NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

THESIS

AN EXPERIMENTAL INVESTIGATION OF THE IMPACT OF RISK ON SOFTWARE PROJECT MANAGEMENT

by

Kimberly Sue Russ

September, 1995

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In this thesis the author investigates the impact of risk on dynamic decision making in software project management. Graduate students participate as project managers making management decisions pertaining to total staff acquisition, its allocation to development versus quality assurance, and cost and schedule adjustments. Data analyses reveal that risk does significantly impact decision making and in turn project performance in terms of final cost and duration.

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AN EXPERIMENTAL INVESTIGATION OF THE IMPACT OF RISK ON SOFTWARE PROJECT MANAGEMENT

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The ability to develop information systems within cost and schedule is a difficult task for the DoD. The Systems Dynamics Model of Software Project Management is an interactive, computer simulation which allows for the investigation of decision making in a software development environment.

In this thesis the author investigates the impact of risk on dynamic decision making in software project management. Graduate students participate as project managers making management decisions pertaining to total staff acquisition, its allocation to development versus quality assurance, and cost and schedule adjustments. Data analyses reveal that risk does significantly impact decision making and in turn project performance in terms of final cost and duration.

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I. INTRODUCTION

A. BACKGROUND

Developing and maintaining software that is acceptable to the end user continues to challenge the Department of Defense (DoD). The DoD currently spends about $9 billion each year on general purpose automated data processing equipment, software, and related services [Ref. 1]. With increasingly constrained budgets, improved management can lead to significant cost savings.

The General Accounting Office (GAO) reported that cost overruns and schedule slippages plague DoD systems [Ref. 2]. Surveys of experienced project managers identify personnel shortfalls, unrealistic schedules and budgets, and a continuing stream of requirement changes as serious sources of risk on software projects. Postmortems of software project disasters reveal that their problems would have been avoided or strongly reduced with an explicit early concern for identifying and resolving high-risk elements. [Ref. 3] New concepts from behavioral decision theory have sparked research into human decision making.

Behavioral decision theory concludes that people make choices using only a few sources of information processed with simple rules of thumb. Morecroft modeled the idea that only a few information flows actually penetrate to the heart of the decision function, passing through several cognitive and organizational filters, where they influence the choices and actions of the individual. The influence of behavioral decision theory on system dynamics can be seen in the development of microworlds or models that represent organizations as decision making/information processing systems involving many players, with multiple (often conflicting) goals and limited processing capability. [Ref. 4]

The Systems Dynamics Model (SDM) of Software Project Management models the dynamic nature of software project development [Ref. 5]. This simulation-based model has been used to conduct micro-empirical research on dynamic decisions made by software project managers [Ref. 6-11].

B. PURPOSE OF RESEARCH

The purpose of this thesis is to design and conduct an experimental investigation into the effects of risk on software project management. The SDM of Software Project Management will be used to study in a controlled environment, how project managers handle risk factors, how perceived risk affects decision making, and in turn project outcome in terms of final cost and schedule.

C. SCOPE OF RESEARCH

The scope of this research includes the experimental design, development of software to support the design, preparation of documentation and instruction sets for the participants, tailoring of the gaming interface to include risk factors, providing additional report capabilities, execution, and performance assessment of the allocation of resources by differing group project managers. Care was taken in the preparation of additional report capabilities and smoothing of the instruction sets in an effort to prevent introducing external biases. This research was conducted in a single project environment.

D. LIMITATIONS

Forty-one graduate students at the Naval Postgraduate School participated in the experiment as surrogates for software project managers. These students were in their seventh quarter of a masters program in Information Technology Management. They have completed significant course work and posses several years of practical managerial experience. These students also participated in a similar experimental investigation on the effect of goals on dynamic decision making as part of a software engineering course requirement.

E. THESIS ORGANIZATION

Chapter II is a detailed description of the experimental design and the methodology used. The design includes preparing the gaming interface, the software, the documentation, conducting the practice experiment, and making final preparations.

Chapter III describes conducting and organizing the experiment, including the dependent measures to be used. Chapter IV is the data analyses and experimental results. Specifically this chapter contains descriptive statistics from the three groups and discusses the findings. Chapter V contains the conclusions and recommendations for further study.

II. PREPARING THE GAME INTERFACE

A. EXPERIMENTAL DESIGN

The Systems Dynamics Model of Software Development is a role playing computer based simulation game that mimics the programming phase of a real software development project. The participants assume the role of software project manager and make resource allocation decisions to complete the project on time and within schedule. The software project manager makes staff allocation decisions including the total number of staff and the percent of staff allocated to quality assurance. The project managers also provide their estimates of cost and schedule throughout the project at each of the 40 day intervals.

The project begins with a core team of four. These software professionals provide the continuity between the requirements/design phase and the programming phase. The project managers initially receive estimates of the size of the system in delivered source instructions, cost of the programming phase in person days, and duration of the programming phase in days. Every two month interval, 40 working days, the model generates status information on the projects' progress. At the end of the period and after reviewing these reports and graphs, the project manager is able to make adjustments to the staffing level and its allocation.

The research question is to determine the effects of risk in terms of staff turnover on software project management. The 41 students were randomly assigned to three groups [Ref. 12]. The randomization worksheet is contained in Appendix P. All three groups interacted with projA.dnx. The source code is available in Appendix J. The three groups were the uncertainty group, the risk group, and the certainty group.

B. THE THREE GROUPS

The software program managers of the uncertainty group (A1) did not receive any probability information about staff turnover. The risk group (A2) managers were told that historically the turnover rate averages to 1.5 people lost every reporting period. The certainty group (B1) managers were notified in advance about personnel intending to leave the project during the next 40 day period. The number of staff lost due to turnover experienced in a period was determined in advance and designed into the simulation at the onset. The project was created using data collected from an actual NASA development effort.

C. THE SOFTWARE

The students for this experiment had participated in an experimental investigation of the impact of goals on software project development six months earlier. First, part of the feedback from that experiment included a request to capture cumulative information on project status from several periods and make it available to the project manager. To incorporate this change, a new report, the Project Cumulative Report, was created. It is a report specification file that captures the values of variables in different periods and displays them to the user. This file is written in Dynamo Plus and is displayed in Appendix A.

Two other new dynamo report specification (.drs) files are contained in Appendices B and C. These files are the staff loss notices for the project. These files were created to display staff turnover information to the project managers of the three groups. The project managers for the uncertainty and risk groups used the project A batch control file while the managers for the certainty group used the project B batch control file.

During execution of the batch control files, the Staff Loss Report Specification and the Planned Loss Report Specification programs are called and allow for the information contained in them to be displayed. A sample of the report shown to the managers of the certainty group is contained in Appendix D. This report flashes on the screen and notifies the project manager of personnel leaving within the next 40 days. For the participants of the uncertainty and risk groups the report differs in that it flashes on the screen the total number of personnel lost in the previous period. This staff loss notice is displayed in Appendix F.

Time	0	40	80	120	160	200	240
Loss	0	0	3	0	2	1	3
Time	280	320	360	400	440	480	520
Loss	1	1	1	1	0	3	0

Figure 2-1 Number of Staff Losses Per 40 Day Time Period

Figure 2-1 displays the number of people lost due to turnover in each of the 40 day periods throughout the project. For example at time 120, project managers of the certainty group would receive a staff loss notice telling them that 2 people intend to leave the project within the next 40 days. The same is not true for managers in the risk and uncertainty groups. However during time 160 these two groups would be notified that the project lost two people due to turnover.

A menu capability for accessing multiple reports and graphs was developed in an earlier research effort along with a detailed description of module interaction for the simulation [Ref. 13]. The Project Staffing Report was modified to provide additional information for this project. Two output variables were created to report the total staff at the beginning of the period and the total staff hired in the period. This information was provided to the project manager to clarify what staffing changes had occurred. The report includes the total staff size, the percent of workforce experienced as of a particular day in the programming phase, and is displayed in Appendix E.

Another dynamo report specification was developed for this experiment. A progress.drs file was created to flash the current period prior to any loss notices being displayed. This progress report specification is contained in Appendix G. The report specifications for the graphs were also changed. These changes are summarized in Appendix O. Coding was added to the batch control files to allow these reports to be displayed to the user. These batch control files are contained in Appendices H and I. Having completed the software, the documentation was developed to provide the details of the experiment to the users.

D. THE DOCUMENTATION

A written description of the simulation interface, the menu, the reports, and the graphs available to the project managers is contained in Appendix E. The menu allows the project manager to select the report or graph to be viewed. These can be viewed repeatedly. An option at the bottom of the menu allows the user to proceed with the simulation.

The first report is the Project Status Report. This report shows the initial estimates for the project, updated estimates entered by the project manager, and reported progress on the project. This information is also contained in the Project Cumulative Report. This report aggregates the information from the start of the project to the current period. When the percent DSI reaches 100, the simulation is complete.

The Staffing Report provides the current total staff size and the allocation of staff between programming and quality assurance. The report reflects any changes in the staffing level hired or lost and provides the program manager with the percent of workforce that is experienced. A trained staff member is twice as productive as a new hire. A Defect Report details the total defects detected and the defect density for the current period and for the last 40 days.

Additional documentation was provided. Each project manager received an instruction set, Appendices K-M. The group instruction sets were different. Duplicate information includes the rules of the game, instructions for starting the system, and initial project estimates.

Project managers were told that for modest additions in staffing, the average hiring delay is 40 days. Requests for a large number of additional staff will cause longer delays and these new hires must be trained and assimilated. The assimilation period is typically 80 days. Project managers were also given information about the possibility of losing people due to turnover. Lastly, they were given a goal to minimize both cost and schedule.

E. TRIAL EXPERIMENT

The purpose of the trial experiment was to find problems with either the software or the documentation. Two people participated in the trial experiment. These were the same people designated as lab attendants in the actual experiment. This was an opportunity to gain feedback on the experiments' design. Neither student experienced any difficulty in the trial run.

F. FINAL PREPARATIONS

Two labs were reserved for conducting the experiment. Each student received an envelope containing a description of the simulation interface, an instruction set, a seating chart, and a disk. The disk contained the files for running the experiment.

All copies of the documentation and the files were made corresponding to the random assignment of personnel into the three groups conducted earlier. The randomization worksheet is contained in Appendix P. The terminals in the labs were checked prior to assigning personnel. Signs were posted on the labs during the experiment to prevent other students from entering. The remaining task was to assemble the envelope contents.

III. CONDUCTING THE EXPERIMENT

A. TASKS AND PROJECT CHARACTERISTICS

The students for the experiment received a 40 minute briefing on the documentation for the experiment and a review of the terminology present in the reports. They proceeded to the labs to conduct a practice experiment. Each student was given a folder containing a description of the simulation interface, an instruction set, a seating chart, and a disk. The students were instructed that their level of effort on the simulation would be reflected in their class participation grade.

The practice instruction set is displayed in Appendix N. Seating charts were developed and were the same for both the practice and the actual experiment. The goal for the practice experiment was for the students to familiarize themselves with the simulation environment. The inial estimates for the practice project remained constant and no personnel turnovers occurred.

The instruction set for the practice experiment was similar to that of the other instruction sets except that it lacked any information on the project risk, that of losing people due to turnover. The students conducted the practice experiment in 30 minutes. Each student had the opportunity to make staffing allocation decisions, review reports and graphs, and ask questions. The lab attendants received a 15 minute briefing to ensure questions asked were answered consistently. The designer frequently moved between the labs during the practice experiment.

B. THE EXPERIMENTAL SUBJECTS

Project managers for this experiment were graduate students in their seventh quarter of an eight quarter program in Information Technology Management at the Naval Postgraduate School. They have taken courses in software engineering, participated in a similar experiment six months earlier, and have practical managerial experience. These students participated in the actual experiment two days after conducting the practice experiment.

Before proceeding to the labs to conduct the actual experiment, the students received a ten minute briefing on project risk. Mentioned were the primary sources of risk including personnel shortfalls, unrealistic cost/schedule, and changing requirements.

In the actual experiment, the project is originally underestimated. The project grows from the original estimate of 42,000 DSI to 64,000 DSI. Students are briefed that the simulation ends when the reported percent DSI complete reaches 100.

C. DEPENDENT MEASURES

At project completion ten performance variables are captured. These variables are dependent upon the decisions made by the project manager throughout the experiment. An explanation of these performance variables can be found in Appendix Q. Three of these performance variables are final cost, final cumulative time, and final errors remaining undetected. These variables are compared to determine differing or similar project outcomes between the three groups; uncertainty, risk, and certainty.

Final cost is measured in person days and final cumulative time is measured in days. Final errors remaining undetected is a measure used to determine the quality of the software. These three performance variables are compared as part of the data analysis in Chapter IV.

IV. EXPERIMENTAL RESULTS AND ANALYSES

A. MODEL OF ANALYSIS

Several sets of data were captured during the simulation. These data include performance data, a measure of project outcome; process data, a measure of decisions made over time; and demographic data. The demographic data was obtained through the use of a questionnaire. A questionnaire was completed by each student and a sample is contained in Appendix R.

The analysis of the data was conducted using the Statistical Analysis System (SAS) software, Procedure Means, and the Procedure General Linear Models (GLM). The GLM Procedure was used for multivariate analyses. The Correlation Procedure was used to determine correlation between independent and dependent variables.

B. PERFORMANCE DATA

Final cost, final schedule, and final errors are the three dependent measures used to evaluate performance differences among the three groups. Figure 4-1 shows means

Group	FNCOST, Mean and (Stnd Dev)	FNSKED, Mean and (Stnd Dev)	FNERR, Mean and (Stnd Dev)
Uncertainty (A1)	3333.66 (733.04)	339.15 (54.9)	13414.73 (10470.29)
Risk (A2)	2941.76 (523.73)	310.21 (43.54)	14654.44 (9912.12)
Certainty (B1)	2667.01 (425.91)	274.64 (47.49)	11559.47 (8144.78)

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

and standard deviations for the three groups for the three variables mentioned. The certainty group had the lowest final cost, final schedule, and errors remaining.

The subjects of the certainty group were given advance notice of staff losses to occur during the next 40 day period. The group with the most risk, the uncertainty group, had the highest mean final cost and schedule. The risk group participants, given the probability of staff losses to occur during the next 40 day period, had the next highest final cost and schedule. The results indicate that the information received by the groups pertaining to staff turnover significantly influenced project outcome in terms of final cost and schedule.

The GLM Procedure was used for comparison of the groups' performance to determine if there were significant differences between the groups. For final cost, the GLM yielded a p value of 0.0187. This rejects the null hypothesis of no differences between the groups in terms of final cost. This result indicates that for final cost there were significant differences between the three experimental groups.

For final schedule the GLM produced a p value of 0.0066. Again, the null hypothesis is rejected and this result indicates that there were significant differences between the three groups in terms of schedule. The GLM Procedure for final errors revealed a p value of 0.7182. The null hypothesis is accepted that there was no significant difference between the three groups in terms of final errors.

C. PROCESS DATA

The subjects made four decisions in each period. At each 40 day interval the project managers selected their total staff, percentage of staff allocated to quality assurance, and estimates of the projects' final cost and schedule. The process data was analyzed to compare group means at each 40 day interval. In graphing the group means for the process data obtained, the last interval used is day 200. This is the last period in which all participants were still making decisions and had not completed the project. An analysis using the SAS GLM procedure was conducted to first determine if there was a period effect, second to determine any time effect between the different risk groups, and thirdly to determine if there was significant difference between subjects of the three groups.

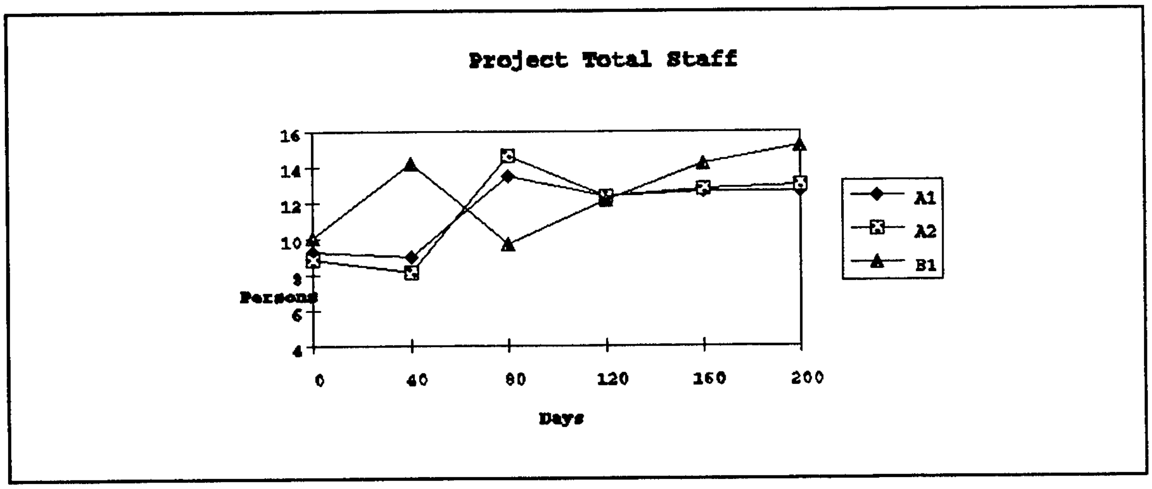

Figure 4-2 Mean Total Staff Requested by Group

1. Total Staff

Figure 4-2 is a graph of the group means for the total staff requested by each group at each 40 day interval. The graph reveals that for total staff the uncertainty group and the risk group made similar decisions. These project managers received notice of a staff turnover after it had occurred. The first staff loss occurred at day 40.

The decisions made by the project managers of the certainty group are different. These project managers were notified at day 40 that three people intended to leave during the next 40 day period due to turnover. It can be seen that the certainty group staff decisions' increase and decrease earlier than the other groups.

The analysis for a period effect yielded a p value of 0.0001. This allows the null hypothesis of no period effect to be rejected. There is a period effect. The test for interaction between the groups yielded a p value of 0.0001. Again, the null hypothesis of no interaction is rejected. The test for between subject effects yielded a p value of 0.1925. The null hypothesis is accepted that the subjects' decisions toward staffing are not significantly different.

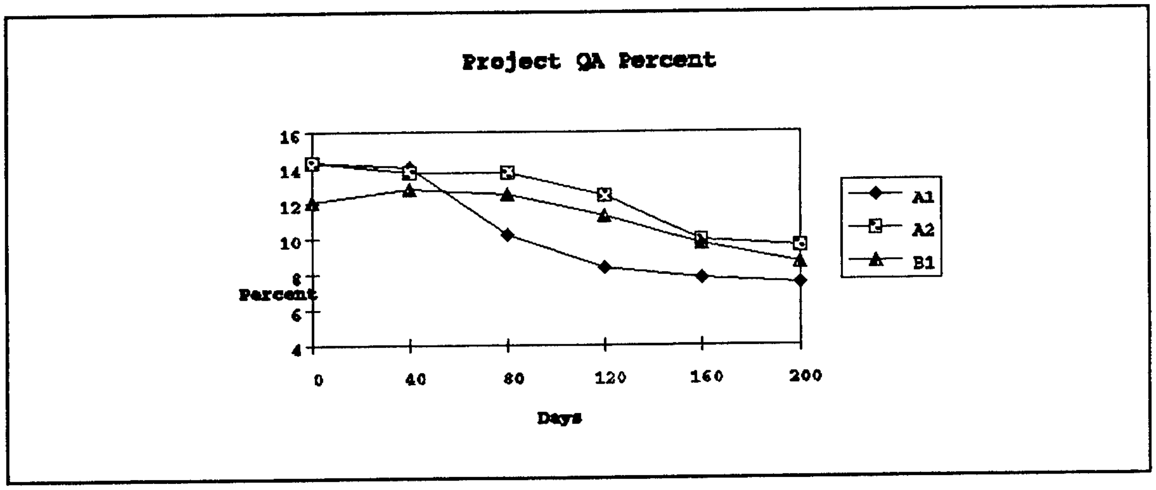

Figure 4-3 Percent of Requested Staff Allocated to QA by Group

2. Quality Assurance

Above is Figure 4-3, the percent of staff allocated to quality assurance by group. This graph depicts that there is a period effect. Both the uncertainty group and the risk group had their percent staff allocated to quality assurance decline while the certainty group had an initial increase in staff assigned to quality assurance. This can be explained by a shift in personnel from quality assurance to programming as staff turnovers occurred.

The test for a period effect yielded a p value of 0.0001. The null hypothesis of no period effect is rejected. The test for interaction between groups yielded a p value of 0.0078. The null hypothesis of no interaction is rejected. For the between subjects effects test, the p value was 0.7630. The null hypothesis of no significant difference between subjects is accepted.

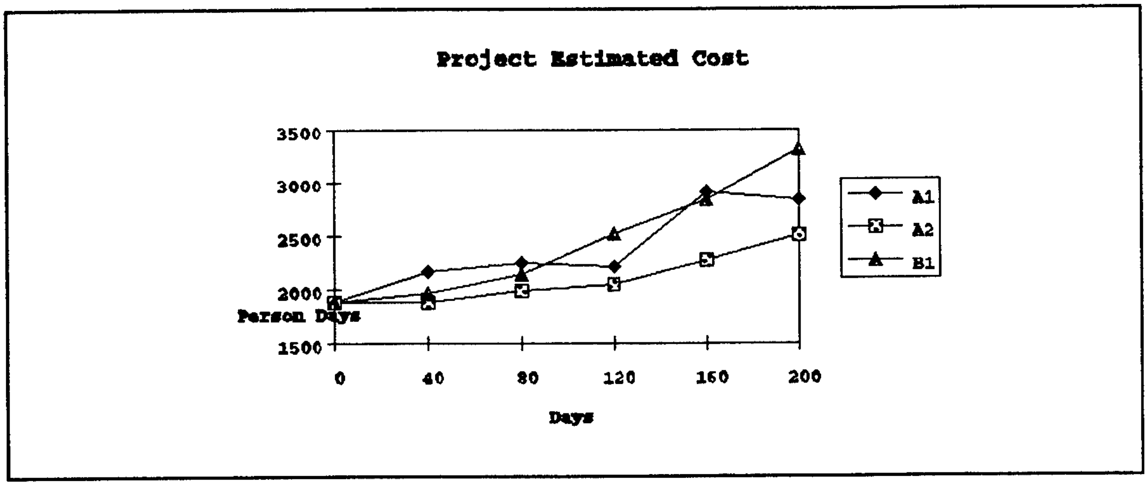

Figure 4-4 Estimates of Project Final Cost by Group

3. Cost Estimates

The project mean cost estimates by group are shown in Figure 4-4. All three groups had cost estimates that continually increased. This can be explained by the growth in project size from its initial estimate of 42,000 DSI to 64,000 DSI. Again the graph shows that there is a period effect.

The test for a period effect revealed a p value of 0.0001 indicating that there is a period effect and the null hypothesis is rejected. The test for interaction yielded a p value of 0.1751. The null hypothesis of no interaction is accepted. For the between subjects effects the p value was 0.1219. The null hypothesis of no between subjects effect is accepted.

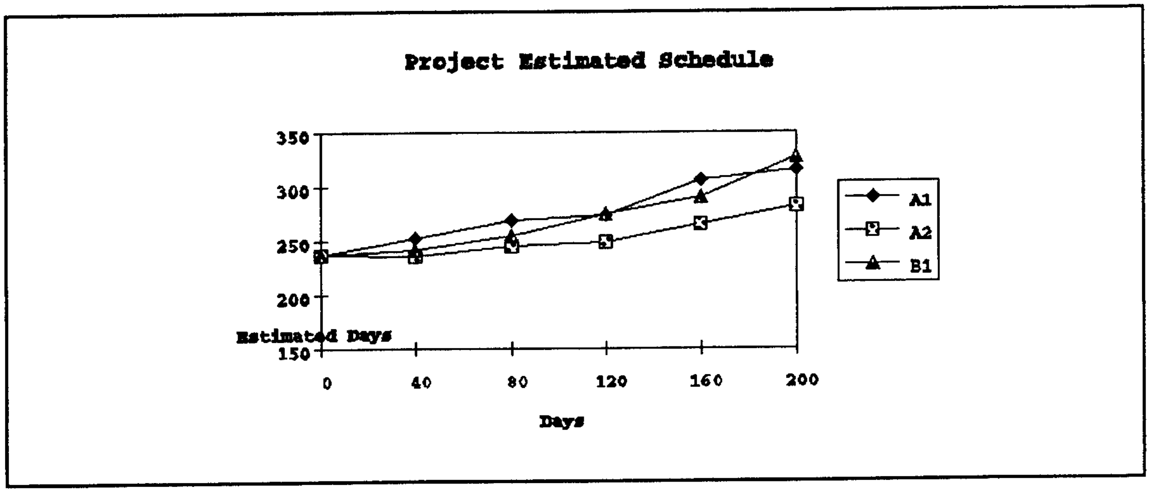

Figure 4-5 Estimates of Project Final Schedule by Group

4. Schedule Estimates

Figure 4-5 represents the project final schedule estimates by group. The graph depicts a period effect. All three groups also had increasing estimates for the final schedule. Again, this can be explained by the fact that the project increased in size from the initial estimates.

With a p value of 0.0001, the null hypothesis of no period effect is rejected. The test for interaction revealed a p value of 0.0857. The null hypothesis of no interaction is accepted. The test for between subjects effects yielded a p value of 0.0848. The null hypothesis of no between subjects effect is accepted.

D. QUESTIONNAIRE AND DEMOGRAPHIC DATA

At project completion each participant filled out a questionnaire. The final section of the questionnaire was dedicated to demographics. The demographic data format can be found in Appendix S and sample data for all the subjects is in Appendix T.

Group	AGE	CHRSWK	WKEXP	EDAGO
Uncertainty	34.9	28.1	14.3	13.3
Risk	34.5	15.8	12.6	10.8
Certainty	32.8	20.6	10.8	9.4

Figure 4-6 Group Mean Demographics

Figure 4-6 represents the sample profile by group. CHRSWK represents the number of hours spent on the computer per week, WKEXP represents the years of work experience, and EDAGO is the number of years since the subject completed undergraduate education. The uncertainty group subjects have the highest mean age, have more work experience, and spend the most hours per week on the computer. The risk group subjects spend the least amount of time on the computer per week. The certainty group subjects are the youngest with the least amount of work experience and have most recently completed their undergraduate education.

V. CONCLUSIONS

A. FINDINGS AND IMPLICATIONS

The results of this experimental investigation into the effects of risk on dynamic decision making in a software project environment reveal that the presence of risk significantly impacts project outcome. The uncertainty group, the group receiving the least information about staff turnover, had a higher final cost and schedule at project completion. The risk group had the next highest final cost and schedule. The certainty group, which were informed about staff departures prior to their occurrence, performed better than the other two groups.

The analysis of the process data which was concerned with the mean performance of the groups over time, revealed that the groups perform significantly different. This is especially visible in the graphical depictions of total staffing and quality assurance allocation decisions.

The certainty group once informed that a staff loss was to occur, padded the staffing level in anticipation of the loss while the other two groups responded with additional hires immediately following the loss. This perceived risk had an impact on their decision making. In addition the risk group subjects shifted their staffing resources from quality assurance to programming following the initial loss of personnel.

This research effort provides empirical findings that support the assessment and management of risk as significant factors in achieving successful project outcome. The greater the risk the greater the cost and schedule overrun. Additionally, this research effort seeks to provide impetus toward investigation of other human behavioral decision making characteristics found in the software project development domain.

B. FURTHER RESEARCH

One area with potential for further research is to investigate the impact of risk on team decision making. This experiment could be repeated with teams managing the project rather than single individuals. This would provide insight into team management of risk and the communication required. It is likely that that the groups would identify and deal with risk differently. Finally, this research could be duplicated in a multi-project environment.

APPENDIX A: PROJECT CUMULATIVE REPORT SPECIFICATION

```
;
;
report
time = maxtime,
FORMAT="5<"
">>>>>>>>>>>>>>>>>>>>> PROJECT CUMULATIVE REPORT
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<";
;
Format="5<,43<"
"UPDATED ESTIMATES","REPORTED PROGRESS";
;
Format="5<,13<,20<,26<,31<,43<,49<,58<,72>,"
"TIME","SIZE","COST","DUR","TIMREM","%DSI","TOT DSI","PD
EXP'D","PROD";

FOR TIME = 40 TO MAXTIME BY 40 DO
Format="2<,10<,17<,22<,30<,40<,49<,59<,72>",
PICTURE="ZZZ,ZZ9V"
TIME,PJBSZT,JBSZMD,SCHCDT,TIMERM,PRCMPL,CMDSI,CUMMD,RPPROD
;
END
;
;

"PRESS <ENTER> TO RETURN TO THE MENU"
```

APPENDIX B: STAFF LOSS REPORT SPECIFICATION

```
;
;
;
;
;
report
time=maxtime,

if maxtime<41 then
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
end

if maxtime >41 then
if maxtime<81 then
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","!! STAFF LOSS NOTICE !!","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,29<,42<,48<,67<",PICTURE="Z,ZZ9V"
"*","[Current TIME =",TM,"DAYS]","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,21<,67<"
"*","During the last 40 day Period, the project","*";
FORMAT="15<,21<,22<,28<,67<"
"*","lost",WFLOSA,"people due to turnover.","*";
FORMAT="15<,67<"
"*","*";
```

```
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
end
end

if maxtime>81 then
if maxtime<121 then
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
end
end

if maxtime >121 then
if maxtime<401 then
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","!! STAFF LOSS NOTICE !!","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,29<,42<,48<,67<",PICTURE="Z,ZZ9V"
"*","Current TIME =",TM,"DAYS","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,21<,67<"
"*","During the last 40 day Period, the project","*";
FORMAT="15<,21<,22<,28<,67<"
```

```
"*","lost",WFLOSA,"people due to turnover.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
end
end

if maxtime >401 then
if maxtime<441 then

FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
end
end

if maxtime>441 then
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","!! STAFF LOSS NOTICE !!","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,29<,42<,48<,67<",PICTURE="Z,ZZ9V"
"*","Current TIME =",TM,"DAYS","*";
FORMAT="15<,67<"
"*","*";
```

```
FORMAT="15<,21<,67<"
"*","During the last 40 day Period, the project","*";
FORMAT="15<,21<,22<,28<,67<"
"*","lost",WFLOSA,"people due to turnover.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"****************************************************";
end

if maxtime>481 then
FORMAT="15<"
"****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"****************************************************";
end
```

APPENDIX C: PLANNED LOSS REPORT SPECIFICATION

```
;
;
;
;
;
report
time=maxtime,

if maxtime <41 then
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","!! STAFF LOSS NOTICE !!","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,29<,42<,48<,67<",PICTURE="Z,ZZ9V"
"*","[Current TIME =",TM,"DAYS]","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,21<,41<,47<,67<"
"*","We received notice from",WFLOSB,"people that","*";
FORMAT="15<,21<,67<"
"*","they intend to leave the project","*";
FORMAT="15<,21<,67<"
"*","within the next 40 days.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
end

if maxtime>41 then
if maxtime<81 then
```

```
FORMAT="15<"
"****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"****************************************************";
end
end

if maxtime >81 then
if maxtime<361 then
FORMAT="15<"
"****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","!! STAFF LOSS NOTICE !!","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,29<,42<,48<,67<",PICTURE="Z,ZZ9V"
"*","[Current TIME =",TM,"DAYS]","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,21<,41<,47<,67<"
"*","We received notice from",WFLOSB,"people that","*";
FORMAT="15<,21<,67<"
"*","they intend to leave the project","*";
FORMAT="15<,21<,67<"
"*","within the next 40 days.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"****************************************************";
```

```
end
end

if maxtime >361 then
if maxtime<401 then
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
end
end

if maxtime>401 then
if maxtime<441 then
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","!! STAFF LOSS NOTICE !!","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,29<,42<,48<,67<",PICTURE="Z,ZZ9V"
"*","[Current TIME =",TM,"DAYS]","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,21<,41<,47<,67<"
"*","We received notice from",WFLOSB,"people that","*";
FORMAT="15<,21<,67<"
"*","they intend to leave the project","*";
FORMAT="15<,21<,67<"
"*","within the next 40 days.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
```

```
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
end
end

if maxtime>441 then
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
end
```

APPENDIX D: PLANNED LOSS OUTPUT

```
*****************************************************
*                                                   *
*            !!  STAFF LOSS NOTICE  !!              *
*                                                   *
*             [Current TIME =120 DAYS]              *
*                                                   *
*     We received notice from 2 people that         *
*     they intend to leave the project              *
*     within the next 40 days.                      *
*                                                   *
*                                                   *
*            Press <ENTER> to continue.             *
*                                                   *
*****************************************************
```

APPENDIX E: DESCRIPTION OF THE SIMULATION INTERFACE

REPORTS AND GRAPHS MENU:

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

REPORTS AND GRAPHS MENU

REPORTS:

1 PROJECT SIZE & STATUS REPORT

2 STAFFING REPORT

3 DEFECT REPORT

4 CUMULATIVE REPORT

GRAPHS:

5 PROJECT SIZE & STATUS GRAPH

6 STAFFING GRAPH

7 DEFECT GRAPH

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

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

Report 1 (PROJECT STATUS REPORT) A sample report is pictured below:

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

                          AT TIME =    120  DAYS

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

UPDATED ESTIMATES
   New Est of System Size
         due to Changes in Requirements             20,000      DSI
   Your Last Est of Programming Phase Cost           1,567      Person Days
   Your Last Est of Prog Phase Duration (start-end)353          Days
   Time Remaining                                      153      Days
REPORTED PROGRESS
   % DSI Reported Complete                              63.33   Percent
   Total DSI Reported Complete to Date              12,665      DSI
   Total Person Days Expended to Date                  817      Person Days
   Reported Productivity                                16      DSI/Person Day

  PRESS <ENTER> TO RETURN TO THE MENU
```

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

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

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

Your Task is complete when the **% DSI Reported Complete** is 100%.

Report 2 (STAFFING LEVEL REPORT) A sample report is pictured below:

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

                             AT TIME =    160  DAYS

STAFFING ADDITIONS/LOSSES LAST 40 DAY PERIOD ONLY
   Total Staff At Beginning of Period                    7.21     People
   Total Staff Hired this Period                         2.49     People
   Total Staff Lost this Period                          2.00     People

         Current Total Staff Size                        7.69     People

STAFF ALLOCATION
   Staff Allocated to Programming                        6.92     People
   Staff Allocated to QA                                  .77     People
         Current Total Staff Size                        7.69     People

Percent of Workforce that is Experienced                   43     Percent

PRESS <ENTER> TO RETURN TO THE MENU
```

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

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

Report 3 (DEFECT REPORT) A sample report is pictured below:

```
>>>>>>>>>>>>>>>>>>>>>>>>> DEFECT REPORT <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

-----CUMULATIVE STATUS FROM START OF PROJECT TO CURRENT DAY =>  200---------

    TOTAL Person Days Expended to Date                   817     Person Days
       Programming Person Days Expended to Date          735     Person Days
       QA Person Days Expended to Date                    82     Person Days

    TOTAL Defects Detected                               137     Defects
    TOTAL KDSI Completed                                  12.67  KDSI
    Defect Density                                        10.9   Defects/KDSI

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

    QA Person Days Expended Last 40 Days                  18     Person Days
    Defects Detected Last 40 Days                         38     Defects
    Defect Density Observed Last 40 Days                  11.6   Defects/KDSI


  PRESS <ENTER> TO RETURN TO THE MENU
```

This report recaps the **TOTAL Person Days Expended to Date** and provides a breakdown of the number of person days expended on both the QA and programming activities.

In the top section, this report gives cumulative defect data (i.e. from start of programming phase to current time). The bottom section shows data for the last 40 day period only.

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

Comparing the aggregate data and the data for the last period can indicate trends.

Report 4 (CUMULATIVE REPORT) A sample report is pictured below:

```
>>>>>>>>>>>>>>>>>>>>> PROJECT CUMULATIVE REPORT <<<<<<<<<<<<<<<<<<<<<<<<

UPDATED ESTIMATES                    REPORTED PROGRESS

TIME    SIZE    COST  DUR  TIMREM    %DSI  TOT DSI  PD EXP'D    PROD
  40  20,000  1,400  350     310       7    1,434        78      18
  80  20,000  1,400  350     270      15    3,020       199      15
 120  20,000  1,400  350     230      25    5,092       366      14
 160  20,000  1,400  350     190      38    7,587       550      14
 200  20,000  1,400  350     150      52   10,483       738      14

PRESS <ENTER> TO RETURN TO THE MENU
```

This report contains Cumulative Project Status information from the start of the project to the current period. The report is divided into 2 sections.

The left portion is the **UPDATED ESTIMATES** section. It reflects cumulative changes in the following project estimates:

SIZE New Estimate of System Size due to changes in Requirements (DSI)
COST Your Last Est of Programming Phase Cost (Person Days)
DUR Your Last Est of Prog Phase Duration (start-end) (Days)
TIMREM Time Remaining (Days)

The right portion is the **REPORTED PROGRESS** section. Remember that this is "reported" information and is not guaranteed to be totally accurate, especially early in the phase. It reflects cumulative changes in the following project estimates:

%DSI %DSI Reported Complete (Percent)
TOT DSI Total DSI Reported Complete to Date (DSI)
PD EXP'D Total Person Days Expended to Date (Person Days)
PROD Reported Productivity (DSI/Person Day)

Your Task is complete when the **% DSI** is 100%.

Graph 5 (PROJECT STATUS GRAPH)

This graph shows how the total staff level and the estimates of system size and programming cost are changing 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 (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 F: STAFF LOSS OUTPUT

```
******************************************************
*                                                    *
*          !!  STAFF LOSS NOTICE  !!                 *
*                                                    *
*           Current TIME = 160 DAYS                  *
*                                                    *
*     During the last 40 day Period, the project     *
*     lost 2 people due to turnover.                 *
*                                                    *
*                                                    *
*          Press <ENTER> to continue.                *
*                                                    *
******************************************************
```

APPENDIX G: PROGRESS REPORT SPECIFICATION

```
;
;
;
;
;
report
time=maxtime,
FORMAT="15<"
"*****************************************************";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,21<,67<"
"*","The model has simulated a 40 day period.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,29<,42<,48<,67<",PICTURE="Z,ZZ9V"
"*","[Current TIME =",TM,"DAYS]","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<,28<,67<"
"*","Press <ENTER> to continue.","*";
FORMAT="15<,67<"
"*","*";
FORMAT="15<"
"*****************************************************";
```

APPENDIX H: BATCH CONTROL FILE (PROJECTA)

```
@echo off
rem PROJA initially underestimated project

cls
rem init.exe requires 3 parameters i.e. [project,group,ins.set]
init A 1 1
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 PROCESSS.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 PROCESSS.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


-STAFLOSS ***** VIEW STAFFING LOSS REPORT ********************
      timestmp
      rep PROJA STAFLOSS.DRS -outf STAFLOSS.OUT -t -sc -ls -plm 16
      inkey
      capture R6 >NUL
      cls
      color \1F


-menu
      color \1F
      cls
      begtype
```

```
                         REPORTS AND GRAPHS MENU

\1EREPORTS:\1F
           \1E 1 \1F PROJECT SIZE & 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 SIZE & STATUS \1BGRAPH\1F

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

           \1B 7 \1F DEFECT \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 -STATPLOT
     if %2 = 6 goto -STAFPLOT
     if %2 = 7 goto -DEFPLOT
     if %2 = P goto -proceed
     if %2 = KEY011 return
     beep goto -menu


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


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


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

        THE FOLLOWING PROJECT STATUS VARIABLES WILL BE PLOTTED:
```

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



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



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


end
     inkey
     cls
     rep PROJA STATPLOT.DRS
     capture G5 >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 . . . . . . . . NUMBER OF PERSONS ALLOCATED TO QA
    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 STAFPLOT.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 DEFPLOT.DRS
     capture G7 >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 I: BATCH CONTROL FILE (PROJECTB)

```
@echo off
rem PROJA initially underestimated project

cls
rem init.exe requires 3 parameters i.e.
[project,group,ins.set]
init B 1 1
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 PROCESSS.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 PROCESSS.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


-STAFLOSS ***** VIEW STAFFING LOSS REPORT
********************
     timestmp
     rep PROJA PLANLOSS.DRS -outf PLANLOSS.OUT -t -sc -ls
-plm 16
```

```
          inkey
          capture R6 >NUL
          cls
          color \1F


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

\1EREPORTS:\1F
           \1E 1 \1F PROJECT SIZE & 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 SIZE & STATUS \1BGRAPH\1F

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

           \1B 7 \1F DEFECT \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 -STATPLOT
     if %2 = 6 goto -STAFPLOT
     if %2 = 7 goto -DEFPLOT
     if %2 = P goto -proceed
     if %2 = KEY011 return
     beep goto -menu
```

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




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

```
    begtype

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

        THE FOLLOWING PROJECT STATUS VARIABLES WILL BE PLOTTED:

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

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

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

end
     inkey
     cls
     rep PROJA STATPLOT.DRS
     capture G5 >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 STAFPLOT.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 DEFPLOT.DRS
     capture G7 >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 J: PROJECT DYNEX FILE

```
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                          42000. 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 project cost (person days) =
dendq
dq TOTMD1=0<
```

```
display
Your updated estimate for project duration (days) =
dendq
dq PROJDR=0<

display
Your total requested staffing level =
dendq
dq WFS1=0.5<

display
The percent to allocate to QA (a number from 0 - 100) =
dendq
dq FRMPQA=0<100


display clear

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


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

display
The updated estimate for project cost (person days) =
dendq
```

```
dq TOTMD1=0<

display
The updated estimate for project duration (days) =
dendq
dq PROJDR=0<

display
Your total requested staffing level =
dendq
dq WFS1=0.5<

display
The percent allocated to QA =
dendq
dq FRMPQA=0<100
cend
cend

end
display

************************************************************
*   Press <ENTER> to simulate this interval and return to  *
*   the menu.                                              *
*                                                          *
************************************************************
dendq
choice 1
display clear

            ******************************************
            *                                        *
            *                                        *
            *    There will be a short pause while   *
            *    the model simulates the next period. *
            *                                        *
            *                                        *
            ******************************************
dendq
report
time=maxtime,
cend 1/1
spec md_length=#length+40
```

APPENDIX K: UNCERTAINTY GROUP INSTRUCTION SET (A1)

Your Name: ______________________ A11
SMC No.: ______________________

1. Introduction

The exercise you are about to undertake is similar in many ways to flight simulators that pilots use to mimic flying an aircraft from takeoff at point A to landing at point B. Instead of flying an aircraft, though, the simulator mimics the programming phase of a real software project. In this simulation, you will be more than an observer. In fact, you will play the role of manager of the programming phase of the project. Specifically, your role will be to track the progress of the project by reviewing status reports and graphs available every two-month interval (40 working days) during the programming phase. As the manager, you must then make two staffing decisions:

First, the total number of staff you need. (You can hire additional staff, or decrease the staffing level as you deem necessary to complete your programming task successfully.)

Second, you need to decide on what percent of your total staff to allocate to the Quality Assurance activity to be conducted throughout the programming phase (e.g. to do inspections).

2. Project

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

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

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

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

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

3. Your task

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

1. Decide on the total staffing level, and

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

4. Your Goal for the Task:

Minimize overruns in both cost and schedule.

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

5. Some Important Points to Consider in Managing Your Task

1. As the manager of the programming phase, you specify the desired staffing level. You may find that your actual staffing level (as it will appear in the reports) is different from what you requested. This would be due to the delay in hiring people. 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.

2. 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.

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

4. Adding more people increases communication and coordination overhead as happens in reality.

5. You will need to take into account the possibility of losing people due to turnover.

You will receive a staff loss notice once a turnover occurs.

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 overruns in both cost and schedule.

INITIAL ESTIMATES:

Project Size	42,000 DSI
Project Cost	1887 Person Days
Project Duration (start-end)	237 Days

TIME ELAPSED (DAYS)	ESTIMATED COST (PERS-DAYS)	ESTIMATED DURATION (DAYS)	STAFFING LEVEL (PERSONS)	QUALITY ASSURANCE (PERCENT)
Initial Decision	1887	237		
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 L: RISK GROUP INSTRUCTION SET (A2)

A21

Your Name: ______________________________
SMC No.: ______________________________

1. Introduction

The exercise you are about to undertake is similar in many ways to flight simulators that pilots use to mimic flying an aircraft from takeoff at point A to landing at point B. Instead of flying an aircraft, though, the simulator mimics the programming phase of a real software project. In this simulation, you will be more than an observer. In fact, you will play the role of manager of the programming phase of the project. Specifically, your role will be to track the progress of the project by reviewing status reports and graphs available every two-month interval (40 working days) during the programming phase. As the manager, you must then make two staffing decisions:

First, the <u>total</u> 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 <u>throughout</u> 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 to make any necessary adjustments to the staffing level and its allocation. In order to do so, you may feel that is necessary to first adjust the project's cost and duration targets. The staffing decision should be done as follows:

1. Decide on the total staffing level, and

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

4. Your Goal for the Task:

Minimize overruns in both cost and schedule.

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

5. Some Important Points to Consider in Managing Your Task

1. As the manager of the programming phase, you specify the desired staffing level. You may find that your actual staffing level (as it will appear in the reports) is different from what you requested. This would be due to the delay in hiring people. 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.

2. 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.

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

4. Adding more people increases communication and coordination overhead as happens in reality.

5. A project risk in this organization is that of losing people due to turnover. Historically, the turnover rate averages to 1.5 people lost every reporting period (i.e., every 40 days).

   The following are the probabilities of possible staff losses every 40 day period:

   25% probability of no loss in staff.
   25% probability of 1 person lost.
   25% probability of 2 people lost.
   25% probability of 3 people lost.
   You will receive a staff loss notice once a turnover occurs.

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 overruns in both cost and schedule.

INITIAL ESTIMATES:

Project Size	42,000 DSI
Project Cost	1887 Person Days
Project Duration (start-end)	237 Days

TIME ELAPSED (DAYS)	ESTIMATED COST (PERS-DAYS)	ESTIMATED DURATION (DAYS)	STAFFING LEVEL (PERSONS)	QUALITY ASSURANCE (PERCENT)
Initial Decision	1887	237		
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 M: CERTAINTY GROUP INSTRUCTION SET (B1)

Your Name: ______________________________ B11
SMC No.: ______________________________

1. Introduction

The exercise you are about to undertake is similar in many ways to flight simulators that pilots use to mimic flying an aircraft from takeoff at point A to landing at point B. Instead of flying an aircraft, though, the simulator mimics the programming phase of a real software project. In this simulation, you will be more than an observer. In fact, you will play the role of manager of the programming phase of the project. Specifically, your role will be to track the progress of the project by reviewing status reports and graphs available every two-month interval (40 working days) during the programming phase. As the manager, you must then make two staffing decisions.

First, the total number of staff you need. (You can hire additional staff, or decrease the staffing level as you deem necessary to complete your programming task successfully.)

Second, you need to decide on what percent of your total staff to allocate to the Quality Assurance activity to be conducted throughout the programming phase (e.g. to do inspections).

2. Project

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

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

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

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

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

3. Your task

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

1. Decide on the total staffing level, and

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

4. Your Goal for the Task:

Minimize overruns in both cost and schedule.

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

5. Some Important Points to Consider in Managing Your Task

1. As the manager of the programming phase, you specify the desired staffing level. You may find that your actual staffing level (as it will appear in the reports) is different from what you requested. This would be due to the delay in hiring people. 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.

2. 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.

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

4. Adding more people increases communication and coordination overhead as happens in reality.

5. A project risk in this organization is that of losing people due to turnover. Historically, the turnover rate averages to 1.5 people lost every reporting period (i.e., every 40 days).

   To minimize the negative impacts of staff turnover on a project, the organization has instituted a policy of requiring a 40 day notice of leaving. As the project manager, this guarantees that you will be aware of any staff losses in a 40 day period at the <u>beginning</u> of the period.

   You will receive a staff loss notice once an employee plans to leave.

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

<u>Follow the instructions Carefully</u>. 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 **<u>Call the lab attendant</u>.**

Your Name: ______________________

SMC No.: ______________________

YOUR GOAL IS:

Minimize overruns in both cost and schedule.

INITIAL ESTIMATES:

Project Size	42,000 DSI
Project Cost	1887 Person Days
Project Duration (start-end)	237 Days

TIME ELAPSED (DAYS)	ESTIMATED COST (PERS-DAYS)	ESTIMATED DURATION (DAYS)	STAFFING LEVEL (PERSONS)	QUALITY ASSURANCE (PERCENT)
Initial Decision	1887	237		
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 N: PRACTICE EXPERIMENT INSTRUCTION SET

Your Name: ______________________________

SMC No.: ______________________________

1. Introduction

The exercise you are about to undertake is similar in many ways to flight simulators that pilots use to mimic flying an aircraft from takeoff at point A to landing at point B. Instead of flying an aircraft, though, the simulator mimics the programming phase of a real software project. In this simulation, you will be more than an observer. In fact, you will play the role of manager of the programming phase of the project. Specifically, your role will be to track the progress of the project by reviewing status reports and graphs available every two-month interval (40 working days) during the programming phase. As the manager, you must then make two staffing decisions:

First, the total number of staff you need. (You can hire additional staff, or decrease the staffing level as you deem necessary to complete your programming task successfully.)

Second, you need to decide on what percent of your total staff to allocate to the Quality Assurance activity to be conducted throughout the programming phase (e.g. to do inspections).

2. Project

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

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

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

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

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

3. Your task

Your task at every 40-day interval is to review the project's status, and to 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:

Familiarize yourself with the simulation.

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 the delay in hiring people. 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.

2. 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.

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

4. 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 PRACTICE at the B:\ prompt.

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

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

Your Name: ____________________
SMC No.: ____________________

YOUR GOAL IS:

Familiarize yourself with the simulation.

INITIAL ESTIMATES:

Project Size	20,000 DSI
Project Cost	1400 Person Days
Project Duration (start-end)	350 Days

TIME ELAPSED (DAYS)	ESTIMATED COST (PERS-DAYS)	ESTIMATED DURATION (DAYS)	STAFFING LEVEL (PERSONS)	QUALITY ASSURANCE (PERCENT)
Initial Decision	1400	350		
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 O: GRAPHS.DRS FILES

STATPLOT.DRS

```
plotxy <TM"TIME (DAYS) ",0,600>,<FTEQWF"TOTAL STAFF (PERSONS)
",0,40>,
 <PJBSZT/1000"EST SYSTEM SIZE (KDSI) ",0,80>,
 <JBSZMD"EST PROGRAMMING COST (PERSON DAYS) ",0,6000>
```

STAFPLOT.DRS

```
plotxy <TM"TIME (DAYS) ",0,600>,<FTEQWF"TOTAL STAFF (PERSONS)
",0,40>,
 <CRQAWF"QA STAFF (PERSONS) ",0,40>,<CRDVWF"PROG STAFF
(PERSONS) ",0,40>
```

DEFPLOT.DRS

```
plotxy <TM"TIME (DAYS) ",0,600>,<PRQAMD"QA PERSON DAYS PER
PERIOD ",0,240>,
 <PRERD"DEFECTS DETECTED PER PERIOD ",0,240>
```

APPENDIX P: RANDOMIZATION WORKSHEET

Kelly, John	104
King, A.	150
Lamb, V.	015
Langhorne, W.	020
Larochelle, L.	816
Lewis, J.	916
Mancano, V.	691
Michal, T.	141
Nault, M.	625
Oneill, T.	223
Onorati, A.	465
Pemberton, L.	255
Prell, M.	853
Robillard, S.	309
Sears, G.	891
Staten, R.	279
Tate, W.	939
Trepanier, D.	241
Weiss, K.	483
Wilcox, R.	225
Chou, M.	972
Kelly, James	763

Barnum, T.	648
Berry, E.	151
Bitzer, S.	248
Callaghan, V.	493
Cragmiles, R.	421
Downs, M.	930
Emde, C.	062
Emswiler, T.	616
Encinas, T.	078
Franklin, B.	163
Gregorie, J.	394
Hodges, J.	535
Howard, L.	713
Johnson, S.	375
McGibbon, H.	399
McQuay, D.	818
Monroe, W.	166
Swain, W.	917
Tharpe, G.	604

Lamb, V.	015	A11
Langhorne, W.	020	A12
Emde, C.	062	A21
Encinas, T.	078	A22
Kelly, John	104	B11
Michal, T.	141	B12
King, A.	150	A11
Berry, E.	151	A12
Franklin, B. class	163	A21
Monroe, W.	166	A22
Oneill, T.	223	B11
Wilcox, R.	225	B12
Trepanier, D.	241	A11
Bitzer, S.	248	A12
Pemberton, L.	255	A21
Staten, R.	279	A22
Robillard, S.	309	B11
Johnson, S.	375	B12
Gregorie, J.	394	A11
McGibbon, H.	399	A12
Cragmiles, R.	421	A21
Onorati, A.	465	A22
Weiss, K.	483	B11
Callaghan, V.	493	B12
Hodges, J.	535	A11
Tharpe, G.	604	A12
Emswiler, T.	616	A21
Nault, M.	625	A22
Barnum, T.	648	B11
Mancano, V.	691	B12
Howard, L.	713	A11
Kelly, James	763	A12*
Larochelle, L.	816	A21
McQuay, D.	818	A22
Prell, M.	853	B11
Sears, G.	891	B12
Lewis, J.	916	A11
Swain, W.	917	A12
Downs, M.	930	A21
Tate, W.	939	A22+
Chou, M.	972	B11*

A1 Uncertainty
A2 Risk
B1 Certainty
<u>Order</u>
1 C/S
2 S/C

+ No goals experiment
* Attend but not in

Both Experiments	No goals Experiment+	Not in McCaffrey*	41 Students
U 13		1	14
R 13	1		14
C 12		1	13

APPENDIX Q: PERFORMANCE VARIABLES

FNCOST	Final Cost (Person Days)
FNSKED	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 Person Days
FNTRMD	Final Cumulative Training Person Days
FNRWMD	Final Cumulative Rework Person Days

APPENDIX R: PROJECT QUESTIONNAIRE

Your Name: ______________________________________
SMC No.: ____

Group All

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 ____________

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

____

____

____

4. Please elaborate on how you handled the problem of staff turnover.

____

____

____

5. How clear were the instructions regarding the task?

1	2	3	4	5	6	7	8	9
Not at all Clear								Very 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 Helpful								Very 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 Helpful								Very 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 CUMULATIVE report (Y/N)? ________

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

____

____

____

12. In the project you just completed, did you

(a) Use the PROJECT STATUS 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 STAFFING LEVEL graph (Y/N)? ________

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

____

____

____

14. 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.

____

____

____

15. Have you in the past participated in project management (Y/N)? If YES, to what extent was the task in this simulation similar to your previous experience?

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

16. How interesting was the task you just performed?

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

17. How serious were you in performing the task?

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

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

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

19. How easy was the simulation to use?

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

20. Please give us some information about yourself (**in absolute confidence.** At no time will your name appear in the results. The data will only be used in an aggregate statistical sense).

(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?

____

21. Your general comments regarding the simulation:

____

____

____

*** END OF SIMULATION ***
Thank you for your participation.

APPENDIX S: FORMAT OF DEMOGRAPHIC DATA

Q1S	Question 1 Schedule Percent
Q1Q	Question 1 Quality Percent
Q1C	Question 1 Cost Percent
Q5	Question 5 Response (1-9)
Q6	Question 6 Response (1-9)
Q7	Question 7 Response (1-9)
Q8	Question 8 Response (0/1 0-No 1-Yes)
Q9	Question 9 Response (0/1 0-No 1-Yes)
Q10	Question 10 Response (0/1 0-No 1-Yes)
Q11	Question 11 Response (0/1 0-No 1-Yes)
Q12	Question 12 Response (0/1 0-No 1-Yes)
Q13	Question 13 Response (0/1 0-No 1-Yes)
Q14	Question 14 Response (0-9 0-No 1-9 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)
Q19	Question 19 Response (1-9)
CURR	Curriculum
AGE	Age (years)
SEX	M=Male, F=Female
WKEXP	Work Experience (years)
EDAGO	Years since undergraduate education was completed
FAM	Computer familiarity
CHRSWK	Number of computer hours per week

APPENDIX T: PERFORMANCE/DEMOGRAPHIC DATA

Risk experiment: Comparison of performance

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-------------------------- PROJECT=A RISKTYPE=R -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
FNCOST	14	2941.76	523.7349118	2256.31	4146.24
FNSKED	14	310.2142857	43.5447225	258.0000000	390.5000000
FNERR	14	14654.44	9912.12	2008.65	32462.84
FNERG	14	1819.48	119.1415691	1676.29	2032.23
FNERD	14	592.0057143	369.7023526	216.1100000	1432.60
FNERES	14	1227.47	342.4663414	409.1300000	1608.85
FNPRDT	14	32.2107143	19.3308098	12.0000000	77.7900000
FNQAMD	14	347.5107143	267.8133500	119.7700000	1036.56
FNTRMD	14	233.6628571	39.3861243	163.7800000	316.1500000
FNRWMD	14	426.0671429	261.2214201	168.4100000	1006.00
Q1	14	53.2142857	10.6711586	35.0000000	70.0000000
Q2	14	0	0	0	0
Q3	14	46.7857143	10.6711586	30.0000000	65.0000000
Q4	14	7.8571429	1.7913099	3.0000000	9.0000000
Q5	14	4.7857143	3.2623392	1.0000000	9.0000000
Q6	14	7.6428571	2.0232169	3.0000000	9.0000000
Q7	14	0.9285714	0.2672612	0	1.0000000
Q8	14	0.9285714	0.2672612	0	1.0000000
Q9	14	0.7142857	0.4688072	0	1.0000000
Q10	14	0.6428571	0.4972452	0	1.0000000
Q11	14	0.5000000	0.5188745	0	1.0000000
Q12	14	0.3571429	0.4972452	0	1.0000000
Q13	14	0.2857143	0.4688072	0	1.0000000
Q14	14	5.2142857	3.5772480	0	9.0000000
Q15	14	6.7142857	1.8156826	4.0000000	9.0000000
Q16	14	7.8571429	1.1673206	5.0000000	9.0000000
Q17	14	8.0714286	1.3847680	4.0000000	9.0000000
Q18	14	8.2857143	1.4373358	4.0000000	9.0000000
Q20	14	34.5000000	5.3601091	28.0000000	44.0000000
Q22	14	12.6071429	6.1022649	6.0000000	26.0000000
Q23	14	10.8214286	5.4688177	6.0000000	23.0000000
Q24	14	7.3571429	1.7805420	3.0000000	9.0000000
Q25	14	15.7857143	12.0203582	2.0000000	50.0000000

-------------------------- PROJECT=A RISKTYPE=U -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
FNCOST	15	3333.66	733.0443938	2468.45	4895.83
FNSKED	15	339.1555556	54.8975766	247.5416667	451.7500000

FNERR	15	13414.73	10470.29	1710.86	30882.80
FNERG	15	1730.40	106.0497911	1591.83	1909.39
FNERD	15	542.8013333	416.9957476	0	1209.17
FNERES	15	1187.60	457.0779389	429.0900000	1662.76
FNPRDT	15	31.8653333	25.6257889	0	73.8100000
FNQAMD	15	352.9280000	323.1240968	0	972.8700000
FNTRMD	15	231.2413333	37.6845861	181.1500000	302.9500000
FNRWMD	15	412.7433333	326.2204636	0	996.0900000
Q1	15	51.6666667	9.9402980	30.0000000	75.0000000
Q2	15	0	0	0	0
Q3	15	48.3333333	9.9402980	25.0000000	70.0000000
Q4	15	8.4000000	0.9856108	6.0000000	9.0000000
Q5	15	5.1333333	3.2041640	1.0000000	9.0000000
Q6	15	8.0000000	0.9258201	7.0000000	9.0000000
Q7	15	1.0000000	0	1.0000000	1.0000000
Q8	15	0.7333333	0.4577377	0	1.0000000
Q9	15	0.5333333	0.5163978	0	1.0000000
Q10	15	0.4000000	0.5070926	0	1.0000000
Q11	15	0.5333333	0.5163978	0	1.0000000
Q12	15	0.2666667	0.4577377	0	1.0000000
Q13	15	0.3333333	0.4879500	0	1.0000000
Q14	15	1.6000000	2.6672618	0	7.0000000
Q15	15	7.8666667	1.3020131	6.0000000	9.0000000
Q16	15	8.2000000	0.5606119	7.0000000	9.0000000
Q17	15	8.5333333	0.6399405	7.0000000	9.0000000
Q18	15	7.7333333	1.1629192	5.0000000	9.0000000
Q20	15	34.9333333	6.0411289	26.0000000	47.0000000
Q22	15	14.3333333	6.4660284	5.0000000	27.0000000
Q23	15	13.2666667	6.1582310	5.0000000	25.0000000
Q24	15	7.4000000	1.5491933	3.0000000	9.0000000
Q25	15	28.1333333	19.9530401	6.0000000	90.0000000

-------------------------- PROJECT=B RISKTYPE=C --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
FNCOST	12	2667.01	425.9057526	1705.57	3299.61
FNSKED	12	274.6428571	47.4928566	206.5714286	383.5714286
FNERR	12	11559.47	8144.78	2170.06	31597.91
FNERG	12	1711.85	119.6097295	1635.10	1997.45
FNERD	12	576.1850000	218.4170454	0	925.7500000
FNERES	12	1135.66	267.6175064	709.3500000	1737.02
FNPRDT	12	33.9508333	13.4710818	0	56.6200000
FNQAMD	12	340.0333333	140.0635348	0	594.1300000
FNTRMD	12	262.0550000	44.6549005	184.1100000	327.1300000
FNRWMD	12	465.0475000	189.0080956	0	788.1800000
Q1	12	56.6666667	11.5470054	40.0000000	80.0000000
Q2	12	0	0	0	0
Q3	12	43.3333333	11.5470054	20.0000000	60.0000000
Q4	12	8.0000000	1.7056057	3.0000000	9.0000000
Q5	12	4.9166667	2.4664414	1.0000000	9.0000000
Q6	12	8.4166667	0.7929615	7.0000000	9.0000000
Q7	12	1.0000000	0	1.0000000	1.0000000

Q8	12	0.9166667	0.2886751	0	1.0000000
Q9	12	0.8333333	0.3892495	0	1.0000000
Q10	12	0.6666667	0.4923660	0	1.0000000
Q11	12	0.5000000	0.5222330	0	1.0000000
Q12	12	0.2500000	0.4522670	0	1.0000000
Q13	12	0.3333333	0.4923660	0	1.0000000
Q14	12	0.7500000	2.5980762	0	9.0000000
Q15	12	8.0833333	1.3113722	5.0000000	9.0000000
Q16	12	8.4166667	0.7929615	7.0000000	9.0000000
Q17	12	8.3333333	0.9847319	6.0000000	9.0000000
Q18	12	7.9166667	1.4433757	4.0000000	9.0000000
Q20	12	32.8333333	3.2983008	28.0000000	39.0000000
Q22	12	10.8333333	3.8336627	7.0000000	20.0000000
Q23	12	9.4166667	2.9682665	6.0000000	16.0000000
Q24	12	6.5000000	1.1677484	4.0000000	8.0000000
Q25	12	20.6666667	7.7146064	15.0000000	40.0000000

Risk experiment: Comparison of performance
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General Linear Models Procedure
Class Level Information

Class	Levels	Values
RISKTYPE	3	C R U

Number of observations in data set = 41

Risk experiment: Comparison of performance
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General Linear Models Procedure

Dependent Variable: FNCOST

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	3047055.74	1523527.87	4.42	0.0187
Error	38	13084187.33	344320.72		
Corrected Total	40	16131243.07			

R-Square	C.V.	Root MSE	FNCOST Mean
0.188892	19.52887	586.788	3004.72

Source DF Type I SS Mean Square F Value Pr >

```
F

RISKTYPE                      2     3047055.74    1523527.87      4.42
0.0187

Source                       DF     Type III SS   Mean Square   F Value     Pr >
F

RISKTYPE                      2     3047055.74    1523527.87      4.42
0.0187
                  Risk experiment: Comparison of performance
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                        General Linear Models Procedure

Dependent Variable: FNSKED
                                            Sum of          Mean
Source                       DF           Squares         Square   F Value     Pr >
F

Model                         2       27746.5886     13873.2943      5.75
0.0066

Error                        38       91653.5577      2411.9357

Corrected Total              40      119400.1463

                       R-Square             C.V.        Root MSE           FNSKED
Mean

                       0.232383         15.82243         49.1115
310.391


Source                       DF        Type I SS   Mean Square   F Value     Pr >
F

RISKTYPE                      2       27746.5886    13873.2943      5.75
0.0066

Source                       DF      Type III SS   Mean Square   F Value     Pr >
F

RISKTYPE                      2       27746.5886    13873.2943      5.75
0.0066
                  Risk experiment: Comparison of performance
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                        General Linear Models Procedure

Dependent Variable: FNERR
                                            Sum of          Mean
Source                       DF           Squares         Square   F Value     Pr >
F

Model                         2       62232814.9     31116407.4      0.33
```

0.7182

Error	38	3541740642.9	93203701.1		
Corrected Total	40	3603973457.7			

	R-Square	C.V.	Root MSE	FNERR
Mean				
	0.017268	72.61508	9654.21	
13295.0				

Source F	DF	Type I SS	Mean Square	F Value	Pr >
RISKTYPE 0.7182	2	62232814.9	31116407.4	0.33	

Source F	DF	Type III SS	Mean Square	F Value	Pr >
RISKTYPE 0.7182	2	62232814.9	31116407.4	0.33	

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