15.00 | 15.00 |

OBS _280D00 _320D00 _360D00 _40D00 _80D00 _400D00 _440D00 _480D00

| | | | | | | | | |
|---|-------|-------|-------|-------|-------|---|---|---|
| 1 | 20.00 | 22.00 | 22.00 | 16.00 | 16.00 | . | . | . |
| 2 | . | . | . | 20.00 | 20.00 | . | . | . |

| | | | | | | | | |
|----|--------|-------|-------|-------|-------|------|-------|-------|
| 3 | . | . | . | 18.32 | 17.89 | . | . | . |
| 4 | 16.00 | . | . | 15.00 | 14.00 | . | . | . |
| 5 | 15.00 | . | . | 10.00 | 10.00 | . | . | . |
| 6 | 11.00 | 12.00 | 12.00 | 11.00 | 8.00 | . | . | . |
| 7 | . | . | . | 15.00 | 15.00 | . | . | . |
| 8 | 16.00 | . | . | 10.00 | 14.00 | . | . | . |
| 9 | . | . | . | 16.00 | 16.00 | . | . | . |
| 10 | 26.00 | 26.00 | . | 25.00 | 26.00 | . | . | . |
| 11 | . | . | . | 28.00 | 28.00 | . | . | . |
| 12 | 13.03 | 13.64 | 14.30 | 25.20 | 24.80 | . | . | . |
| 13 | . | . | . | 24.00 | 24.00 | . | . | . |
| 14 | 20.50 | . | . | 25.00 | 25.00 | . | . | . |
| 15 | 100.00 | . | . | 25.00 | 50.00 | . | . | . |
| 16 | . | . | . | 25.00 | 25.00 | . | . | . |
| 17 | 16.00 | . | . | 26.00 | 26.00 | . | . | . |
| 18 | 20.00 | . | . | 25.00 | 28.00 | . | . | . |
| 19 | 30.00 | 25.00 | . | 26.00 | 26.00 | . | . | . |
| 20 | 14.00 | . | . | 18.00 | 15.00 | . | . | . |
| 21 | 16.00 | 16.00 | 16.00 | 12.00 | 12.00 | . | . | . |
| 22 | . | . | . | 17.00 | 12.00 | . | . | . |
| 23 | 11.00 | 11.00 | . | 11.00 | 10.00 | . | . | . |
| 24 | . | . | . | 26.00 | 26.00 | . | . | . |
| 25 | . | . | . | 16.00 | 14.00 | . | . | . |
| 26 | . | . | . | 18.00 | 20.00 | . | . | . |
| 27 | 12.00 | 12.00 | . | 18.00 | 18.00 | . | . | . |
| 28 | . | . | . | 10.80 | 7.07 | . | . | . |
| 29 | . | . | . | 23.14 | 22.70 | . | . | . |
| 30 | 11.00 | 11.00 | . | 24.00 | 24.00 | . | . | . |
| 31 | 13.00 | . | . | 25.00 | 25.00 | . | . | . |
| 32 | 15.00 | . | . | 25.00 | 25.40 | . | . | . |
| 33 | 15.00 | 15.00 | 12.00 | 25.00 | 24.40 | . | . | . |
| 34 | 13.00 | 15.00 | . | 27.00 | 27.00 | . | . | . |
| 35 | 11.00 | . | . | 16.00 | 12.00 | . | . | . |
| 36 | 8.00 | 8.73 | 9.34 | 25.00 | 25.38 | 9.99 | 10.42 | 10.37 |
| 37 | 12.00 | 13.00 | . | 25.00 | 25.00 | . | . | . |
| 38 | 15.00 | 15.00 | 15.00 | 25.00 | 25.00 | . | . | . |

Repeated measures on process data.

2

09:37 Sunday, March 3, 1996

General Linear Models Procedure
Class Level Information

Class Levels Values

GOALS 2 1 2

PROJECT 2 A B

Number of observations in data set = 38

Repeated measures on process data. 3
09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

| | | | | | | |
|--------------------|-------|--------|--------|---------|---------|---------|
| Dependent Variable | _0D00 | _40D00 | _80D00 | _120D00 | _160D00 | _200D00 |
| Level of PERIOD | 1 | 2 | 3 | 4 | 5 | 6 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect
H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|-------------|----------|--------|--------|--------|
| Wilks' Lambda | 0.01900105 | 320.0978 | 5 | 31 | 0.0001 |
| Pillai's Trace | 0.98099895 | 320.0978 | 5 | 31 | 0.0001 |
| Hotelling-Lawley Trace | 51.62867719 | 320.0978 | 5 | 31 | 0.0001 |
| Roy's Greatest Root | 51.62867719 | 320.0978 | 5 | 31 | 0.0001 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect

H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.73634416 | 2.2200 | 5 | 31 | 0.0773 |
| Pillai's Trace | 0.26365584 | 2.2200 | 5 | 31 | 0.0773 |
| Hotelling-Lawley Trace | 0.35806062 | 2.2200 | 5 | 31 | 0.0773 |
| Roy's Greatest Root | 0.35806062 | 2.2200 | 5 | 31 | 0.0773 |

Manova Test Criteria and Exact F Statistics for

the Hypothesis of no PERIOD*PROJECT Effect
H = Type III SS&CP Matrix for PERIOD*PROJECT E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|---------|--------|--------|--------|
| Wilks' Lambda | 0.24104698 | 19.5211 | 5 | 31 | 0.0001 |
| Pillai's Trace | 0.75895302 | 19.5211 | 5 | 31 | 0.0001 |
| Hotelling-Lawley Trace | 3.14856880 | 19.5211 | 5 | 31 | 0.0001 |
| Roy's Greatest Root | 3.14856880 | 19.5211 | 5 | 31 | 0.0001 |

Repeated measures on process data. 4
09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---------|----|---------------|---------------|---------|--------|
| GOALS | 1 | 433.12746711 | 433.12746711 | 3.31 | 0.0776 |
| PROJECT | 1 | 2780.84385965 | 2780.84385965 | 21.23 | 0.0001 |
| Error | 35 | 4585.27692456 | 131.00791213 | | |

Repeated measures on process data. 5
09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|----------------|---------------|---------|--------|------------|--------|--------|
| 5 | 11710.55586480 | 2342.11117296 | 69.37 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

Source: PERIOD*GOALS

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|--------------|-------------|---------|--------|------------|--------|-------|
| 5 | 428.81399342 | 85.76279868 | 2.54 | 0.0301 | 0.1046 | 0.1001 | |

Source: PERIOD*PROJECT

Adj Pr > F

| | | | | | | |
|----|--------------|--------------|---------|--------|--------|--------|
| DF | Type III SS | Mean Square | F Value | Pr > F | G - G | H - F |
| 5 | 913.25745427 | 182.65149085 | 5.41 | 0.0001 | 0.0142 | 0.0119 |

Source: Error(PERIOD)

| | | |
|-----|---------------|-------------|
| DF | Type III SS | Mean Square |
| 175 | 5908.81074047 | 33.76463280 |

Greenhouse-Geisser Epsilon = 0.2872
Huynh-Feldt Epsilon = 0.3133

Repeated measures on process data. 6
09:37 Sunday, March 3, 1996

----- GOALS=1 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|------------|-----------|------------|------------|
| 0D00 | 9 | 0 | 0 | 0 | 0 |
| 40D00 | 9 | 14.5911111 | 3.5797641 | 10.0000000 | 20.0000000 |
| 80D00 | 9 | 14.5433333 | 3.6992432 | 8.0000000 | 20.0000000 |
| 120D00 | 9 | 14.9277778 | 3.6941771 | 9.0000000 | 20.0000000 |
| 160D00 | 9 | 15.5888889 | 4.3641850 | 9.0000000 | 20.0000000 |
| 200D00 | 9 | 16.7111111 | 3.4425443 | 10.0000000 | 20.4000000 |

----- GOALS=1 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|------------|------------|------------|-------------|
| 0D00 | 10 | 0 | 0 | 0 | 0 |
| 40D00 | 10 | 25.4200000 | 1.0685400 | 24.0000000 | 28.0000000 |
| 80D00 | 10 | 28.2800000 | 7.7420640 | 24.0000000 | 50.0000000 |
| 120D00 | 10 | 26.7000000 | 1.6193277 | 24.5000000 | 30.0000000 |
| 160D00 | 10 | 23.1700000 | 11.7426147 | 5.5000000 | 50.0000000 |
| 200D00 | 10 | 26.7400000 | 26.0863608 | 12.4000000 | 100.0000000 |

----- GOALS=2 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|------|---------|---------|---------|
| 0D00 | 9 | 0 | 0 | 0 | 0 |

| | | | | | |
|--------|---|------------|-----------|-----------|-----------|
| 40D00 | 9 | 16.311111 | 4.7456413 | 10.800000 | 26.000000 |
| 80D00 | 9 | 14.8966667 | 5.7204545 | 7.070000 | 26.000000 |
| 120D00 | 9 | 12.660000 | 3.2102025 | 8.940000 | 20.000000 |
| 160D00 | 9 | 13.9677778 | 3.7622260 | 9.000000 | 20.000000 |
| 200D00 | 9 | 14.5988889 | 3.6234322 | 9.000000 | 20.000000 |

----- GOALS=2 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|------------|-----------|-----------|-----------|
| 0D00 | 10 | 0 | 0 | 0 | 0 |
| 40D00 | 10 | 24.0140000 | 2.9765312 | 16.000000 | 27.000000 |
| 80D00 | 10 | 23.5880000 | 4.2165937 | 12.000000 | 27.000000 |
| 120D00 | 10 | 22.9960000 | 5.1565863 | 13.000000 | 29.000000 |
| 160D00 | 10 | 18.6680000 | 4.3959598 | 13.000000 | 26.000000 |
| 200D00 | 10 | 13.1540000 | 4.3651962 | 6.540000 | 23.000000 |

Repeated measures on process data. 25
09:37 Sunday, March 3, 1996

```

P
R      1 1 2 2 2 3 3      4 4 4
G O L   N    2 6 0 4 8 2 6  4 8 0 4 8
O J N   A    0 0 0 0 0 0 0  0 0 0 0 0
O A E A   M    D D D D D D D  D D D D D
B L C M   E    0 0 0 0 0 0 0  0 0 0 0 0
S S T E   -    0 0 0 0 0 0 0  0 0 0 0 0

```

| | | | | | | | | | | | | |
|-----------------|----|------|----|----|----|-------|-------|-------|------|-------|-------|-------|
| 1 1 A Asmus | QC | 15.0 | 12 | 5 | 2 | 2 | 2 | 2 | 2 | 15.0 | 15 | . . . |
| 2 1 A Stueve | QC | 5.0 | 2 | 2 | 2 | 2 | . . . | 2.0 | 2 | . . . | . . . | . . . |
| 3 1 A gearhard | QC | 0.5 | 1 | 1 | 10 | 20 | . . . | 0.5 | 1 | . . . | . . . | . . . |
| 4 1 A johnson | QC | 10.0 | 10 | 10 | 10 | 10 | 10 | . . . | 10.0 | 10 | . . . | . . . |
| 5 1 A jones | QC | 25.0 | 30 | 30 | 30 | 20 | 15 | . . . | 25.0 | 30 | . . . | . . . |
| 6 1 A leonard | QC | 25.0 | 25 | 25 | 25 | 25 | 25 | 20 | 20 | 25.0 | 25 | . . . |
| 7 1 A norris | QC | 10.0 | 20 | 20 | 25 | 15 | . . . | 15.0 | 20 | . . . | . . . | . . . |
| 8 1 A stone | QC | 23.0 | 10 | 10 | 7 | 7 | 5 | . . . | 20.0 | 15 | . . . | . . . |
| 9 1 A west | QC | 10.0 | 10 | 10 | 10 | 10 | . . . | 10.0 | 10 | . . . | . . . | . . . |
| 10 1 B CELEBI | QC | 10.0 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10.0 | 10 | . . . |
| 11 1 B Cooke | QC | 10.0 | 5 | 2 | 2 | 2 | . . . | 10.0 | 5 | . . . | . . . | . . . |
| 12 1 B Jacobson | QC | 20.0 | 13 | 15 | 15 | 15 | 15 | 10 | 10 | 20.0 | 15 | . . . |
| 13 1 B brady | QC | 15.0 | 10 | 10 | 10 | . . . | . . . | 15.0 | 10 | . . . | . . . | . . . |
| 14 1 B casey | QC | 10.0 | 10 | 10 | 10 | 10 | 10 | . . . | 10.0 | 10 | . . . | . . . |
| 15 1 B flick | QC | 20.0 | 30 | 30 | 20 | 10 | 10 | . . . | 20.0 | 20 | . . . | . . . |
| 16 1 B gillum | QC | 15.0 | 10 | 10 | 10 | 10 | . . . | 10.0 | 10 | . . . | . . . | . . . |

17 1 B Hague QC 15.0 15 10 10 10 10 . . 15.0 15 . . .
 18 1 B Hsing QC 13.0 13 10 10 10 10 . . 13.0 12 . . .
 19 1 B Romano QC 15.0 15 10 10 10 10 20 . 15.0 15 . . .
 20 2 A Dennis QC 15.0 14 14 12 12 8 . . 15.0 15 . . .
 21 2 A Lankhous QC 20.0 20 20 20 20 20 20 20 20.0 20 . . .
 22 2 A Shaffer QC 20.0 15 25 30 35 . . . 20.0 15 . . .
 23 2 A TURNER QC 15.0 23 23 23 20 25 15 . 18.0 21 . . .
 24 2 A King QC 15.0 10 15 15 18 . . . 17.0 17 . . .
 25 2 A Kopper QC 10.0 10 10 8 5 . . . 15.0 12 . . .
 26 2 A Mihlon QC 10.0 5 4 3 2 . . . 8.0 6 . . .
 27 2 A Ring QC 15.0 20 21 20 11 13 9 . 17.0 20 . . .
 28 2 A Staier QC 20.0 10 15 20 25 . . . 20.0 15 . . .
 29 2 B Cameron QC 10.0 20 10 10 10 . . . 10.0 20 . . .
 30 2 B Cepek QC 20.0 40 30 30 40 40 40 . 30.0 40 . . .
 31 2 B Chalfant QC 25.0 25 15 15 15 15 . . 25.0 25 . . .
 32 2 B Chaney QC 15.0 25 25 20 20 20 . . 20.0 20 . . .
 33 2 B Earley QC 20.0 25 25 25 25 20 20 25 20.0 25 . . .
 34 2 B Geberth QC 15.0 20 20 20 20 20 20 . 15.0 20 . . .
 35 2 B Heaton QC 15.0 18 18 18 20 20 . . 18.0 18 . . .
 36 2 B James QC 50.0 55 40 40 40 30 30 25 50.0 50 20 25 40
 37 2 B Coats QC 15.0 25 20 20 20 20 20 . 15.0 20 . . .
 38 2 B Waller QC 30.0 80 30 50 40 20 20 30 30.0 60 . . .

Repeated measures on process data. 26
 09:37 Sunday, March 3, 1996

General Linear Models Procedure
 Class Level Information

Class Levels Values

GOALS 2 1 2

PROJECT 2 A B

Number of observations in data set = 38

Repeated measures on process data. 27
 09:37 Sunday, March 3, 1996

General Linear Models Procedure
 Repeated Measures Analysis of Variance
 Repeated Measures Level Information

| | | | | | | |
|--------------------|-------|--------|--------|---------|---------|---------|
| Dependent Variable | _0D00 | _40D00 | _80D00 | _120D00 | _160D00 | _200D00 |
| Level of PERIOD | 1 | 2 | 3 | 4 | 5 | 6 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect
H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.83872781 | 1.1921 | 5 | 31 | 0.3358 |
| Pillai's Trace | 0.16127219 | 1.1921 | 5 | 31 | 0.3358 |
| Hotelling-Lawley Trace | 0.19228192 | 1.1921 | 5 | 31 | 0.3358 |
| Roy's Greatest Root | 0.19228192 | 1.1921 | 5 | 31 | 0.3358 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect
H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.81500205 | 1.4073 | 5 | 31 | 0.2490 |
| Pillai's Trace | 0.18499795 | 1.4073 | 5 | 31 | 0.2490 |
| Hotelling-Lawley Trace | 0.22699077 | 1.4073 | 5 | 31 | 0.2490 |
| Roy's Greatest Root | 0.22699077 | 1.4073 | 5 | 31 | 0.2490 |

Manova Test Criteria and Exact F Statistics for
the Hypothesis of no PERIOD*PROJECT Effect
H = Type III SS&CP Matrix for PERIOD*PROJECT E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.72838370 | 2.3120 | 5 | 31 | 0.0677 |
| Pillai's Trace | 0.27161630 | 2.3120 | 5 | 31 | 0.0677 |
| Hotelling-Lawley Trace | 0.37290277 | 2.3120 | 5 | 31 | 0.0677 |
| Roy's Greatest Root | 0.37290277 | 2.3120 | 5 | 31 | 0.0677 |

Repeated measures on process data. 28

09:37 Sunday, March 3, 1996

General Linear Models Procedure
 Repeated Measures Analysis of Variance
 Tests of Hypotheses for Between Subjects Effects

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---------|----|----------------|---------------|---------|--------|
| GOALS | 1 | 3793.42105263 | 3793.42105263 | 8.35 | 0.0066 |
| PROJECT | 1 | 1229.06842105 | 1229.06842105 | 2.71 | 0.1089 |
| Error | 35 | 15891.54561404 | 454.04416040 | | |

Repeated measures on process data. 29
 09:37 Sunday, March 3, 1996

General Linear Models Procedure
 Repeated Measures Analysis of Variance
 Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|--------------|-------------|---------|--------|------------|--------|-------|
| 5 | 190.16140351 | 38.03228070 | 1.80 | 0.1153 | 0.1694 | 0.1634 | |

Source: PERIOD*GOALS

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|--------------|-------------|---------|--------|------------|--------|-------|
| 5 | 258.72368421 | 51.74473684 | 2.45 | 0.0357 | 0.0888 | 0.0810 | |

Source: PERIOD*PROJECT

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|--------------|-------------|---------|--------|------------|--------|-------|
| 5 | 334.74035088 | 66.94807018 | 3.17 | 0.0092 | 0.0438 | 0.0374 | |

Source: Error(PERIOD)

| DF | Type III SS | Mean Square |
|-----|---------------|-------------|
| 175 | 3698.59298246 | 21.13481704 |

Greenhouse-Geisser Epsilon = 0.4341
 Huynh-Feldt Epsilon = 0.4903

Repeated measures on process data. 30
 09:37 Sunday, March 3, 1996

----- GOALS=1 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|------------|------------|-----------|------------|
| 0D00 | 9 | 13.7222222 | 8.9061464 | 0.5000000 | 25.0000000 |
| 40D00 | 9 | 13.6111111 | 8.9225059 | 0.5000000 | 25.0000000 |
| 80D00 | 9 | 14.2222222 | 9.7439440 | 1.0000000 | 30.0000000 |
| 120D00 | 9 | 13.3333333 | 9.8361578 | 1.0000000 | 30.0000000 |
| 160D00 | 9 | 12.5555556 | 10.2238827 | 1.0000000 | 30.0000000 |
| 200D00 | 9 | 13.4444444 | 10.4894127 | 2.0000000 | 30.0000000 |

----- GOALS=1 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|------------|-----------|------------|------------|
| 0D00 | 10 | 14.3000000 | 3.7133393 | 10.0000000 | 20.0000000 |
| 40D00 | 10 | 13.8000000 | 3.9384148 | 10.0000000 | 20.0000000 |
| 80D00 | 10 | 12.2000000 | 4.1579910 | 5.0000000 | 20.0000000 |
| 120D00 | 10 | 13.1000000 | 6.6407831 | 5.0000000 | 30.0000000 |
| 160D00 | 10 | 11.7000000 | 7.1499806 | 2.0000000 | 30.0000000 |
| 200D00 | 10 | 10.7000000 | 4.5227818 | 2.0000000 | 20.0000000 |

----- GOALS=2 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|------------|-----------|------------|------------|
| 0D00 | 9 | 15.5555556 | 3.9086798 | 10.0000000 | 20.0000000 |
| 40D00 | 9 | 16.6666667 | 3.8078866 | 8.0000000 | 20.0000000 |
| 80D00 | 9 | 15.6666667 | 4.6904158 | 6.0000000 | 21.0000000 |
| 120D00 | 9 | 14.1111111 | 5.9465209 | 5.0000000 | 23.0000000 |
| 160D00 | 9 | 16.3333333 | 6.6708320 | 4.0000000 | 25.0000000 |
| 200D00 | 9 | 16.7777778 | 8.1972218 | 3.0000000 | 30.0000000 |

----- GOALS=2 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|------------|------------|------------|------------|
| 0D00 | 10 | 21.5000000 | 11.5590273 | 10.0000000 | 50.0000000 |
| 40D00 | 10 | 23.3000000 | 11.4022415 | 10.0000000 | 50.0000000 |

| | | | | | |
|--------|----|------------|------------|------------|------------|
| 80D00 | 10 | 29.800000 | 14.8832493 | 18.0000000 | 60.0000000 |
| 120D00 | 10 | 33.3000000 | 19.8888579 | 18.0000000 | 80.0000000 |
| 160D00 | 10 | 23.3000000 | 8.6287633 | 10.0000000 | 40.0000000 |
| 200D00 | 10 | 24.8000000 | 12.1271046 | 10.0000000 | 50.0000000 |

 Repeated measures on process data. 13
 09:37 Sunday, March 3, 1996

| | | | | | | | | | | | | |
|------|---|---|---|---|---|---|---|---|---|---|---|-----|
| P | | | | | | | | | | | | |
| R | | 1 | 1 | 2 | 2 | 2 | 3 | 3 | | 4 | 4 | 4 |
| GOL | N | 2 | 6 | 0 | 4 | 8 | 2 | 6 | 4 | 8 | 0 | 4 |
| OJN | A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OAEA | M | D | D | D | D | D | D | D | D | D | D | DDD |
| BLCM | E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SSTE | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | |
|----------------|-------|------|------|------|------|------|------|------|------|------|------|-----|
| 11 A Asmus | STAFF | 3.5 | 3.5 | 3.5 | 3.0 | 3.0 | 3.0 | 2.9 | 2.9 | 3.5 | 3.5 | ... |
| 21 A Stueve | STAFF | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | . | . | . | 4.0 | 5.0 | ... |
| 31 A gearhard | STAFF | 5.2 | 5.2 | 5.2 | 5.0 | 3.6 | . | . | . | 5.2 | 5.2 | ... |
| 41 A johnson | STAFF | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | . | . | 4.0 | 6.0 | ... |
| 51 A jones | STAFF | 5.0 | 8.0 | 8.0 | 10.0 | 10.0 | 7.0 | . | . | 6.0 | 6.0 | ... |
| 61 A leonard | STAFF | 4.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 4.0 | 7.0 | ... |
| 71 A norris | STAFF | 6.5 | 9.0 | 9.5 | 9.5 | 7.0 | . | . | . | 7.5 | 8.5 | ... |
| 81 A stone | STAFF | 6.0 | 6.0 | 6.0 | 5.8 | 6.0 | 6.0 | . | . | 6.0 | 6.0 | ... |
| 91 A west | STAFF | 5.5 | 6.5 | 5.5 | 4.5 | 4.5 | . | . | . | 6.5 | 6.5 | ... |
| 101 B CELEBI | STAFF | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | ... |
| 111 B Cooke | STAFF | 4.0 | 4.0 | 8.0 | 8.0 | 8.0 | . | . | . | 4.0 | 4.0 | ... |
| 121 B Jacobson | STAFF | 4.0 | 4.2 | 4.2 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 4.0 | 4.0 | ... |
| 131 B brady | STAFF | 3.5 | 7.0 | 7.0 | 7.0 | . | . | . | . | 10.0 | 10.0 | ... |
| 141 B casey | STAFF | 5.0 | 4.5 | 4.5 | 5.5 | 5.5 | 5.5 | . | . | 5.0 | 5.0 | ... |
| 151 B flick | STAFF | 5.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | . | . | 5.0 | 8.0 | ... |
| 161 B gillum | STAFF | 6.0 | 5.3 | 5.5 | 8.0 | 6.0 | . | . | . | 6.0 | 5.5 | ... |
| 171 B Hague | STAFF | 7.0 | 7.0 | 7.0 | 9.0 | 9.0 | 9.0 | . | . | 7.0 | 7.0 | ... |
| 181 B hsing | STAFF | 3.5 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | . | . | 5.0 | 5.0 | ... |
| 191 B romano | STAFF | 4.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 4.0 | 4.0 | ... |
| 202 A Dennis | STAFF | 5.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | . | . | 5.0 | 7.0 | ... |
| 212 A Lankhors | STAFF | 10.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 10.0 | 6.0 | ... |
| 222 A Shaffer | STAFF | 5.0 | 9.0 | 15.0 | 15.0 | 7.0 | . | . | . | 5.0 | 9.0 | ... |
| 232 A TURNER | STAFF | 4.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 6.0 | 8.0 | ... |
| 242 A king | STAFF | 5.0 | 8.0 | 8.0 | 8.0 | 7.0 | . | . | . | 6.5 | 7.5 | ... |
| 252 A kopper | STAFF | 4.0 | 6.0 | 6.5 | 6.5 | 6.5 | . | . | . | 5.0 | 5.0 | ... |
| 262 A mihlon | STAFF | 4.0 | 6.0 | 6.0 | 8.0 | 7.0 | . | . | . | 4.0 | 6.0 | ... |
| 272 A ring | STAFF | 5.0 | 7.0 | 7.0 | 8.0 | 10.0 | 10.0 | 10.0 | 10.0 | 5.0 | 7.0 | ... |
| 282 A staiser | STAFF | 5.5 | 12.0 | 11.0 | 9.5 | 6.0 | . | . | . | 9.0 | 10.0 | ... |
| 292 B Cameron | STAFF | 5.0 | 6.0 | 10.0 | 10.0 | 10.0 | . | . | . | 6.0 | 6.0 | ... |
| 302 B Cepek | STAFF | 6.0 | 7.0 | 8.0 | 8.0 | 9.0 | 9.0 | 9.0 | 9.0 | 7.0 | 7.0 | ... |

31 2 B Chalfant STAFF 8.0 7.0 7.0 6.0 6.0 6.0 . . 8.0 8.0...
 32 2 B Chaney STAFF 5.0 7.0 8.0 10.0 15.0 15.0 . . 7.0 7.0...
 33 2 B Earley STAFF 3.5 5.0 8.0 8.0 8.0 8.0 8.0 8.0 3.5 5.0...
 34 2 B Geberth STAFF 4.0 5.0 5.0 5.0 5.0 5.0 6.0 . 4.0 5.0...
 35 2 B Heaton STAFF 5.0 8.0 8.0 10.0 10.0 10.0 . . 6.0 8.0...
 36 2 B James STAFF 4.0 5.0 5.0 5.0 5.0 5.0 6.0 6.0 5.0 5.0 6 6 6
 37 2 B coats STAFF 5.0 6.0 6.0 8.0 8.0 8.0 8.0 . 5.0 5.0...
 38 2 B waller STAFF 5.0 5.0 5.0 5.0 7.0 10.0 20.0 20.0 5.0 5.0...

Repeated measures on process data. 14
 09:37 Sunday, March 3, 1996

General Linear Models Procedure
Class Level Information

Class Levels Values

GOALS 2 1 2

PROJECT 2 A B

Number of observations in data set = 38

Repeated measures on process data. 15
 09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

| Dependent Variable | _0D00 | _40D00 | _80D00 | _120D00 | _160D00 | _200D00 |
|--------------------|-------|--------|--------|---------|---------|---------|
| Level of PERIOD | 1 | 2 | 3 | 4 | 5 | 6 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect
H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|---------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.51513667 | 5.8356 | 5 | 31 | 0.0007 |

| | | | | | |
|------------------------|------------|--------|---|----|--------|
| Pillai's Trace | 0.48486333 | 5.8356 | 5 | 31 | 0.0007 |
| Hotelling-Lawley Trace | 0.94123242 | 5.8356 | 5 | 31 | 0.0007 |
| Roy's Greatest Root | 0.94123242 | 5.8356 | 5 | 31 | 0.0007 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect

H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.95522269 | 0.2906 | 5 | 31 | 0.9145 |
| Pillai's Trace | 0.04477731 | 0.2906 | 5 | 31 | 0.9145 |
| Hotelling-Lawley Trace | 0.04687631 | 0.2906 | 5 | 31 | 0.9145 |
| Roy's Greatest Root | 0.04687631 | 0.2906 | 5 | 31 | 0.9145 |

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*PROJECT Effect

H = Type III SS&CP Matrix for PERIOD*PROJECT E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

| Statistic | Value | F | Num DF | Den DF | Pr > F |
|------------------------|------------|--------|--------|--------|--------|
| Wilks' Lambda | 0.80610911 | 1.4913 | 5 | 31 | 0.2211 |
| Pillai's Trace | 0.19389089 | 1.4913 | 5 | 31 | 0.2211 |
| Hotelling-Lawley Trace | 0.24052686 | 1.4913 | 5 | 31 | 0.2211 |
| Roy's Greatest Root | 0.24052686 | 1.4913 | 5 | 31 | 0.2211 |

Repeated measures on process data. 16

09:37 Sunday, March 3, 1996

General Linear Models Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---------|----|--------------|-------------|---------|--------|
| GOALS | 1 | 45.63157895 | 45.63157895 | 4.05 | 0.0519 |
| PROJECT | 1 | 12.88507018 | 12.88507018 | 1.14 | 0.2921 |
| Error | 35 | 394.13475439 | 11.26099298 | | |

Repeated measures on process data. 17

09:37 Sunday, March 3, 1996

General Linear Models Procedure
 Repeated Measures Analysis of Variance
 Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|--------------|-------------|---------|--------|------------|--------|--------|
| 5 | 131.39669591 | 26.27933918 | 14.42 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

Source: PERIOD*GOALS

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|-------------|-------------|---------|--------|------------|--------|-------|
| 5 | 6.85157895 | 1.37031579 | 0.75 | 0.5856 | 0.4724 | 0.4858 | |

Source: PERIOD*PROJECT

| DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | G - G | H - F |
|----|-------------|-------------|---------|--------|------------|--------|-------|
| 5 | 6.97774854 | 1.39554971 | 0.77 | 0.5755 | 0.4660 | 0.4790 | |

Source: Error(PERIOD)

| DF | Type III SS | Mean Square |
|-----|--------------|-------------|
| 175 | 318.86453216 | 1.82208304 |

Greenhouse-Geisser Epsilon = 0.3907

Huynh-Feldt Epsilon = 0.4372

Repeated measures on process data. 18

09:37 Sunday, March 3, 1996

----- GOALS=1 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|-----------|-----------|-----------|------------|
| _0D00 | 9 | 4.9666667 | 0.9861541 | 3.5000000 | 6.5000000 |
| _40D00 | 9 | 5.1888889 | 1.3905435 | 3.5000000 | 7.5000000 |
| _80D00 | 9 | 5.9666667 | 1.3865425 | 3.5000000 | 8.5000000 |
| _120D00 | 9 | 6.2444444 | 1.6432522 | 3.5000000 | 9.0000000 |
| _160D00 | 9 | 6.1888889 | 1.7702009 | 3.5000000 | 9.5000000 |
| _200D00 | 9 | 6.2000000 | 2.2961925 | 3.0000000 | 10.0000000 |

----- GOALS=1 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|-----------|-----------|-----------|------------|
| _0D00 | 10 | 4.6000000 | 1.1498792 | 3.5000000 | 7.0000000 |
| _40D00 | 10 | 5.4000000 | 1.8973666 | 4.0000000 | 10.0000000 |
| _80D00 | 10 | 5.6500000 | 2.0554805 | 4.0000000 | 10.0000000 |
| _120D00 | 10 | 5.6000000 | 1.9544820 | 4.0000000 | 10.0000000 |
| _160D00 | 10 | 6.2200000 | 1.8635689 | 4.0000000 | 10.0000000 |
| _200D00 | 10 | 6.9500000 | 1.8020051 | 4.0000000 | 10.0000000 |

----- GOALS=2 PROJECT=A -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|-----------|-----------|-----------|------------|
| _0D00 | 9 | 5.2777778 | 1.8559215 | 4.0000000 | 10.0000000 |
| _40D00 | 9 | 6.1666667 | 2.0310096 | 4.0000000 | 10.0000000 |
| _80D00 | 9 | 7.2777778 | 1.5634719 | 5.0000000 | 10.0000000 |
| _120D00 | 9 | 7.5555556 | 2.2422707 | 4.0000000 | 12.0000000 |
| _160D00 | 9 | 8.1666667 | 3.1819805 | 4.0000000 | 15.0000000 |
| _200D00 | 9 | 8.3333333 | 2.9261750 | 4.0000000 | 15.0000000 |

----- GOALS=2 PROJECT=B -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|-----------|-----------|-----------|------------|
| _0D00 | 10 | 5.0500000 | 1.2572015 | 3.5000000 | 8.0000000 |
| _40D00 | 10 | 5.6500000 | 1.4151953 | 3.5000000 | 8.0000000 |
| _80D00 | 10 | 6.1000000 | 1.2866839 | 5.0000000 | 8.0000000 |
| _120D00 | 10 | 6.1000000 | 1.1005049 | 5.0000000 | 8.0000000 |
| _160D00 | 10 | 7.0000000 | 1.6996732 | 5.0000000 | 10.0000000 |
| _200D00 | 10 | 7.5000000 | 2.1213203 | 5.0000000 | 10.0000000 |

APPENDIX Q: PERFORMANCE DATA

Performance data

1

14:59 Tuesday, February 27, 1996

| OBS | LNAME | PROJECT | GOALS | ORDER | FNCOST | FNSKED | FNERR |
|-----|----------|---------|-------|-------|---------|--------|---------|
| 1 | Asmus | A | 1 | 1 | 1082.44 | 360.0 | 1266.44 |
| 2 | johnson | A | 1 | 1 | 1496.63 | 312.0 | 1885.45 |
| 3 | jones | A | 1 | 1 | 1968.05 | 307.5 | 622.44 |
| 4 | leonard | A | 1 | 1 | 2040.21 | 365.5 | 559.06 |
| 5 | norris | A | 1 | 1 | 1756.22 | 251.0 | 1481.82 |
| 6 | gearhard | A | 1 | 2 | 1199.47 | 270.5 | 9781.81 |
| 7 | stone | A | 1 | 2 | 1630.60 | 310.0 | 738.44 |
| 8 | Stueve | A | 1 | 2 | 1142.96 | 269.0 | 7302.89 |
| 9 | west | A | 1 | 2 | 1348.78 | 271.0 | 2126.43 |
| 10 | Dennis | A | 2 | 1 | 1810.19 | 299.0 | 1097.82 |
| 11 | kopper | A | 2 | 1 | 1280.43 | 268.0 | 1932.55 |
| 12 | Lankhors | A | 2 | 1 | 1639.19 | 374.0 | 578.61 |
| 13 | Shaffer | A | 2 | 1 | 1972.70 | 258.5 | 771.77 |
| 14 | TURNER | A | 2 | 1 | 2061.62 | 327.0 | 873.75 |
| 15 | king | A | 2 | 2 | 1521.59 | 251.5 | 1184.90 |
| 16 | mihlon | A | 2 | 2 | 1280.33 | 264.0 | 2573.47 |
| 17 | ring | A | 2 | 2 | 2068.38 | 329.0 | 910.61 |
| 18 | staier | A | 2 | 2 | 1996.02 | 257.0 | 786.59 |
| 19 | brady | B | 1 | 1 | 1387.75 | 240.0 | 1334.88 |
| 20 | CELEBI | B | 1 | 1 | 1274.16 | 352.0 | 1822.62 |
| 21 | flick | B | 1 | 1 | 2083.64 | 295.0 | 689.42 |
| 22 | hsing | B | 1 | 1 | 1349.10 | 289.5 | 1588.36 |
| 23 | romano | B | 1 | 1 | 1398.31 | 321.5 | 1251.58 |
| 24 | casey | B | 1 | 2 | 1381.59 | 312.0 | 1800.63 |
| 25 | Cooke | B | 1 | 2 | 1167.53 | 259.0 | 2676.52 |
| 26 | gillum | B | 1 | 2 | 1328.09 | 259.0 | 1500.12 |
| 27 | hague | B | 1 | 2 | 1473.53 | 244.0 | 1290.76 |
| 28 | Jacobson | B | 1 | 2 | 1668.26 | 379.5 | 677.79 |
| 29 | Cepek | B | 2 | 1 | 2227.05 | 336.0 | 604.23 |
| 30 | coats | B | 2 | 1 | 1878.66 | 338.0 | 933.29 |
| 31 | Heaton | B | 2 | 1 | 2165.74 | 315.5 | 909.67 |
| 32 | James | B | 2 | 1 | 2389.62 | 502.0 | 501.79 |
| 33 | waller | B | 2 | 1 | 2311.00 | 378.0 | 607.66 |
| 34 | Cameron | B | 2 | 2 | 1700.44 | 274.5 | 1824.09 |
| 35 | Chalfant | B | 2 | 2 | 1848.91 | 307.5 | 570.79 |
| 36 | Chaney | B | 2 | 2 | 1936.47 | 285.5 | 955.76 |
| 37 | Earley | B | 2 | 2 | 2080.11 | 374.5 | 634.56 |
| 38 | Geberth | B | 2 | 2 | 1520.04 | 354.0 | 932.55 |

Performance data

2

14:59 Tuesday, February 27, 1996

----- PROJECT=A GOALS=1 -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|-------------|-------------|-------------|-------------|
| FNCOST | 9 | 1518.37 | 354.5411686 | 1082.44 | 2040.21 |
| FNSKED | 9 | 301.8333333 | 40.6717039 | 251.0000000 | 365.5000000 |
| FNERR | 9 | 2862.75 | 3323.77 | 559.0600000 | 9781.81 |
| FNERG | 9 | 576.5511111 | 48.1981378 | 535.7200000 | 678.5300000 |
| FNERD | 9 | 271.6488889 | 167.1901172 | 52.8800000 | 536.4400000 |
| FNRES | 9 | 304.9011111 | 140.5700447 | 136.9500000 | 516.3700000 |
| FNPRDT | 9 | 46.1355556 | 26.0814619 | 9.2900000 | 79.0600000 |
| FNQAMD | 9 | 219.7011111 | 183.5586347 | 26.5200000 | 506.8600000 |
| FNTRMD | 9 | 94.2944444 | 34.9914965 | 39.2100000 | 141.9100000 |
| FNRWMD | 9 | 197.8455556 | 118.9816874 | 36.9800000 | 359.2900000 |

----- PROJECT=A GOALS=2 -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|---|-------------|-------------|-------------|-------------|
| FNCOST | 9 | 1736.72 | 319.4066121 | 1280.33 | 2068.38 |
| FNSKED | 9 | 292.0000000 | 42.8872067 | 251.5000000 | 374.0000000 |
| FNERR | 9 | 1190.01 | 648.4037547 | 578.6100000 | 2573.47 |
| FNERG | 9 | 604.9800000 | 52.1847159 | 550.1000000 | 690.5500000 |
| FNERD | 9 | 368.2533333 | 120.7299899 | 115.9300000 | 532.1700000 |
| FNRES | 9 | 236.7255556 | 111.7545648 | 151.0600000 | 455.6100000 |
| FNPRDT | 9 | 60.7177778 | 18.7304203 | 20.2800000 | 77.0600000 |
| FNQAMD | 9 | 284.8488889 | 135.3733590 | 62.9400000 | 468.1000000 |
| FNTRMD | 9 | 125.6377778 | 34.8176284 | 77.7900000 | 179.9500000 |
| FNRWMD | 9 | 271.3388889 | 87.3096888 | 87.0600000 | 339.3700000 |

----- PROJECT=B GOALS=1 -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|-------------|-------------|-------------|-------------|
| FNCOST | 10 | 1451.20 | 257.4781858 | 1167.53 | 2083.64 |
| FNSKED | 10 | 295.1500000 | 46.7006127 | 240.0000000 | 379.5000000 |
| FNERR | 10 | 1463.27 | 581.0722069 | 677.7900000 | 2676.52 |
| FNERG | 10 | 633.2490000 | 62.8253792 | 535.0200000 | 747.9700000 |
| FNERD | 10 | 325.0920000 | 117.2672678 | 96.6400000 | 566.6200000 |
| FNRES | 10 | 308.1570000 | 102.0192853 | 181.3500000 | 551.1500000 |
| FNPRDT | 10 | 51.0770000 | 15.8040255 | 14.9200000 | 75.7500000 |

| | | | | | |
|--------|----|-------------|-------------|------------|-------------|
| FNQAMD | 10 | 179.4270000 | 100.7888221 | 51.9100000 | 431.2800000 |
| FNTRMD | 10 | 96.1850000 | 27.0112126 | 58.4800000 | 161.4300000 |
| FNRWMD | 10 | 218.9240000 | 89.2661783 | 71.2600000 | 418.7300000 |

----- PROJECT=B GOALS=2 -----

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|----------|----|-------------|-------------|-------------|-------------|
| FNCOST | 10 | 2005.80 | 277.9513111 | 1520.04 | 2389.62 |
| FNSKED | 10 | 346.5500000 | 64.6204517 | 274.5000000 | 502.0000000 |
| FNERR | 10 | 847.4390000 | 386.1544804 | 501.7900000 | 1824.09 |
| FNERG | 10 | 594.4380000 | 62.0690900 | 529.1400000 | 717.9000000 |
| FNERD | 10 | 436.6400000 | 72.4674781 | 333.3700000 | 581.1000000 |
| FNERES | 10 | 157.7990000 | 36.4246688 | 124.2400000 | 251.2300000 |
| FNPRDT | 10 | 73.2200000 | 6.6202853 | 57.0300000 | 80.9400000 |
| FNQAMD | 10 | 502.2280000 | 237.0315975 | 213.9400000 | 875.8100000 |
| FNTRMD | 10 | 136.3760000 | 30.4277831 | 81.7400000 | 189.1200000 |
| FNRWMD | 10 | 318.7870000 | 31.6099137 | 245.5600000 | 357.8000000 |

Performance data 3
14:59 Tuesday, February 27, 1996

General Linear Models Procedure
Class Level Information

Class Levels Values

PROJECT 2 A B

GOALS 2 1 2

ORDER 2 1 2

Number of observations in data set = 38

Performance data 4
14:59 Tuesday, February 27, 1996

General Linear Models Procedure

Dependent Variable: FNCOST

| Sum of | Mean |
|--------|------|
|--------|------|

| Source | DF | Squares | Square | F Value | Pr > F |
|-----------------|----------|------------|-----------|-------------|--------|
| Model | 4 | 2277775.07 | 569443.77 | 7.00 | 0.0003 |
| Error | 33 | 2684989.92 | 81363.33 | | |
| Corrected Total | 37 | 4962765.00 | | | |
| | R-Square | C.V. | Root MSE | FNCOST Mean | |
| | 0.458973 | 16.97186 | 285.243 | 1680.68 | |

| Source | DF | Type I SS | Mean Square | F Value | Pr > F |
|---------------|----|------------|-------------|---------|--------|
| PROJECT | 1 | 96554.96 | 96554.96 | 1.19 | 0.2839 |
| GOALS | 1 | 1484675.65 | 1484675.65 | 18.25 | 0.0002 |
| ORDER | 1 | 428737.80 | 428737.80 | 5.27 | 0.0282 |
| PROJECT*GOALS | 1 | 267806.67 | 267806.67 | 3.29 | 0.0787 |

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---------------|----|-------------|-------------|---------|--------|
| PROJECT | 1 | 120152.18 | 120152.18 | 1.48 | 0.2329 |
| GOALS | 1 | 1415022.07 | 1415022.07 | 17.39 | 0.0002 |
| ORDER | 1 | 428737.80 | 428737.80 | 5.27 | 0.0282 |
| PROJECT*GOALS | 1 | 267806.67 | 267806.67 | 3.29 | 0.0787 |

Performance data 5

14:59 Tuesday, February 27, 1996

General Linear Models Procedure

Dependent Variable: FNSKED

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|----------|----------------|-------------|-------------|--------|
| Model | 4 | 29400.5405 | 7350.1351 | 3.24 | 0.0239 |
| Error | 33 | 74829.7029 | 2267.5668 | | |
| Corrected Total | 37 | 104230.2434 | | | |
| | R-Square | C.V. | Root MSE | FNSKED Mean | |
| | 0.282073 | 15.38512 | 47.6190 | 309.513 | |

| Source | DF | Type I SS | Mean Square | F Value | Pr > F |
|---------------|----|------------|-------------|---------|--------|
| PROJECT | 1 | 5426.5684 | 5426.5684 | 2.39 | 0.1314 |
| GOALS | 1 | 4764.4803 | 4764.4803 | 2.10 | 0.1566 |
| ORDER | 1 | 10329.0471 | 10329.0471 | 4.56 | 0.0403 |
| PROJECT*GOALS | 1 | 8880.4447 | 8880.4447 | 3.92 | 0.0562 |

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---------------|----|-------------|-------------|---------|--------|
| PROJECT | 1 | 6272.2748 | 6272.2748 | 2.77 | 0.1058 |
| GOALS | 1 | 4092.1289 | 4092.1289 | 1.80 | 0.1883 |
| ORDER | 1 | 10329.0471 | 10329.0471 | 4.56 | 0.0403 |
| PROJECT*GOALS | 1 | 8880.4447 | 8880.4447 | 3.92 | 0.0562 |

Performance data 6
14:59 Tuesday, February 27, 1996

General Linear Models Procedure

Dependent Variable: FNERR

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|--------|----|----------------|-------------|---------|--------|
| Model | 4 | 33357863.8 | 8339466.0 | 3.26 | 0.0233 |
| Error | 33 | 84440905.2 | 2558815.3 | | |

Corrected Total 37 117798769.0

| R-Square | C.V. | Root MSE | FNERR Mean |
|----------|----------|----------|------------|
| 0.283177 | 102.0208 | 1599.63 | 1567.95 |

| Source | DF | Type I SS | Mean Square | F Value | Pr > F |
|---------------|----|------------|-------------|---------|--------|
| PROJECT | 1 | 7187571.8 | 7187571.8 | 2.81 | 0.1032 |
| GOALS | 1 | 11841878.1 | 11841878.1 | 4.63 | 0.0389 |
| ORDER | 1 | 11682715.6 | 11682715.6 | 4.57 | 0.0401 |
| PROJECT*GOALS | 1 | 2645698.3 | 2645698.3 | 1.03 | 0.3166 |

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---------------|----|-------------|-------------|---------|--------|
| PROJECT | 1 | 8218043.7 | 8218043.7 | 3.21 | 0.0823 |
| GOALS | 1 | 12404779.3 | 12404779.3 | 4.85 | 0.0348 |
| ORDER | 1 | 11682715.6 | 11682715.6 | 4.57 | 0.0401 |
| PROJECT*GOALS | 1 | 2645698.3 | 2645698.3 | 1.03 | 0.3166 |

APPENDIX R. SAMPLE CAPTURE.DAT

NAME SMC# A 2 1 40 R1 70
NAME SMC# A 2 1 40 R2 29
NAME SMC# A 2 1 40 R3 54
NAME SMC# A 2 1 40 G4 33
NAME SMC# A 2 1 40 G8 13
NAME SMC# A 2 1 40 R1 280
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 G8 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 G8 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

PERFORMANCE.SAS:

```
title "Performance data " ;
options linesize=75;
options pagesize=200;
data one;

infile "/h/joshua_u1/tmroylan/thesis/Timdata/performance.dat";
input lname $ smc $ project $ goals $ order $ fncost fnsked fnerr
      fnerg fnerd fneres fnprdt fnqamd fntrmd fnrwmd;

/*
if (project='B') then delete;
if (project='A') then delete;
if (project='A') then initcost=944;
if (project='A') then initsked=272;
if (project='B') then initcost=1960;
if (project='B') then initsked=272;
costdev = abs(fncost-initcost);
pcostdev = abs(fncost-initcost)/fncost;
skeddev = abs(fnsked-initsked);
pskeddev = abs(fnsked-initsked)/fnsked;
*/

if (project='C') then delete;

proc sort;
  by project goals order ;

proc print; var lname project goals order fncost fnsked fnerr;

proc means; by project goals ;
```

```

proc glm;
class project goals order ;
model fncost fnsked fnerr /* fnerg fnerd fneres fnprdt
      fnqamd fntrmd fnrwmd fncost */= project goals order project*goals ;

run;

```

PROCESS.SAS

```

libname dataname "/h/joshua_u1/tmroylan/thesis/Timdata";
options pagesize=200;
title "Repeated measures on process data. " ;
data dataname.dat (keep= lname smc project goals order time
                  qc);
infile "/h/joshua_u1/tmroylan/thesis/Timdata/process.dat";
input lname $ smc $ project $ goals $ order $ time $ var1-var27 prod
staff qc cost duration ;

if (project='C') then delete;

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

/*
proc means; by project goals lname time ;
var staff qc cost duration;
*/

proc transpose data=dataname.sort out=dataname.trans
/* (rename=( _0.00=y1 _40.00=y2 _80.00=y3 _120.00=y4 _160.00=y5
_200.00=y6
_240.00=y7))*/;
by goals project lname;
id time;

proc print;

proc glm data=dataname.trans;
class goals project ;

```

```

model _0D00 _40D00 _80D00 _120D00 _160D00 _200D00
    = goals project/nouni;
repeated period /*polynomial /short summary*/;
proc means;
var _0D00 _40D00 _80D00 _120D00 _160D00 _200D00;
by goals project;
run;

```

CAPTURE.SAS

```

libname dataname "/h/joshua_u1/tmroylan/thesis/Timdata";
options pagesize=200;
title "Repeated measures on capture data. " ;
data dataname.dat (keep= lname smc project goals order time
                    g4time);
infile "/h/joshua_u1/tmroylan/thesis/Timdata/capture.dat";
input lname $ smc $ project $ goals $ order $ time $ r1freq r1time r2freq r2time
r3freq r3time r4freq r4time g1freq g1time g2freq g2time g3freq g3time
g4freq g4time;

```

```

if (project='C') then delete;

```

```

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

```

```

proc transpose data=dataname.sort out=dataname.trans
/* (rename=( _0.00=y1 _40.00=y2 _80.00=y3 _120.00=y4 _160.00=y5
_200.00=y6
_240.00=y7))*/;
by goals project lname;
id time;

```

```

proc print;

```

```

proc glm data=dataname.trans;
class goals project ;
model _0 _40 _80 _120 _160 _200
    = goals project/nouni;

```

```
repeated period /*polynomial /short summary*/;  
proc means;  
var _0_40_80_120_160_200;  
by goals project;  
run;
```

LIST OF REFERENCES

1. Abdel-Hamid, T.K., "The Dynamics of Software project Staffing: A system Dynamics Based Simulation Approach," *IEEE Transactions on Software engineering*, vol. 15, no. 2, Feb. 1989.
2. Abdel-Hamid, T.K., and Madnick, S.E., "Lessons Learned from Modeling the Dynamics of Software Development," *Communications of the ACM*, vol. 32, no. 12, Dec. 1989.
3. Boehm, B.W., *Software Engineering Economics*, Englewood Cliffs N.J.:Prentice-Hall Inc., 1981.
4. Daniel, W.W., and Terrell, James C., *Business Statistics*, Boston:Houghton Mifflin Company, 1975.
5. Remus, William, "Graduate Students as Surrogates for Managers in Experiments on Business Decision Making," *Journal of Business Research*, vol. 14, 1986.
6. Weinburg, G. M. and E. L. Schulman, "Goals and Performance in Computer Programming," *Human Factors*, vol. 16, 1974, pp. 70-77.
7. Swett, C., "An Experimental Investigation of the Impact of Conflicting Project Goals on Staff Resource Allocation", M.S. Thesis, Naval Postgraduate School, Monterey, California, Jun. 1995.
8. Klein, H., "An Integrated Control Theory Model of Work Motivation," *Academy of Management Review*, vol. 14, 1989, pp. 150-170.
9. Vance, R., and Colella, A., "Effects of Two Types of Feedback on Goal Acceptance and Personal Goals," *Journal of Applied Psychology*, vol. 75., No. 1, 1990, pp. 68-76.
10. Erez, M., "Feedback: A Necessary Condition for the Goal Setting-Performance Relationship," *Journal of Applied Psychology*, vol. 62., No. 5, 1977, pp. 624-627.

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