NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

VALIDATION OF A QUALITY MANAGEMENT METRIC

by

Mary Alice Grossman

September 2000

Thesis Co-Advisors: John Osmundson
J. Bret Michael

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** September 2000	**3. REPORT TYPE AND DATES COVERED** Master's Thesis	
4. TITLE AND SUBTITLE: Title (Mix case letters) Validation of a Quality Management Metric			**5. FUNDING NUMBERS**
6. AUTHOR(S) Mary A. Grossman			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			**12b. DISTRIBUTION CODE**

13. ABSTRACT ***(maximum 200 words)***

The quality of software management in a development program is a major factor in determining the success of a program. The four main areas where a software program manager can affect the outcome of a program are requirements management, estimation/planning management, people management, and risk management. In this thesis a quality management metric (QMM) was used to measure the performance of ten software managers on Department of Defense (DoD) software development programs. Informal verification and validation of the metric compared the QMM score to an overall program success score for the entire program and yielded positive correlation. The results of applying the QMM can be used to characterize the quality of software management and can serve as a template to improve software management performance. Future work includes further refining the QMM, applying the QMM scores to provide feedback and appropriate training to program managers, and using the QMM scores as an input to program cost and schedule estimation methodologies to provide better program estimates.

14. SUBJECT TERMS Software Management, Requirements Management, Estimation/Planning Management, Risk Management, People Management, Quality Management Metric (QMM)			**15. NUMBER OF PAGES** 146
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited.

VALIDATION OF A QUALITY MANAGEMENT METRIC

Mary A. Grossman
United States Air Force
B.S./A.A.E., Purdue University, 1985

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN SOFTWARE ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
September 2000

Author: Mary A. Grossman
Mary A. Grossman

Approved by: John S. Osmundson
John Osmundson, Thesis Co-Advisor

James Bret Michael
J. Bret Michael, Thesis Co-Advisor

Luqi, Chairman
Software Engineering

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

The quality of software management in a development program is a major factor in determining the success of a program. The four main areas where a software program manager can affect the outcome of a program are requirements management, estimation/planning management, people management, and risk management. In this thesis a quality management metric (QMM) was used to measure the performance of ten software managers on Department of Defense (DoD) software development programs. Informal verification and validation of the metric compared the QMM score to an overall program success score for the entire program and yielded positive correlation. The results of applying the QMM can be used to characterize the quality of software management and can serve as a template to improve software management performance. Future work includes further refining the QMM, applying the QMM scores to provide feedback and appropriate training to program managers, and using the QMM scores as an input to program cost and schedule estimation methodologies to provide better program estimates.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

The quality of management in a software-development program is a major factor in determining the success of the program. Software development by its very nature can be a complex process because the product or products developed are logical, rather than physical systems, and therefore the development can not be approached as a manufacturing problem. Software is not a visible and tangible product. The success or failure of a software-development program depends to some degree on the ability of the program manager to estimate and plan the program, coordinate the work force efforts, facilitate communications, define requirements, and control the amount of risk exposure the program experiences.

Program-management tools have been developed to assist the program manager in estimating the cost and schedule of software programs. However, the estimation tools available assume consistent and high-quality program management. Although the quality of software development management tools has improved over the past thirty years, software-development programs are still often notoriously behind schedule and over budget. Hence there still appears to be something missing in the software-program management equation that has been overlooked in the quest to produce cost-effective, high-quality software. The missing something may be good management. If the quality of the software program management were measurable and available to be input into the costing and scheduling tools, then the resulting estimates could be provided to program

managers so that they could pinpoint areas of software-program management in which improvement needs to be made.

The Quality Management Metric (QMM) is a survey instrument which measures in a repeatable manner, the quality of management for a software-development program. The QMM consists of four separate metrics which measure the program manager's performance in the areas of requirements management, estimation/planning management, people management, and risk management. The results of the four metrics are then combined to provide a Quality Management Metric score which predicts the quality of the program management and the success of the program. The QMM survey instrument has been applied to measure the performance of three software managers on Department of Defense (DoD) software development programs. The resulting QMM scores of the program managers were informally verified and validated in a comparison with an overall program success score and yielded positive correlation.

This thesis evaluates the QMM as a viable software-management-quality survey instrument. for monitoring, evaluating, and improving the enactment of the software process. The survey and this research are a step in that direction.

In the current research, the QMM survey instrument is used to measure the performance of ten program managers on DoD software-development programs. In order to gain a measure of the validity of the QMM, the QMM survey instrument was given to the program manager and also to one or two other independent individuals who were closely associated with the program and knowledgeable about the overall practices and success of the program. The program manager QMM scores were compared to the

program manager's subjective overall program success scores and the correlation yielded strong positive results. In addition to the comparison of the QMM score with the overall program scores, the results from the four separate metrics were analyzed. The study examined the correlations between the program manager scores and each sub-area metric and the QMM scores and each sub-area metric to determine whether there were relationships between the overall program manager performance and the program manager performance in a specific area or areas. The independent QMM scores were compared with the independent overall program scores and yielded a strong positive correlation. The independent scores in each of the four sub-areas were also compared against the independent QMM and overall program scores to determine whether there were any relationships between the overall program manager performance as rated by the independent and the overall program success, as rated by the independent.

From the results of the data analysis several conclusions are drawn:

- The QMM survey instrument yields a strong correlation with the QMM score and the overall program score for both the program manager and the independent data sets. This indicates the QMM survey instrument does measure the quality of management on a software-development program where the management policies and procedures are the same as or similar to the currently accepted software engineering management practices, as defined by the QMM survey instrument. In the case where the management practices and procedures are known to diverge from the currently accepted practices, the QMM survey instrument may be used to measure the level to which the currently accepted practices are implemented, but will likely yield a lower QMM score and probably predict a lower success rate for the program than the actual rate.

- The data indicates that, in general, program managers believe that they are good managers of people. However, the independent evaluators do not believe the program managers are as good at managing people as the program managers themselves.

- The QMM survey instrument may be useful in detecting discrepancies between the program manager's and the individual team member's perspectives and understanding.

- The results of the study indicate that there is a great deal of uncertainty involved in managing estimation/planning and risk, and that the program managers who are good at managing the uncertainty in one of these areas are usually good at managing the uncertainty in the other area as well.

- The data correlations between the program manager data set and the independent data set indicate that perhaps the area of requirements management is more visible and better understood by the entire development team than other areas of management.

Recommendations for future work include updating and further testing the QMM survey instrument, developing a mechanism to provide the program managers with feedback on their management performance and possible courses of action to take to improve their performance, and integrating the QMM survey instrument results into existing cost, schedule and risk models to improve program estimation accuracy.

ACKNOWLEDGMENTS

Sincere appreciation to

Dr. John Osmundson and Dr. J. Bret Michael

for their guidance and support in the endeavor.

And also to all the interviewees.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION AND BACKGROUND

A. SOFTWARE DEVELOPMENT

In addition to the normal development difficulties of a non-software product development, software development introduces additional complexity and potential problems which with the program manager must deal. Software is a logical, rather than a physical system, therefore, development cannot be approached as a manufacturing problem. Software is not a visible and tangible product. Per dollar spent, software products are more complex than other engineering products [Ref. 1]. Software is flexible and can be easily changed, at least on the surface. Often one of the difficulties facing a program manager is the idea that software is flexible and easily changed at any point in the development process. Studies have shown that changing software requirements late in a development effort has a much more significant and adverse impact on the program cost and schedule than changing the requirements early on in the program. However, since the development effort is for a software product the customer often asks for changes in the requirements up until the end of the program. The program manager must control the amount of change to the requirements and communicate the impact of proposed changes to the customer to coordinate and maintain control of the change process and keep the program on schedule, within budget and produce a quality product the customer enjoys.

The program manager is responsible for gathering the requirements and ensuring they fulfill the customer's needs and wants. Getting the correct requirements is difficult because the customer often does not know exactly what they want until they have seen

the software product or a prototype of the product and try to use it. Many requirements are implicit in the customer's understanding and not made explicit until the customer realizes they are missing during the use of the product. There are also misinterpretations between the way the customers expect the requirements to be implemented and the way the developers interpret them.

The software development personnel the program manager leads are intelligent, educated professionals who demand good management to be highly productive. If they believe they are being mismanaged they may rebel against the system. The developers thrive on challenging tasks which are perceived as being significant, appropriate feedback and peer recognition, and require a good work environment to be their most productive.

The software development process is further complicated by the interactions and communication required for a successful software development program. The program manager is responsible for facilitating the flow of communication not only within the development program but of equal importance, outside of the program with the customers. The customers must be kept up to date on the program requirements, cost, schedule, problems, and possible tradeoffs so they can provide feedback to the program manager allowing the manager to make informed decisions which will lead to a successful program product and a satisfied customer. In addition, the program manager must ensure good communication between the developers to reduce misunderstandings and the need for rework, particularly if part of the product is being developed by one or more subcontractors.

Various program management tools have been developed to assist the program manager in estimating the cost and schedule of software programs. The COnstructive COst Model [Ref. 2] or COCOMO model is a well known software development cost and schedule estimation tool. It is representative of the type of estimation tools available to software program managers in that it uses software product metric measures such as the estimated number lines of code delivered in the final product as the basis for the program cost and schedule estimations throughout the program development. Although the quality of the software development management tools has improved over the past thirty years, software development programs are still notoriously behind schedule, over budget, etc. For example, in March 1999 Constance Fabian-Isaacs and Ed Robinson [Ref. 3] wrote,

> Software development projects are notorious for running over budget and behind schedule. The Center for Project Management in San Ramon, California reports that 99% of commercial software products are not completed on time, within budget, or according to specifications, and that the average project is underestimated by 285%. With statistics like these, it's no wonder software project managers are looking for ways to improve their processes.

Clearly, there is still something missing in the software program development equation which has been overlooked in the quest to produce cost effective, high quality software. Randall Jensen suggests the missing something may be good management which he states is "the most important productivity and quality driver" [Ref. 4]. In 1981 Barry Boehm [Ref. 2] wrote,

> Poor management can increase software costs more rapidly than any other factor.

Gerald Weinberg took Barry Boehm's concept one step further by summarizing the four most important cost drivers and the relative importance of each as identified by Barry Boehm; see Figure 1.

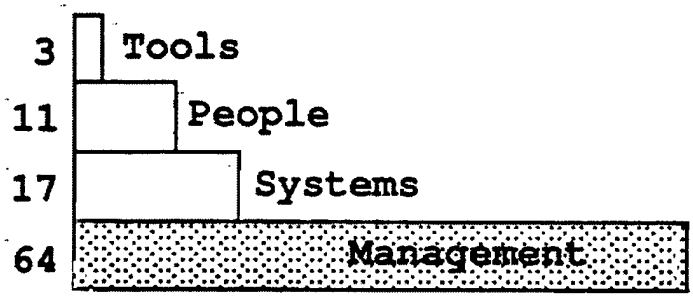


Figure 1. From [Ref. 5] The Four Most Important Cost Drivers on a Software Development Program.

From Figure 1 it is obvious that the quality of the program management may be a major factor in the success or failure of a software development program. The COCOMO cost and schedule estimation model, and many others like it, assume uniform, good management for both the developer and the customer organizations. From the frequency with which software development programs experience cost, schedule and performance overruns and problems, the assumption of good management may be incorrect in many cases. If the quality of the software program management were measurable and available to be input into the cost and schedule tools, the resulting estimates would provide more accurate information for the program managers and possibly improve the overall program performance.

B. INSTRUMENTS FOR MEASURING THE QUALITY OF SOFTWARE MANAGEMENT

Finding an instrument to measure the quality of software management is difficult. There are many instruments available to measure the product metrics which focus on individual aspects of the software item (usually volume) under development. There are also many instruments available to measure the process metrics which focus on the activities involved in software development. Both metrics typify most program performance evaluations and ignore any consideration of the quality of software management.

The People Capability Maturity Model (P-CMM) [Ref. 6] provides a framework from which the program organization can stabilize their procedures and get repeatable results. However, the P-CMM does not provide a specific set of metrics for measuring the quality of or the improvement of program management. Instead, the P-CMM assists the program organization in defining its approach to measuring the performance of the management, hiring managers which conform to the expected performance and training its managers to attain the desired performance.

There are few if any instruments available to measure the quality of the software management. One instrument which does measure the quality of software management is the Quality Management Metric (QMM) developed by Martin Machniak [Ref. 7]. The QMM measures the software program management quality through the use of a survey which is given to the program manager. From the program manager's responses to the pair-choice and yes/no questions a profile of the program manager is built up in the areas

of requirements management, estimation/planning management, people management and risk management. From the manager's score in each of the four areas a total QMM score is computed which predicts the manager's current and future performance as well as the program's current and future performance.

To date the QMM has undergone limited testing. Martin Machniak used the QMM survey instrument to measure the performance of three software program managers on Department of Defense (DoD) software development programs. The resulting QMM scores of the program managers were informally verified and validated in a comparison with an overall program success score and yielded positive correlation [Ref. 7].

This thesis evaluates the QMM as a viable software management quality survey instrument. The long-term goal is to provide a means for monitoring, evaluating, and improving the enactment of the software process. The survey and this research are a step in that direction.

C. SCOPE OF THE RESEARCH

Since the QMM has been tested in a limited fashion (3 programs), the thesis further explores the validity of the QMM in measuring the quality of software managers and in predicting the success of programs. The QMM survey instrument was used to measure the performance of ten program managers on DoD software development programs. To gain a measure of the validity of the QMM, the QMM survey instrument was given to the program manager and also to one to two other individuals who were closely associated with the program and knowledgeable about the overall practices and

success of the program. The program manager QMM scores were compared to the program manager overall program success scores and the correlation yielded positive results. In addition to the comparison of the QMM score with the overall program scores, the results from the four sub-areas of the QMM: requirements management, estimation/planning management, people management, and risk management were analyzed as well. The study examined the correlations between the program manager scores and each sub-area and the QMM scores and each sub-area to determine if there were any relationships between overall program manager performance and the program manager performance in a specific area or areas. The independent QMM scores were compared with the independent overall program scores and yielded a positive correlation. The independent scores in the four sub-areas were also compared against the independent QMM and overall program scores to determine if there were any relationships between the overall program manager performance as rated by the independent and the overall program success as rated by the independent.

From the results of the data analysis several conclusions are drawn, these are presented in Chapter V. Recommendations for future work are also presented in Chapter V.

THIS PAGE INTENTIONALLY LEFT BLANK

II. RELATED WORK

A. BACKGROUND OF THE QMM

The QMM is a repeatable set of metrics that can be used to assess the quality of software-development management. It can also be used to measure improvement in the quality of the management of software development and predict future success levels of software-development projects. The definition of software development extends to both development of new software and maintenance efforts to maintain and extend the existing functionality of systems. Application of the QMM outside of the software-development domain has not been addressed in the development or testing of the QMM survey instrument.

The QMM survey instrument consists of four categories of software-management metrics: requirements management, estimation/planning management, people management, and risk management. The scores for each category provide an indication of the quality of the program manager's management of a software-development project.

The program manager is asked to fill out the QMM survey instrument to attain a measure of the quality of the management on the software development program. The resulting QMM score predicts the program manager's overall performance and the success of the program. Each of the four sections of the QMM has the same number of total points possible. The total points for each section are multiplied by its relative Importance Coefficient (IC) to yield a weighted score. After the weighted scores for each section are computed, they are summed together to yield the Quality Management Metric (QMM) score [Ref. 7].

The IC for each section was determined from the relative rankings of importance of each of the sections. The IC rankings were determined through interviews with senior program managers and focus groups.

The overall QMM score is made up of the sum of the scores of the each of the individual sections multiplied by an IC for that section. The QMM equation is as follows [Ref. 7]:

$$QMM = 0.92\ RqM + 0.67\ EPM + 1.86\ PM + 0.55\ RkM$$

The QMM is the sum of the four components:

RqM is the requirements management metric

EPM is the estimation/planning metric

PM is the people management metric

RkM is the risk management metric

The QMM survey instrument is intended to pertain to only one program at a specific point in time. Each program manager who participates in the survey is asked to answer the survey questions from the perspective of what was happening on a specific program at a specific point in time, such as a milestone or delivery.

It is envisioned that the QMM survey instrument can be used to measure the improvement in a program manager's performance. The program manager can take the survey at different points in time on the same program or on two different programs, and

the results of the surveys can be compared to obtain an indication of the improvement of the program manager in managing the software-development program.

The questions used on the QMM survey instrument were gathered from periodicals, textbooks, interviews with senior program managers, and focus groups. The intent was to be as inclusive as possible with respect to judging the quality of management. Appendix A contains the QMM survey instrument forms with the weighting for the individual questions.

Part one of the questionnaire contains pair-choice questions. These questions require the participant to choose one of two statements that best describes what was happening on the program at the evaluation point in time. The choice does not have to match exactly: the participant selects the choice which best describes the program. The model for this type of survey instrument is the Myers-Briggs Type Indicator questionnaire. Each pair choice represents two differing ideas in an effort to ascertain a tendency of the individual. Often the pair choices are repeated with different wording to confirm earlier choices and measure the strength of the tendency [Ref. 7]. Each section has approximately 70 questions and each section has a total of 70 points for part one of the questionnaire.

Part two of the questionnaire contains questions to be answered with yes, no, or not applicable(n/a). This part of the questionnaire is user-friendly for conducting surveys, requiring minimum writing. Each question has a point value based upon the relative importance of the question in that section. Each section has approximately fifty questions and a maximum score of sixty-two points. The entire survey, including both parts for all four sections contains 457 questions.

The QMM survey instrument was conceived and targeted for high-level program managers. High-level program managers are often in charge of more than just a software development effort, including system-level design, hardware development, integration and testing of an entire system which includes software development as a component of the overall system. The high-level program manager is asked to answer the questions as the questions pertain to the software development portion of the program in question.

In order for a program to qualify for participation in a QMM survey, the minimum requirement is that a program manager be in charge of at least three software developers. The software developers do not have to be working as software coders; they can be working in any of the software development areas such as design, requirements analysis, documentation, coding, and testing. A requirement of the software developers is that they have defined areas of responsibility. These areas can be shared with other developers, but specific developers are assigned to each area.

Administration of the survey was conducted such that the participants had no information on the point totals or relative weightings of the questions before hand. This was done to avoid introducing additional bias into the results of the survey. Each survey was given to the participant in a private, one-to-two hour interview. The results were manually scored to focus attention on the entire process and de-emphasize focusing on only the final Quality Management Metric (QMM) score [Ref. 7]. In order to obtain complete and full disclosure on the surveys, the results were reported anonymously as programs A, B, and C.

Collectively, the measures in the four sections give an objective view of the quality of the software management. Thus, two programs scoring equally on product and

process metrics can be further measured and compared on the basis of the quality of their management.

B. SOFTWARE MANAGEMENT COMPONENTS OF THE QMM

The QMM provides a repeatable set of metrics to determine the quality of software management, measure the improvement, and predict future success levels of programs. The QMM survey instrument is made up of four sections: requirements management, estimation/planning management, people management, and risk management.

1. Requirements Management

Requirements management focuses on managing the process of extracting, developing, defining, and refining the requirements of a software development program [Ref. 7]. The QMM requirements metric is not a product or process metric for requirements nor is it intended to be one. Many product and process metrics already exist for requirements. The QMM requirements metric is intended to objectively measure the quality of the program manager in the area of requirements management.

Requirements are necessary for software programs because they define the product to be produced. Well documented and written requirements unambiguously state the capabilities which the software product will have upon completion and form a contract between the customer and the developer which defines the scope of the work to be accomplished. The program manager is responsible for establishing procedures to ensure that the requirements specification is complete, consistent, readable, lacks ambiguity, and can be traced to origins. The program manager must also ensure

stakeholder involvement in extracting and refining the requirements to make sure the software product will satisfy the customer's needs.

The program manager is responsible for validating, prioritizing, and conducting tradeoff studies on the requirements. Part of managing the customer expectations is validating the requirements. The requirements should be scrubbed to be certain they reflect the customer needs accurately. Once the requirements are validated, they should be prioritized. Every software development program has cost and schedule constraints. Often, the requirements which are extracted would extend the development program beyond the cost and schedule constraints and so the requirements are prioritized with the customer so that when a constraint exists, the highest priority requirements are executed and the lower priority requirements are cut. Requirements prioritization goes hand-in-hand with requirements tradeoff studies. The customer and the program manager need to know their development options to determine the appropriate requirements and the priority of the requirements for the software product.

The program manager is responsible for implementing change control management for the requirements. Scope creep, where the requirements expand due to new or changed customer requirements or through the developers throwing in nice-to-have features, increase the complexity of the product, thereby increasing the cost to test and debug the product. The new requirements also eat into the cost and schedule constraints of the program, possibly to the point of reducing the number of original requirements which can be accomplished. Requirements change control is necessary to limit the amount of unauthorized change, and ideally, to assist in managing the customer's expectations.

The QMM requirements metric questionnaire evaluates the program manager on the formality of the requirements, the establishment of procedures, extraction management, change management, and testability of requirements. The questionnaire does not seek to determine the quality of judgment on any specific decisions made. The thrust of the questions is to establish the structure, if any, laid out by the program manager in the area of requirements [Ref. 7]. How formal are the processes? How well understood, and implemented are the processes? Who is involved in the extraction process and when is it done? How is change handled? Is each requirement testable and when is testing considered during the development?

2. Estimation/Planning Management

Estimation and planning management focuses on establishing procedures and techniques to accurately estimate the costs and schedule of the development effort, and from these estimates properly plan the program. Accurate estimates are necessary to produce realistic plans which are essential to avoid cost overruns, late deliveries, inefficiency, poor reliability, and lack of user acceptance.

The program manager is responsible for establishing a frame of reference for the program estimates and plans as well as an ability to measure against the reference to determine program progress. Three types of measures used to assess program progress are as follows: product measures, process measures, and resource measures. Product measures are based upon the products produced: lines of code, pages of documentation, and number of modules completed within each phase of the program. Process measures quantify the behavior, strategy, and the execution of the processes used to develop the product. Process measures are based on such things as the number of defects found in

testing, the number of requirements changes, and the milestones which are met. Resource measures are based on the number of labor hours expended, the appropriate assignments of personnel, and the proper work environment to maximize productivity.

The program manager is responsible for implementing the proper procedures and structure to track the product, process, and resource metrics throughout the program, and ensuring the measures being used will yield the most accurate and useful results for the program.

The QMM estimation/planning metric questionnaire does not seek to advocate a specific estimation technique but rather, it seeks to quantify the quality of the management of the estimation and planning process. The questions determine whether the program manager is performing both initial and follow up estimation and planning. Is documentation completed and used? Are currently acceptable software engineering management methods and practices being employed? Is the program manager managing the estimation and planning process sufficiently to give confidence to the program estimates and plans?

3. People Management

The QMM looks at people management from a specific software development/management perspective. It focuses on the unique qualities and needs of people working in a software-development environment.

The people-management metric focuses on the program manager's ability to allocate human resources appropriately, implement a structure to facilitate communication both within and external to the program, and provide leadership to the program. People management is the most important component of the QMM. Quality

people management increases the productivity of the workforce and increases the program's chance to meet budget allocations and schedules and be successful.

The program manager is responsible for establishing the organizational culture at the program-development level. This includes recruiting, training, allocating tasks, building teams, empowering team members, implementing good organization, mentoring, establishing a good work environment and reward structure, and promoting good communications. The developer's productivity is more significantly impacted by the team work environment than the overall organizational work environment. The program manager is responsible for developing the proper work environment on the team level to promote the maximum individual productivity from team members. The program manager is also responsible for fostering open communications within the development team (horizontal), with the program manager (vertical), and with the users and stakeholders (external) to the extent possible within the overall organizational structure. Program manager leadership and mentoring are important in creating and maintaining the team work environment and communication infrastructure. The leadership of the program manager is important in enabling the program manager to establish good practices for managing human resources.

The people-management section of the QMM is composed of four sub-sections: human resources, leadership, communication, and technical competence. The human resources section covers human-resource management. The leadership section covers the personal leadership skills exhibited and the leadership mentoring provided by the program manager. The communication section covers what communication protocols are set up for the program organization and used individually by the program manager. The

technical competency questions cover the level of competency of the program manager within the program on a technical level.

The QMM People-Management metric questionnaire covers the people-management skills the program manager exhibits and the type of organizational and communication structure the program manager establishes at the development-team level. The program managers are rated on their personal leadership skills and team mentoring. The organizational structure set up determines if the program manager creates an adult-to-adult or master-servant type of relationship between the development team and the manager. The adult-to-adult management style is one in which the manager asks for the development team's inputs before making decisions or empowers the development team to make decisions. The master-servant type of management style is one in which the manager does not ask for inputs from the development team; rather, the manager dictates the decisions and the tasks to the team. The adult-to-adult is more favorable for increasing team member job satisfaction, according the focus group feedback.

The questions also ascertain the communications protocols which the program managers establish for program communication as well as the communications formats which the program managers use themselves.

4. Risk Management

Risk management is the process of identifying, mitigating, and eliminating potential problems before they can do result in a loss, such as a efficacy (i.e., productivity) loss.

The QMM examines risk management by looking at the components of risk management: risk assessment, risk control, risk communication, and risk avoidance. Risk

assessment is comprised of identifying the risks, analyzing the risks, and prioritizing the risks. It is important to identify each risk individually so that they can be dealt with on an individual basis. The risks are analyzed for their estimated impact to the program if they occur, and then are prioritized. The prioritization allows the program manager to concentrate the limited program resources on those risks which are the most likely to occur and which will result in the largest of the losses to the program if they do occur.

Risk control is comprised of risk planning, risk tracking, and risk resolution. Risk control consists of managing the risks to obtain the desired outcomes. Risk planning involves determining appropriate actions to mitigate individual risks, prioritizing the actions, and integrating them into an executable risk management plan. Risk tracking involves tracking the status of the risks and their mitigation actions through metrics. Risk resolution is the execution of the risk mitigation plans for each risk.

Risk communication is the process of exchanging risk information throughout the organization at all levels. This activity is critical to the management of risk, allowing the program manager to maintain a level of awareness of the risks, their impacts, and the success or failure of the risk mitigation strategies.

Risk avoidance is one possible strategy for risk resolution which involves avoiding the more risky development strategies or technical challenges. Examples of risk avoidance include using a proven compiler and development environment instead of using a new and untried compiler and development environment, and deciding to use a proven technology component instead of relying upon the development of a new cutting edge technology.

All programs have some element of risk as do all areas of the program—requirements management, estimation/planning management, and people management. Quality management acknowledges the presence of risk and implements some level of systematic risk management.

The QMM risk management metric measures the risk management structure which is set up by the program manager to deal with risks. The questionnaire examines the structures used by the program management for identification, monitoring, and managing risk. The questions determine whether the program manager has implemented strategies and personnel to assess, explore, and prioritize all reasonable risks and also if a risk management plan exists and is implemented and updated throughout the program's development.

C. INITIAL VALIDATION AND VERIFICATION OF THE QMM

The approach to the verification and validation of the QMM was informal. Three DoD programs were evaluated for a QMM score. The program manager and one program development team member evaluated the program management on programs A and C. On program B, the program manager and two program development team members evaluated the program management.

In order to provide a frame of reference in which to correlate the survey results, two other measures were developed and used. These two measures are the QMM percentage score and the overall program success score [Ref. 7].

The QMM percentage score is a derived measure of the overall QMM score. The maximum possible score for the entire survey is 528 points and the minimum possible

score is –130.86 as part-two questionnaires contain negative point response values. In order to obtain a QMM percentage score, the following steps are taken. First, the survey minimum possible score is normalized to zero. Since the survey minimum QMM score is –130.86, 130.86 is added to the survey minimum possible score so that it equals zero. Correspondingly, 130.86 must be added to both the survey maximum score possible and to the actual QMM score obtained in the survey. Since the QMM survey maximum possible score is 528.0, the resulting normalized survey maximum possible score is 658.86 [Ref. 7].

To obtain a QMM percentage score, the normalized QMM score obtained from the survey is divided by the normalized survey maximum possible QMM score and then multiplied by 100. The equations are as follows [Ref. 7]:

$$QMM_{MIN} + 130.86 = 0.00 = QMM_{MIN\ NORMALIZED}$$

$$QMM_{MAX} + 130.86 = 658.86 = QMM_{MAX\ NORMALIZED}$$

$$QMM_{SCORE} + 130.86 = QMM_{SCORE\ NORMALIZED}$$

$$(QMM_{SCORE\ NORMALIZED}/QMM_{MAX\ NORMALIZED}) * 100 = QMM_{PERCENTAGE\ SCORE}$$

The overall program success score is a subjective number assigned by the survey participant rating the overall success of the program. The success of the program is measured in terms of how well the final product performs on a scale of zero to ten. On this scale zero corresponds to complete and utter failure with no viable product produced. A score of ten on the scale is not realizable, except theoretically; it corresponds to complete success, no bugs in the product, delivery on time and within budget, and

complete customer satisfaction with the end product. The cause for success or failure of the program is not important. It may or may not be associated with any actions involving program management.

In addition to the QMM percentage score and the overall program score, a mean overall success score was obtained for each of the three programs. The mean overall success score is derived from each survey participant's overall program success score and at least two other individuals (mostly users, or those somehow associated with the program or delivered product) able to judge the overall success of the program [Ref. 7].

The goal underlying the data analysis was to determine any correlation between the participant's QMM score, their individual overall program score, and the mean overall success ranking of the program. This was done by comparing the QMM percentage score with the individual overall program success score and the mean overall success score for the particular program. For example, an overall program success score of seven corresponding to a QMM percentage score of seventy percent plus or minus five percent indicates a strong correlation. An overall program success score corresponding to a QMM percentage score of between plus or minus five and fifteen percentage points of the QMM percentage score indicates fair correlation. An overall program success score corresponding to more than plus or minus fifteen percentage points of the QMM percentage score indicates weak correlation. If the QMM percentage score has weak correlation with the program overall success score, then the QMM metric is still valid as programs could conceivably fail for a variety of reasons, including a poor choice of technology or a funding shortfall. The reverse condition may also be true for explaining successful programs with low quality of software management. However, it is typically

expected that successful software programs follow superior software program management [Ref. 7].

The results of the data analysis are shown in Table 1 [Ref. 7].

Program	Program A		Program B			Program C	
Participant	A – PM	A – 1	B – PM	B – 1	B – 2	C – PM	C - 1
QMM Score	338	322	386	106	47	198	189
QMM Percent	71.2%	68.8%	78.5%	35.9%	27.0%	49.9%	48.6%
Success Score	7	7	9	4	3	4	4
Mean Success Score (0 – 10)	7		4			4	

Table 1. From [Ref. 7] Results Summary Comparison.

Program	**Program Score**	**QMM Score**	**Req. Man.**	**Est. / Planning Man.**	**People Man.**	**Risk Man.**
A - PM	7	71.0%	67.1%	73.7%	80.0%	41.0%
A - 1	7	68.7%	65.2%	62.3%	80.0%	41.0%
B - PM	9	78.4%	66.5%	76.6%	85.6%	72.9%
B - 1	4	35.8%	41.3%	24.6%	34.4%	36.1%
B - 2	3	26.9%	28.4%	24.0%	27.5%	15.1%
C - PM	4	49.8%	29.7%	15.6%	80.6%	15.1%
C - 1	4	48.5%	37.4%	34.7%	68.1%	10.8%

Table 2. Data From the QMM Survey Summary Sheets

The QMM summary sheets for each survey are summarized in Table 2. The program manager for program A is referred to in the tables as A – PM, the independent evaluator on program A is referred to as A – 1, and so on. An error in the math on the QMM summary sheets has been corrected in the results presented in Table 2. Therefore,

the QMM percentage scores vary slightly between Table 1 and Table 2. Table 2 also presents the percentage of the points scored in each of the four sections: requirements management, estimation/planning management, people management, and risk management.

Programs A and C exhibit correlation between the QMM percentage score and both the overall program success score and the mean overall success score. By examining Table 2 it can be seen that program A shows a weak risk-management section. This appears to be correct, as risk management for this program was not emphasized. The higher scores in the other sections reflect the fact that program A was highly structured and planned, had successful requirements extraction, and enjoyed good technical success with their deliverables.

Program C had essentially no risk management, little planning, and poor requirements extraction. Once again this is reflected in the scores in Table 2. However, this program did have good people-management which allowed them to deliver a usable product, the high people management skill level is also reflected in Table 2.

Program B appears to have a disconnect between the perceptions of the program manager and the development team members interviewed. The difference in perception is possibly due to a widely documented effect in social psychology in which people prefer to see themselves in a self-enhancing fashion. On the job, approximately ninety percent of managers and workers rate their performance superior to that of their peers [Ref. 7].

The conclusion of the thesis was that the goal of creating repeatable metrics for determining the quality of software management was obtained. Further work is needed to

refine the survey questions in wording and clarity, the point values for the questions need to be refined to improve the survey, and additional case studies are required to fine tune the QMM metrics.

THIS PAGE INTENTIONALLY LEFT BLANK

III. CURRENT WORK WITH THE QMM

A. METHODOLOGY AND PROTOCOL

The goal of the current work with the QMM is to further explore the validity of using the QMM for measuring the quality of software program management.

In this research, the QMM survey instrument is used to measure the performance of ten program managers on DoD software development programs. The ten program managers are asked to complete the survey instrument. In addition, the survey instrument is given to one to two development team members on each program who are knowledgeable about the overall practices and success of the program. A requirement for choosing the individual development team members is to select team members who have a good understanding of the overall program and are knowledgeable about the management practices and infrastructure implemented by the program manager throughout the program. The intent is to choose individuals whose experience is not limited to specific areas of the program. The individual development team members are asked to answer the QMM survey questions as they pertain to the program management and the management characteristics of the program manager being evaluated. The program manager is asked to determine a specific point in time on the program, such as a milestone or delivery, for the evaluation of the program management and to define it such that the individual development team members will be able to identify with the point in time that was selected and evaluate the program for that same point in time.

The survey instrument is applied to the interviewees in two ways—either via a private one-on-one personal interview which lasts approximately two hours, or via an

electronic copy which is distributed by email, filled out by the interviewee and returned. In eight of the ten programs (17 surveys total) the survey instrument is applied in personal interviews, in the remaining two, programs H and J, (four surveys total) the survey instrument is applied through email. The emailed surveys executed later in the research process benefited from the experience gained in the execution of the surveys via personal interview. By the time three of the four emailed surveys were distributed, a short data dictionary of terms on the survey and answers to frequently asked questions was available and included with the survey distribution. The questionable terms in the data dictionary and frequently asked questions were identified from feedback obtained during the in-person interviews. The interviewees surveyed via personal interview, programs A – G and program I, benefited from the opportunity to ask for clarification on terms and the intent of individual questions during the interview process.

The format for the personal interviews included scheduling the interview in a conference room or a quiet place away from interruptions, executing the survey, and asking the participant to subjectively rate the success of the program. The interviewees are given the survey instrument on paper along with an explanation of the survey format and are encouraged to request clarification at any time.

Once the survey is completed, the interviewees are asked to subjectively rate the success of the program, at the point in time the program is being evaluated, on a scale of zero to ten. A score of zero corresponds to complete and utter failure, no viable product produced and the program failed miserably. A score of ten corresponds to complete program success, the program produced an outstanding product, on time, within budget, with no bugs, and the customer was ecstatic with the quality of the product. To assist the

interviewees in visualizing the scale the researcher draws and labels a scale as shown in Figure 2 and the interviewees are asked to place an "X" on the scale which represents the success of the program at the evaluation point in time. Once this is done, the researcher asks the interviewee for a specific numerical value to associate with the "X" on the scale.

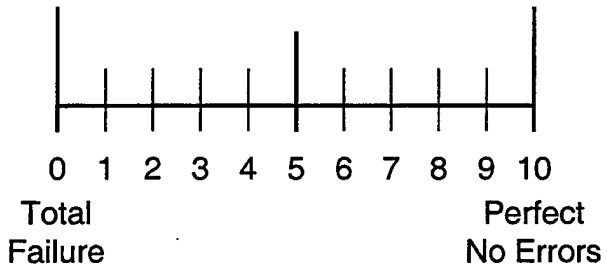


Figure 2. Overall Program Score Scale.

Finally the researcher asks the interviewee for feedback on the survey instrument itself. For example, where there any questions which did not make sense? Are there words which the interviewee did not understand? Is the survey instrument too long? How would they improve the survey instrument? What was their overall impression of the survey instrument? This feedback is collected to obtain a feel for the level of frustration the survey induced in the interviewee and to provide glimpses into the viability of the survey instrument for future improvements.

The email surveys include an additional survey document to collect background information such as the number of software developers working on the program, the time frame of the program and the overall program success score of the interviewee. The email interviewees are encouraged to contact the researcher via telephone or with questions. In one case, the email survey was followed up by a telephone call to gain

further feedback from the interviewee regarding the survey instrument. In this case the interviewee had very strong opinions about the survey instrument and wished to bring them to the researcher's attention. In the other email surveys the interviewees respond to the additional background questions through email alone.

The survey instruments utilized in both the personal interview surveys and the email surveys are identical in content. The only difference in the survey instruments is the medium through which they are applied. The personal interview QMM survey instruments are hard copies of the survey instrument which is emailed with the exception of the additional background-questions document and the data dictionary and frequently-asked-questions document. The emailed survey instruments are made up of the following files:

- Microsoft Word file containing Part I of the QMM survey, the pair-choice questions.
- Microsoft Excel file containing Part II of the QMM survey, the yes/no questions.
- Microsoft Word file containing the additional background questions.
- Microsoft Word file containing background information on the QMM survey and the goals of the current research for the interviewee's information.
- Microsoft Word file containing a data dictionary of QMM terms and answers to questions frequently asked about the QMM survey instrument.

Part I of the QMM survey instrument, the pair-choice questions, consists of two questions side by side on a single line with a column beside each question. The interviewee is asked to check the box next to the question or statement on each line which most closely reflects what is or was happening on the program at the specific point in time (milestone, delivery, etc.) on the program which is being evaluated. The interviewee chooses between the two choices on each line of the survey. The statement

or answer which most closely reflects the program does not need to be an exact match. Each pair statement represents two differing ideas in an effort to ascertain a tendency of the individual in the area of interest, such as the use of formal requirements documentation versus informal or no documentation. Often the pair choices are repeated with different wording to confirm earlier choices and measure the strength of the tendency . The survey format, with the proper mix of questions and variation repetitions is intended to be used to reach consensus on issues and measure the strength of tendencies [Ref. 7].

Part II of the QMM survey instrument, the yes/no questions, consists of a single question per line with three columns next to it labeled "yes," "no," and "n/a" respectively. The interviewee answers the question as it pertains to the program manager and the program at the specific point in time the program is being evaluated by placing a check in the appropriate "yes", "no", or "n/a" box next to the question. The use of the "n/a" box is discouraged. However, it exists and is used in the cases in which the program manager does not have direct control over the issue which is asked in the question. For example, when an interviewee evaluates a government program manager who is in charge of a contractor developing the software, the government program manager does not have direct hire/fire authority over the development personnel. In the case in which the survey question asks if the program manager has direct hire/fire authority over the personnel, the appropriate answer would be "n/a". The "n/a" answer column is present to allow the interviewee to indicate the program manager is constrained in the area being surveyed and does not penalize the program manager for factors beyond their control.

The weighting of the questions on the survey instrument are the same as used by Martin Machniak [Ref. 7]. The pair-choice questions in the requirements management section have a possible score of zero to two with different upper bounds on the score of each question based upon its relative weight and importance in the section. The possible scores in the estimation/planning management, people management, and risk management sections have a possible score of zero to one. The yes/no questions have a possible score of minus four to four with different upper and lower bounds on the score of each question based upon its relative weight and importance in the section.

To score the results of Part I and Part II of the QMM survey instrument, the interviewee responses are entered into a Microsoft Excel spread sheet containing the QMM questions, response columns, and question weighting factors. A separate spread sheet file is created for each interviewee's results for each part of the QMM survey. Thus, interviewee A - PM will have an Excel file containing the results for their QMM Part I results and a separate file containing their QMM Part II results. The spread sheets automatically calculate the total points for each of the four QMM sections: requirements management, estimation/planning management, people management, and risk management. These results, along with the interviewee's subjective overall program score, are entered manually in a QMM summary spread sheet for each interviewee which then calculates the total points for each QMM section, the overall QMM score, and the QMM percentage score.

The summary data for each program and each interviewee is then manually entered into an Excel summary spread sheet. The data contained in the summary spread sheet identifies the program, the interviewee for the program, and the interviewee's

scores for the following QMM sections: requirements management, estimation/planning management, people management, and risk management, QMM score, QMM percentage score, and overall program score. The data in the summary data spread sheets is then used for analyzing the data.

B. ANALYSIS TECHNIQUES

The data analysis consists of graphing the data to look for obvious trends, computing the mean, standard deviation, minimum and maximum values for the data range, variance, and various data set correlation to explore the data further.

The QMM point totals for the four sections—requirements management, estimation/planning management, people management, and risk management—are converted into percentages and constrained to a scale of zero to ten by the following steps. The total points scored for each section are normalized to zero by subtracting the minimum possible points for each section from the points scored for the section. The resulting normalized score is then divided by total of the maximum point totals possible in each section minus the minimum possible points for each section to compute the percentage of the points scored in each section. These section score percentages are then multiplied by a factor of ten to convert the percentages from a scale of zero to 100 percent to a scale of zero to ten. This is done to keep the scales of all the bar charts the same, providing for easier direct comparisons with the overall program scores which are already constrained to the scale of zero to ten. The equations are as follows:

$$SECTION_{MAX} - SECTION_{MIN} = SECTION_{TPP}$$

$$SECTION_{SCORE} - SECTION_{MIN} = SECTION_{SCORE\ NORMALIZED}$$

$$(SECTION_{SCORE\ NORMALIZED}/SECTION_{TPP}) = SECTION_{PERCENTAGE\ SCORE}$$

$$SECTION_{PERCENTAGE\ SCORE} * 10.0 = SECTION_{SCORE\ SCALED\ FROM\ 0\ TO\ 10}$$

where

$SECTION_{MAX}$ is the maximum number of points possible for the section

$SECTION_{MIN}$ is the minimum number of points possible for the section

$SECTION_{TPP}$ is the total points possible for the section

$SECTION_{SCORE\ NORMALIZED}$ is the total points scored for the section normalized to zero

$SECTION_{PERCENTAGE\ SCORE}$ is the percentage of the points scored for the section

$SECTION_{SCORE\ SCALED\ FROM\ 0\ TO\ 10}$ is the percentage score for the section converted to a scale of zero to ten

For graphing purposes and making direct comparisons with the overall program score, the QMM percentage score is divided by a factor of ten to constrain it to a scale of zero to ten. Thus, the summary data tables and bar charts, in Chapter IV and Appendix E respectively, report the QMM percentage scores on a scale of zero to ten with a score of zero corresponding to a QMM percentage score of zero percent and a score of ten corresponding to a QMM percentage score of 100 percent.

The graphs created are bar charts displaying the values of all the surveyed programs for the following data sets:

- Program manager's (PM) overall program score and PM QMM percentage score
- Individual development team member's (IND) overall program score and IND QMM percentage score
- PM overall program success score, PM QMM percentage score, IND overall program success score, and IND QMM percentage score

- PM and IND overall program success scores
- PM and IND QMM percentage scores
- PM and IND requirements management scores
- PM and IND estimation/planning scores
- PM and IND people management scores
- PM and IND risk management scores

The data analysis includes computation of the mean, minimum value, maximum value, standard deviation, and variance for the following data sets:

- PM overall program scores of all the programs
- PM QMM percentage scores of all the programs
- PM requirements management scores of all the programs
- PM estimation/planning management scores of all the programs
- PM people management scores of all the programs
- PM risk management scores of all the programs
- IND overall program scores of all the programs
- IND QMM percentage scores of all the programs
- IND requirements management scores of all the programs
- IND estimation/planning management scores of all the programs
- IND people management scores of all the programs
- IND risk management scores of all the programs

The data analysis also computes the correlation between the following data sets:

- PM overall program scores and PM QMM percentage scores
- PM overall program scores and PM requirements management scores
- PM overall program scores and PM estimation/planning management
- PM overall program scores and PM people management scores
- PM overall program scores and PM risk management scores
- PM QMM percentage scores and PM requirements management scores
- PM QMM percentage scores and PM estimation/planning management
- PM QMM percentage scores and PM people management scores
- PM QMM percentage scores and PM risk management scores
- PM requirements management and PM estimation/planning management
- PM requirements management and PM people management scores
- PM requirements management and PM risk management scores
- PM estimation/planning management and PM people management scores
- PM estimation/planning management and PM risk management scores

- PM people management and PM risk management scores

- IND overall program scores and IND QMM percentage scores
- IND overall program scores and IND requirements management scores
- IND overall program scores and IND estimation/planning management
- IND overall program scores and IND people management scores
- IND overall program scores and IND risk management scores
- IND QMM percentage scores and IND requirements management scores
- IND QMM percentage scores and IND estimation/planning management
- IND QMM percentage scores and IND people management scores
- IND QMM percentage scores and IND risk management scores
- IND requirements management and IND estimation/planning management
- IND requirements management and IND people management scores
- IND requirements management and IND risk management scores
- IND estimation/planning management and IND people management scores
- IND estimation/planning management and IND risk management scores
- IND people management and IND risk management scores

- PM overall program scores and IND overall program scores
- PM QMM percentage scores and IND QMM percentage scores
- PM requirements management scores and IND requirements management scores
- PM estimation/planning management scores and IND estimation/planning management scores
- PM people management scores and IND people management scores
- PM risk management scores and IND risk management scores

IV. RESULTS AND ANALYSIS

A. RESEARCH BACKGROUND

In order to encourage complete and open participation in the QMM survey, the interviewees are assured at the beginning of the survey process that the results of the surveys will be reported anonymously. To this end, the program data reported here is reported as program A, B, C, etc., and the letters associated with the individual programs do not reflect the order in which the programs were surveyed. Appendix B contains the responses to the survey for all of the participants.

The ten programs surveyed range in size from a minimum of three software developers to a maximum of twenty-five software developers; see Figure 3. The time frame of the programs surveyed range from 1992 to present day, with most of them within the last two years; see Figure 4. All of the programs are DoD software development efforts.

The minimum amount of time required to complete the survey instrument in a personal interview is an hour. The average time required to complete the survey instrument is two hours, and the longest time required is four hours.

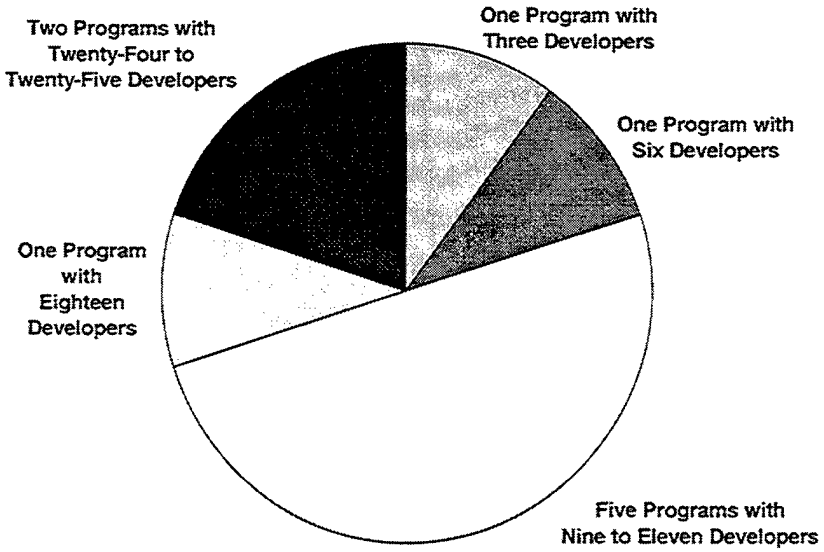


Figure 3. Size of Programs Surveyed.

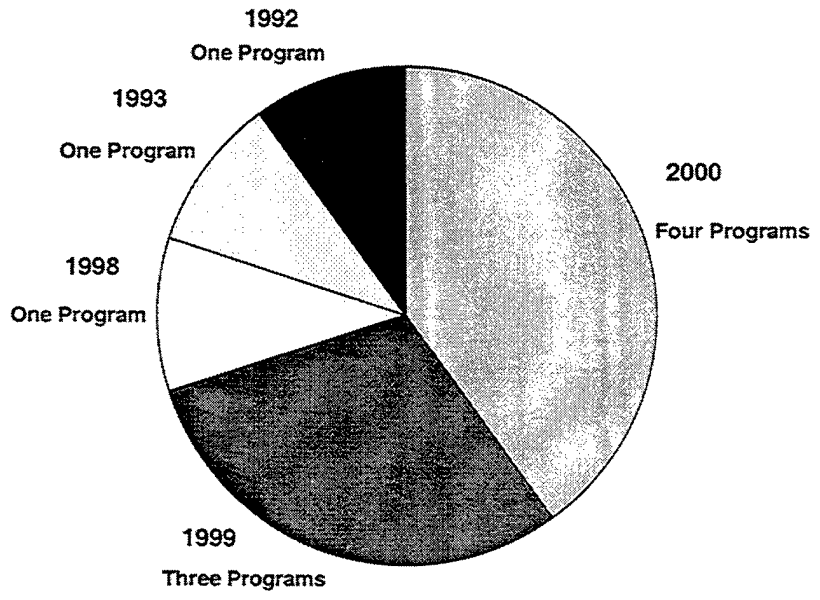


Figure 4. Time Frame of Programs Surveyed.

B. GRAPH ANALYSIS

To allow comparison between the different data types, a standard scale of zero to ten was chosen with the minimum, zero, corresponding to complete and utter program failure and zero percent of the total points possible for the QMM percentage score and the QMM section scores. The maximum possible score is ten which corresponds to complete program success and 100 percent of the total points possible for the QMM percentage score and the QMM sections.

The QMM survey data is shown as bar charts in Appendix C, Figures C1 – C9.

The bar charts are examined to determine if there are any obvious trends. The possibility of the program managers consistently rating the success of the program higher than the corresponding QMM percentage score is not found in the graphs, although it was expected. One instance of the program manager rating the program overall far higher than the QMM percentage score and the individual development team member overall program score and QMM percentage score is shown in program A; see Figure C3. A possible explanation for this is self-enhancement bias on the part of the program manager.

An exciting result of the research is seen in the data for program F; see Figure C3. Program F does not utilize many of the currently accepted software engineering management processes and procedures such as formal risk management. The program is ranked as highly successful by the software developers and the customers with an overall program success score of 9.0, yet the QMM percentage score consistently ranks the program as a 5.4. The exciting part of the discovery is that it appears the QMM survey

instrument does measure the implementation and the successfulness of the implementation of currently accepted software engineering management practices as defined by Martin Machniak [Ref. 7].

In programs C, I, and J, the program manager's QMM percentage score is consistently higher than the program manager's overall program success score and the scores of the individual development team member in the areas of overall program success score and QMM percentage score; see Figure C3. A possible explanation for this discrepancy is that the program manager believes he or she is implementing and using more of the software engineering management practices than are actually being implemented at the development-team level. If this is the case, then the QMM survey scores could be used to assist the program manager in identifying differences in perception between themselves and the rest of the development team, and take steps to improve the communication within the development team. Better communication could assist the program manager to better guide the program development team's efforts and receive feedback on the processes and procedures which the program manager implements to enable the team to improve them.

C. DATA ANALYSIS

A summary of the program manager and independent development team member data for all the programs surveyed is presented in Table 3 and Table 4. In the tables, the QMM percentage score, requirements management, estimation/planning management, people management, and risk management scores are all normalized to a scale of zero to ten. A score of zero corresponds to zero percent or zero percent of the points possible for

the section. A score of ten corresponds to 100 percent or 100 percent of the points possible for the section.

The correlations of the various data sets presented in the following tables are computed using the coefficient of correlation, ρ, where $-1 \leq \rho \leq 1$. A value of $\rho = -1$ implies a perfect straight line relationship between the correlated data sets with a negative slope. A value of $\rho = 1$ implies a perfect straight line relationship between the correlated data sets with a positive slope. A value of $\rho = 0$ implies no linear relationship between the correlated data sets.

The data analysis for the program manager data is presented in Table 5. From this data it can be seen that there exists a relatively high divergence of 2.09 in the overall program scores for the various programs. This is expected as the programs all have different management, requirements, and work forces, and are constrained by different budgets and schedules.

Program	PM Program Score	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
A	9.9	6.8	5.2	6.2	8.6	4.0
B	7.5	8.9	8.6	9.3	8.8	9.5
C	8	8.1	8.8	7.5	8.8	5.1
D	7	7.0	7.2	5.0	7.9	5.9
E	4	5.2	5.2	4.5	6.1	2.6
F	9	5.4	5.5	3.7	7.3	0.7
G	7	6.8	6.0	6.6	7.8	4.9
H	6	7.7	7.1	7.5	7.8	8.3
I	3	4.8	4.8	3.8	6.3	0.9
J	7	8.2	8.6	6.9	8.4	8.1

Table 3. Program Manager Summary Data.

Program	IND Program Score	IND QMM Score	IND Req. Man.	IND Est. / Planning	IND People Man.	IND Risk Man.
A	7	5.7	6.2	5.1	5.6	5.1
B	8	8.7	8.6	9.0	8.5	9.0
C	5	6.4	8.2	4.0	7.8	1.7
D	7	5.2	8.1	3.8	4.1	5.6
D	7.5	7.7	8.0	9.3	6.5	8.9
E	6	6.5	6.6	6.8	6.6	5.2
F	9	5.4	7.0	3.5	5.8	3.3
G	8	7.0	6.7	6.7	8.1	4.3
H	6.5	7.7	6.9	7.5	7.9	8.4
I	3	2.6	3.2	2.2	2.5	1.1
J	7	6.3	7.7	7.2	5.7	4.3

Table 4. Individual Development Team Member Summary Data.

	PM Program Score	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
Mean	6.84	6.91	6.70	6.11	7.77	4.99
High	9.90	8.93	8.77	9.34	8.81	9.46
Low	3.00	4.84	4.77	3.65	6.06	0.72
Standard Deviation	2.09	1.38	1.57	1.85	0.98	3.04
Variance	4.38	1.90	2.48	3.41	0.96	9.23

Table 5. Program Manager Data Analysis.

The standard deviation of the program managers in the area of people management is a relatively low value of 0.98 with a corresponding mean of 7.77. This indicates that the program managers believe they are good people managers or at least believe they are implementing many of the people management policies and procedures

the QMM survey instrument measures. This is further supported by the strong correlation between the program manager overall program score and the people management score of 0.771 in Table 6.

The program manager estimation/planning management and risk management sections have high standard deviations of 1.85 and 3.04, shown in Table 5, along with a strong correlation of 0.886 for these two sections, shown in Table 6. These management areas involve a great deal of uncertainty. The data indicates that program managers who do well managing the uncertainty in one area generally do well managing the uncertainty in the other area as well.

	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
PM Program	0.44694	0.27539	0.31676	0.77114	0.19311
PM QMM Score		0.89919	0.93389	0.88371	0.92171
PM Req. Man.			0.7612	0.73	0.80035
PM Est. / Planning				0.77171	0.88561
PM People					0.67601

Table 6. Program Manager Data Correlation.

In Table 6, the areas of requirements management and risk management show the weakest correlation with the overall program score with correlations of 0.275 and 0.193. This indicates the implementation of the requirements management and risk management

practices do not play a big role in the subjective evaluation of the program manager on the success of the overall program.

The program manager data correlations of the four QMM sections—requirements management, estimation/planning management, people management, and risk management—are strongly correlated with the program manager QMM percentage score. This is expected since the QMM percentage score is comprised of the four section scores. However, the strengths of the correlations are surprising. The strongest correlation is expected to be the correlation with the people management section as this section has the highest Importance Coefficient (IC) of 1.86. Yet, the people management section has the weakest correleation of the four sections with a correlation of 0.884 and the sections with the lowest IC values—estimation/planning management and risk management—have the strongest correlations of 0.933 and 0.922; see Table 6. These results indicate that the QMM percentage scores for the program managers are driven more by the scores in the estimation/planning management and risk management sections. This is not surprising given the fact that the program-manager standard deviation for the people-management section is low with a value of 0.98, and the mean for the section is relatively high with a value of 7.77. The people management scores for the various program managers are relatively constant. Therefore the factors which vary the most and distinguish the QMM percentage scores for the various program managers are the scores for the areas with the highest standard deviation, that is, the estimation/planning management and risk management sections.

In general, the correlation analysis for the program manager data indicates that, except for the subjective overall program success score, all the variables have a strong correlation.

Table 7 presents the results of the analysis of the data gathered from surveying the individual development team members. The standard deviation for the people management section is higher, 1.84, than the program manager standard deviation for the same section, 0.98. The mean for the individual development team member data is 6.27 versus 7.77 for the program manager data. This indicates the individual development team members either do not think the program managers are as good at managing people as the program managers think they are or the individual development team members do not see or do not understand the people-management procedures and practices the program managers believe they have implemented on the program.

	IND Program Score	IND QMM Score	IND Req. Man.	IND Est. / Planning	IND People Man.	IND Risk Man.
Mean	6.73	6.29	7.02	5.92	6.27	5.18
High	9.00	8.71	8.65	9.34	8.50	9.04
Low	3.00	2.57	3.16	2.22	2.50	1.14
Standard Deviation	1.63	1.64	1.49	2.35	1.84	2.70
Variance	2.67	2.68	2.23	5.51	3.37	7.30

Table 7. Individual Development Team Member Data Analysis.

The high standard deviations for estimation/planning management and risk management in Table 7 mirror the results for the program manager data analysis.

Perhaps this is due to these sections having more uncertainty involved in the management of them.

The individual development team member data correlations; see Table 8, between the four QMM sections and the QMM percentage score, are all strong. However, the strongest correlation between the people management section and the QMM percentage score of 0.902, is expected based upon the IC coefficients for the four sections. What is unexpected is the requirements management section has a weaker correlation than either the estimation/planning management or risk management section.

The strong correlation between the estimation/planning management and risk management sections of 0.840 in Table 8 indicates that the program managers who are good at managing the uncertainty in one area are also good at managing the uncertainty in the other area.

	IND QMM Score	IND Req. Man.	IND Est. / Planning	IND People Man.	IND Risk Man.
IND Program	0.58913	0.62901	0.46586	0.46559	0.50638
IND QMM Score		0.76616	0.87752	0.90201	0.78029
IND Req. Man.			0.53456	0.62857	0.5262
IND Est. / Planning				0.66453	0.84014
IND People					0.48039

Table 8. Individual Development Team Member Data Correlation.

Table 9 presents the results of data correlations between the program manager data and the individual development team member data. The correlation of the QMM percentage scores for the program manager and the individual development team members is a strong 0.693.

The correlation between the requirements management and risk management sections in Table 9 are strong: 0.769 and 0.686, respectively. This indicates that perhaps these two areas are the easiest to gain insight into for non-program managers on the practices and procedures implemented by the program manager. The lowest correlation is the people-management section.

	PM Program	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
IND Program	0.66484					
IND QMM Score		0.69338				
IND Req. Man.			0.76933			
IND Est. / Planning				0.53958		
IND People					0.47345	
IND Risk Man.						0.68632

Table 9. Program Manager and Individual Development Team Member Data Correlation.

The data analysis and data correlations are performed on the research data without the inclusion of program F as this program does not use many of the recommended software engineering management practices such as formal risk assessment and management. The results of the analysis are presented in Tables 10 – 14.

The exclusion of program F from the data set shows an increase in the strength of the correlation between the program manager's overall program score and the QMM percentage score from 0.447 to 0.673 as shown in Table 11. The data for the program managers continues to show a very strong correlation between the overall program score and the people-management section. The high standard deviations for the estimation/planning management and risk management sections along with the strong correlation between these two sections also continues to be present; see Table 10 and Table 11. The program manager data continues to show strong correlations between all the variables as was seen in the previous data set; see Table 11.

	PM Program Score	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
Mean	6.60	7.07	6.82	6.38	7.82	5.46
High	9.90	8.93	8.77	9.34	8.81	9.46
Low	3.00	4.84	4.77	3.77	6.06	0.90
Standard Deviation	2.07	1.36	1.61	1.73	1.03	2.80
Variance	4.28	1.84	2.61	3.00	1.06	7.85

Table 10. Program Manager Data Analysis Without Program F.

	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
PM Program	0.67313	0.4089	0.59017	0.90318	0.45897
PM QMM Score		0.896	0.92606	0.89879	0.91413
PM Req. Man.			0.7506	0.72161	0.80154
PM Est. / Planning				0.79726	0.85182
PM People Man.					0.69386

Table 11. Program Manager Data Correlation Without Program F.

The data for the individual development team members shows the same trends as in the previous data with the following exceptions. The correlation between the overall program score and the QMM percentage score has increased from 0.589 to a strong 0.772; see Table 13.

	IND Program Score	IND QMM Score	IND Req. Man.	IND Est. / Planning	IND People Man.	IND Risk Man.
Mean	6.50	6.38	7.02	6.16	6.32	5.37
High	8.00	8.71	8.65	9.34	8.50	9.04
Low	3.00	2.57	3.16	2.22	2.50	1.14
Standard Deviation	1.53	1.70	1.57	2.33	1.93	2.77
Variance	2.33	2.88	2.48	5.42	3.71	7.66

Table 12. Individual Development Team Member Data Analysis Without Program F.

	IND QMM Score	IND Req. Man.	IND Est. / Planning	IND People Man.	IND Risk Man.
IND Program	0.77237	0.70766	0.74455	0.57594	0.71414
IND QMM Score		0.77983	0.88151	0.90408	0.77155
IND Req. Man.			0.56887	0.63158	0.54221
IND Est. / Planning				0.67545	0.83129
IND People Man.					0.47375

Table 13. Individual Development Team Member Data Correlation Without Program F.

	PM Program	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
IND Program	0.60305					
IND QMM Score		0.6853				
IND Req. Man.			0.79838			
IND Est. / Planning				0.46273		
IND People Man.					0.46642	
IND Risk Man.						0.67474

Table 14. Program Manager and Individual Development Team Member Data Correlation Without Program F.

Additionally, the correlation between the overall program score and the areas of requirements management, estimation/planning management, and risk management have increased significantly to 0.708, 0.745, and 0.714 respectively; see Table 13.

Since the program manager's overall program score for program A appears to be unusually high, 9.9, possibly due to enhancement bias, the data analysis and data correlations have been computed without the inclusion of the program A and program F data. These results are presented in Tables 15 – 19.

The program manager data continues to show the same trends as in the previous data analysis with the following exceptions. The overall program score now correlates very strongly with the four QMM sections; see Table 16. The overall program score

	PM Program Score	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
Mean	6.19	7.10	7.03	6.41	7.72	5.65
High	8.00	8.93	8.77	9.34	8.81	9.46
Low	3.00	4.84	4.77	3.77	6.06	0.90
Standard Deviation	1.77	1.45	1.59	1.85	1.05	2.94
Variance	3.14	2.10	2.53	3.42	1.10	8.62

Table 15. Program Manager Data Analysis Without Program A and F.

correlation with the QMM percentage score for the program manager has increased from 0.447 in the original data set to 0.673 in the data set without program F to the present value of 0.891; see Table 16. This indicates the QMM survey instrument produces very

good QMM percentage score results. Additionally, all variables for the program manager correlate very strongly with each other.

	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
PM Program	0.89117	0.86604	0.77184	0.9496	0.73599
PM QMM Score		0.9459	0.92601	0.9627	0.9214
PM Req. Man.			0.7953	0.94741	0.80174
PM Est. / Planning				0.84924	0.86074
PM People Man.					0.80317

Table 16. Program Manager Data Correlation Without Program A and F.

Program	IND Program Score	IND QMM Score	IND Req. Man.	IND Est. / Planning	IND People Man.	IND Risk Man.
Mean	6.38	6.49	7.04	6.16	6.49	5.54
High	8.00	8.71	8.65	9.34	8.50	9.04
Low	3.00	2.57	3.16	2.22	2.50	1.14
Standard Deviation	1.71	1.90	1.74	2.58	2.14	3.10
Variance	2.91	3.61	3.03	6.67	4.60	9.63

Table 17. Individual Development Team Member Data Analysis Without Program A and F.

	IND QMM Score	IND Req. Man.	IND Est. / Planning	IND People Man.	IND Risk Man.
IND Program	0.81724	0.74218	0.77223	0.62948	0.75576
IND QMM Score		0.78682	0.89428	0.90528	0.77863
IND Req. Man.			0.54853	0.65098	0.57526
IND Est. / Planning				0.70012	0.87436
IND People Man.					0.46391

Table 18. Individual Development Team Member Data Correlation Without Program A and F.

	PM Program	PM QMM Score	PM Req. Man.	PM Est. / Planning	PM People Man.	PM Risk Man.
IND Program	0.66555					
IND QMM Score		0.68488				
IND Req. Man.			0.80305			
IND Est. / Planning				0.46578		
IND People Man.					0.53434	
IND Risk Man.						0.6828

Table 19 Program Manager and Individual Development Team Member Data Correlation Without Program A and F.

The individual development team member data continues to show the same trends as in the previous data analysis with the following exceptions. The overall program score correlation with the QMM percentage score and the four QMM sections has increased in strength; see Table 18. The correlation of the overall program score with the QMM percentage score has increased from 0.589 in the original data set to 0.772 in the data set without program F data, to the present strong correlation value of 0.817; see Table 18. This indicates the QMM survey instrument is producing very good QMM percentage score results.

Although the data correlations within the program manager data set and the individual development team member data sets are very strong, the correlation between the two data sets as shown in Table 19 remains weaker. The strongest correlation is between the program manager and individual development team member data for requirements management. Requirements management is an area which by necessity must be managed on the program to understand and clarify the scope and goals of the program. This area is then perhaps more visible to the entire development team whereas the other management areas do not have the same level of visibility and insight throughout the development team.

V. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

A. CONCLUSIONS

The QMM survey instrument yields a strong correlation with the QMM percentage score and the overall program score for both the program manager and individual development team member data sets. This indicates the QMM survey instrument is a viable instrument for measuring the quality of management on a software-development program where the management policies and procedures are the same as or similar to the currently accepted software engineering management practices, as defined by Martin Machniak [Ref. 7]. In the case where the management practices and procedures are known to diverge from the currently accepted practices the QMM survey instrument may be used to measure the level to which the currently accepted practices are implemented but will yield a lower QMM percentage score and probably predict a lower success rate for the program than the actual rate.

The QMM survey instrument may be useful in detecting discrepancies between the program manager's and the individual team member's perspectives and understanding. When the program manager's QMM percentage score is consistently higher than their overall program score, the overall program success score and QMM percentage of the individual development team member, it may indicate the program manager believes he or she is implementing and successfully using more software engineering management practices on the program than are actually being implemented on the development team level.

The low standard deviation and high mean of the program managers in the area of people management indicates that the program managers believe they are good people managers. Further evidence of this is seen in the strong correlation of the program manager's overall program score and the people management score.

A higher standard deviation and lower mean in the area of people management from the individual development team member data than the program manager data indicates that the individual development team members do not believe the program managers are as good at managing people as the program managers themselves.

The estimation/planning management and risk management sections consistently have high standard deviations in both the program manager and individual development team member data and strong correlation between these two sections as well. This indicates that there exists a great deal of uncertainty in managing these areas and that program managers who are good at managing the uncertainty in one of these areas are usually good at managing the uncertainty in the other area as well.

The correlations between QMM percentage score and the four QMM section scores is strong for both the program manager data and the individual development team data in all three data analysis phases. However, the correlation between the program manager and the individual development team member data is much weaker except in the area of requirements management. This indicates that perhaps the area of requirements management is more visible and better understood by the entire team than other areas of management.

The QMM percentage scores have a strong correlation with the overall program scores for both the program manager and the individual development team member data. This is particularly true for the data set which excludes the program A and F data. In this data set the correlation for the program manager is 0.891 and the correlation for the individual development team member is 0.817. This strong correlation indicates the QMM survey instrument is producing very good QMM percentage score results.

B. RECOMMENDATIONS FOR FUTURE WORK

The recommendations for future work include updating and further testing of the QMM survey instrument, developing a mechanism to provide the program managers with feedback on their management performance and possible courses of action to take to improve their performance, and integrating the QMM survey instrument results into existing cost, schedule and risk models to improve program estimation accuracy.

Updating the QMM survey instrument questions includes updating the focus of the survey instrument, refining the question wording, and refining the question weighting. As advances and improvements are made in the area of software engineering management, the QMM survey instrument will need to be updated to reflect these advances and improvements. The wording of the questions should be further refined so the questions do not lead the interviewee in making their choice between two answers and so the clarity of the question intent is improved. Adjustment of the weighting of the questions within each QMM section and among the QMM sections is required to focus the QMM survey instrument on the areas which are the most important in determining and measuring the quality of management on a software-development program. Lastly,

reduce the total number of questions if it is determined that this is appropriate. Reducing the number of questions on the survey instrument includes examining tradeoffs related to the usefulness of the survey instrument versus the ease of executing the survey instrument if it is shorter in length.

The QMM survey instrument requires more testing to formally verify and validate it. Unfortunately, most programs do not keep historical data which can be used to formally validate the QMM survey instrument. Data appropriate for a more formal validation of the QMM survey instrument includes schedule, cost, budget, requirements management, manpower, risk management, people management, and estimation/planning management data throughout the lifetime of a program or at least during the time period when the program manager evaluated is in charge of the program. Formal verification and validation will require a long term commitment from the program and program manager to be evaluated. The researcher will need to collect the data at intervals to ensure the data is not lost as time passes. The QMM survey instrument should not be executed near the beginning of the data collection as it may induce a bias in the way the program manager manages. People concentrate their efforts in areas where they know they will be evaluated and giving the survey instrument to the program manager early in the program may alter their management style. This does not preclude gathering management quality data early in the data collection but a different survey instrument or technique should be employed which will not induce bias. One interviewee thanked the researcher for the opportunity to participate in the current QMM research as they found the QMM survey instrument questions to be a good reminder of all they should be doing

to manage the program. This sentiment was echoed by a number of interviewees as it reminded them of what they were not doing on the program.

Provide feedback from the QMM survey instrument to the evaluated program managers to assist them in improving their performance. An intent of the QMM survey instrument is to apply it to the program manager at the beginning of or at some point during the execution of the program, give them feedback on their performance in each area, and then apply it to the program manager later in the program execution, or the execution of another program they are managing, to measure the improvements in management quality and provide further feedback. The QMM survey instrument currently does not provide specific feedback guidance for the program managers. In fact, the QMM survey instrument measures the performance of the program manager at a high level and only provides feedback to the program manager to the level of their score in each of the four QMM sections: requirements management, estimation/planning management, people management, and risk management. There is currently no provision for providing more specific feedback to the program manager other than in the area of people management which is made up of four sub-sections: human resources, communication, leadership and technical competency. Research is required to evaluate the specific questions in each section and determine which course or courses of action should be recommended for the program manager to pursue to improve their performance in the area depending upon their responses to the individual questions. The feedback can be in the form of an automated program which analyzes the results. However, each manager is different and their personal style and program situation is different. A better way might be to implement an automated program to rank the quality of management in

specific areas and to suggest possible courses of action with the intent of providing the information to a management trainer or mentor who would then work with the program manager to improve their performance in those areas. In the case where the program manager does not have access to a mentor or management trainer, the responses of the automated program could be combined with a Myers-Briggs personality profile of the program manager to suggest possible courses of action for the program manager to pursue and sources of information to help the program manager understand the suggested courses of action and the implications of the actions.

The QMM survey instrument appears to detect differences in perception between the program manager and the development team on what practices and procedures the program manager believes are implemented and working and the actual state of understanding and implementation of the practices and procedures on the development team level. The program manager feedback mechanism described above could include detection of areas where the perceptions of the program manager and the development team differ greatly and the information could be used to alert the program manager and/or the program manager's management trainer or mentor to the problem. Knowledge of areas of potential misunderstandings enables the program manager to begin working on opening up the communication channels to better guide the development team's efforts and receive feedback on the processes and procedures which the program manager implements, enabling them to improve them.

The QMM survey instrument results could be used as an input into current program cost, risk, and schedule estimation models to improve the resultant estimations. Currently these models do not incorporate the quality of software-development

management as a factor other than to assume good management. As this assumption is not necessarily a good assumption, using the QMM results input for the models may increase the accuracy of the estimation results. Barry Boehm [Ref. 2] states the COCOMO model assumes good management for two reasons: the quality of management is difficult to measure, and providing a poor manager with more resources to complete a program than a good manager is bad management practice. Since the COCOMO model assumes good management and provides estimates for managers based upon this assumption, the model will estimate costs and schedules for good managers. This gives the poor managers the same guidelines as the good managers. It is human nature to live up to or down to expectations. If the model provides estimates based upon bad management, will this lower the expectations and goals of the manager and produce programs with lower success levels? It is an interesting question. For planning purposes, accurate estimates are necessary. However, what will the cost of accurate estimates be in the case of poor management, assuming accurate estimates are desired? The research involves implementing a QMM survey score as an input into the current program estimation models to provide "accurate" data on the quality of the program management, such as with a formal model of risk assessment in a software program; for example, see [Ref. 8].

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A. QUALITY MANAGEMENT METRIC SURVEY FORMS WITH SCORING

Quality Management Metric survey instrument forms template with scoring.

Pair choice section ONE: (Requirements Management) choose most applicable term of the two for each row (page 1 of 2):

1.	formal requirement list	2	informal requirement list	1
2.	written requirements	2	oral requirements	0
3.	requirements informal, but recorded	1	requirements not recorded	0
4.	requirements as part of an SRS (or other formal repository)	2	requirements informally recorded	1
5.	requirements taken as is from customer	0	look to reformulate, interview in-depth, or otherwise re-validate	2
6.	only one development strategy used	1	strategies not consistent, used at different times	0
7.	stakeholders as part of requirements development	2	stakeholders approving requirements after formulated by development team	1
8.	requirements are testable	2	requirements have no test plans	0
9.	informal test plan or no test plan	0	formal test plan	2
10.	test team involved with requirements	1	no test team input or plans during requirements development	0
11.	only a percentage of requirements present in baseline	0	baseline must contain all requirements	2
12.	requirements documentation has hierarchical structure	1	all requirements must be implemented	0
13.	requirements have listed responsible party	1	requirements origin not important	0
14.	requirements documentation have versions	2	no requirements history	0
15.	requirements have specific attribute values	1	requirements all rank evenly	0
16.	funding controls requirements definition	0	requirements definition controls funding	1
17.	requirements are top down	1	requirements are bottom up	2
18.	users/stakeholders are identified and interviewed (market survey)	1	no special consideration to identify users/stakeholders	0
19.	each requirement has a singular concept	3	some requirements are compound statements	0
20.	requirements definition minimized when funding short	0	program scope may reduce, but requirements definition completed	1
21.	requirements extraction has formal process	1	requirements extraction ad hoc	0
22.	change procedures formal	1	change procedures ad hoc	0
23.	users/stakeholders somehow involved in requirements definition	1	program team only involved in requirements definition	0
24.	management sets requirements for developers	0	developers at least partially involved in setting requirements	1
25.	requirements changed at least once since baseline established prior to new version	0	requirements in baseline has not changed prior to new version or upgrade	1
26.	no ranking of requirements	0	requirements have priorities assigned	1
27.	use-case diagrams (or other models or scenario developments)	2	no models used for requirements extraction	0
28.	requirements changes informal	0	requirements changes formal	1
29.	plan to "freeze" requirements as some designated milestone	1	no provision for "freezing" requirements	0
30.	requirements must be traceable	1	origin of requirements not important	0
31.	requirements must be testable	3	system developed must be testable	1
32.	test plans to determine requirements implemented	2	no test plans needed for requirements verification	0
33.	requirements have priorities in implementation	1	all requirements must be implemented	0
34.	some requirements have multiple statements or ideas	0	one idea, one statement per requirement	2

Requirements Management (page 1 of 2) score [ ]

Program Name Date

Pair choice section ONE: (Requirements Management) choose most applicable term of the two for each row (page 2 of 2):

ANSWER THIS BLOCK OF QUESTIONS ONLY IF A SEQUENTIAL OR WATERFALL APPROACH IS USED FOR DEVELOPMENT (Requirements page 2 of 2)				
35.	requirements first, then initial development work	1	initial development work then requirements	0
36.	requirements documentation driving development	1	requirements documentation developed in parallel/after development	0
37.	user feedback considered during development	1	after development starts, user feedback serves as input to new work	0
38.	change management procedures used strictly	1	change management procedures as guidance only	0
39.	design decisions prior to or in parallel to requirements development	0	design decisions only after approved requirements stabilized	1
40.	requirements summarized what we have developed	0	requirements are the blueprint for development	1
41.	length of time for requirements work greater than development work	2	length of time for requirements work less than development work	0
42.	requirements have design detail	0	no design detail in requirements	1
43.	requirements creep to be avoided	1	requirements creep o.k., but need to be controlled	0
44.	freeze requirements at some point	1	requirements are fluid throughout development	0
45.	formal change procedure	1	informal change procedure	0
46.	change management plan	2	no change management plan	0
47.	requirements ambiguity always present to some extent	0	requirements ambiguity unacceptable at any level	2
48.	testing considered up front during requirements determination	2	testing considered down the line during development	1
49.	requirements development team members different from implementation	0	those working on requirements, work on implementation	1
50.	start implementation as early as possible to help define requirements	0	requirements must be defined prior to any implementation work	2
ANSWER THIS BLOCK OF QUESTIONS ONLY IF A PROTOTYPING, THROWAWAY, SYNCHRONIZE & STABILIZE, OR OTHER STRATEGY USED				
35.	develop prototype, then determine requirements	1	determine requirements prior to any development work	0
36.	requirements testing done after each iteration	1	no testing	0
37.	individual changes as necessary	1	only block changes made	0
38.	development team decides on changes after iteration	0	users involved with changes	1
39.	changes based on feedback only from user for correction of problems	1	changes to upgrade system and correct problems	1
40.	funding controls changes and change procedures	1	changes control funding	1
41.	requirements documentation finalized prior to development	0	requirements fluid throughout development (only freeze at end)	2
42.	requirements test plans completed prior to development	1	requirements test plans completed after development	0
43.	requirements first, then initial development work	0	initial development work then requirements	1
44.	use development effort to learn more about requirements	2	define all requirements prior to coding anything	0
45.	requirements ambiguity always present to some extent	1	requirements ambiguity unacceptable at any level	0
46.	requirements have design detail	1	no design detail in requirements	1
47.	user feedback considered during development	1	after development starts, user feedback serves as input to new work	0
48.	get something to users as soon as possible for evaluation	2	make sure it is complete before releasing	0
49.	management dictates requirements	0	developm't team visually represent requirements through rapid prototyping	1
50.	new requirements allowed after initial requirements defined	1	new requirements not allowed	0

Requirements Management (pg 2 of 2) score [ ] **+ pg 1 score** [ ] **= TOTAL SCORE** [ ] **Enter on QMM scoresheet blk a.**

Program Name_____ Date_____

Pair choice section TWO: (Estimation/Planning Management) choose most applicable term of the two for each row (page 1 of 2):

1.	At least one estimation method used in program	1	No estimates	0
2.	Formal derivation of product metric for estimation of size	1	Ad hoc size estimation	0
3.	Ad hoc process evaluation	0	Formal derivation of at least one process metric	1
4.	Develop work breakdown structure (WBS)	1	Assign work as needs arise	0
5.	Estimates are developed to fulfill a data call only	0	Use estimates to plan program	1
6.	Use estimates to sell program only	0	Estimates are useful to the project team for planning purposes	1
7.	Resource evaluations made for program	1	No resource evaluation for planning	0
8.	Use both bottom up & top down for estimate, use one stakeholders like	0	Use both bottom up & top down and evaluate significant differences	1
9.	Estimates made and not updated	0	Estimates updated throughout program	1
10.	Resource estimations used to adjust product size estimate	1	Estimations made irregardless of resources available	0
11.	Estimations made to fit budget	0	Budget made from estimations	1
12.	Estimations compromised to get program	0	Rather risk loss of program than compromise confident estimations	1
13.	Cycle time estimations	1	No cycle time estimations	0
14.	Event count estimations	1	No event count estimations	0
15.	Lines of code (LOC) estimation	1	No LOC estimation	0
16.	Function Point (FP) estimation	1	No FP estimation	0
17.	Estimates by algorithmic methods	1	Estimates by analogy	1
18.	Expert judgement for estimation	1	ad hoc estimates	0
19.	Estimates by algorithmic methods	1	ad hoc estimates	0
20.	Expert judgement for estimates	0	Estimates by analogy	1
21.	ad hoc estimates	0	Estimates by analogy	1
22.	Bottom up estimates	1	Expert judgement	0
23.	Top down estimates	1	Expert judgement	0
24.	Ad hoc estimates	0	Any other estimate process	1
25.	Fuzzy logic estimating method	1	No formal estimation methodology	0
26.	WBS development from estimates	1	WBS development in parallel or prior to estimation completion	0
27.	Critical path of program determined	1	Tasks developed but no path is identified	0
28.	Estimators are program team members	1	Estimators are outside program team	0
29.	Management only on estimations	0	All team members involved in estimation process	1
30.	Estimates updated at reviews	1	No updates of estimates	0
31.	Estimates updated at reviews	0	Estimates constantly updates (in between reviews, too)	1
32.	Estimate procedures stay the same	1	Estimate procedures change	0
33.	stakeholders are part of estimation process	1	stakeholders briefed on estimations after completion	0
34.	Estimates are used beyond initial selling of program	1	Estimates are one time events, used for a specific purpose once	0
35.	WBS has objective measure of completeness	1	Important to have WBS as guide, not rigid implementation	0

Estimation/Planning Management page 1 of 2 score ☐

Program Name_____ Date_____

Pair choice section TWO: (Estimation/Planning Management) choose most applicable term of the two for each row (page 2 of 2):

36.	Life cycle estimates	1	Estimates for program initiation only	0
37.	System upgrades (SCR) software change requests estimated individually	1	Systems upgrades estimated as whole	0
38.	Estimates for on-going resources needed to maintain s/w	1	Estimates for maintenance not done	0
39.	Informal re-estimates during development	0	Formal re-estimates at pre-defined milestones	1
40.	Formal re-estimates when amendment changing the system is introduced	1	Informal re-estimates when amendment changing the system	0
41.	person in-charge of estimation walks in a managers office to get an opinion	0	Meeting(s) organized for purpose of performing cost estimations	1
42.	Factor analysis prior to commencement of program	1	None done	0
43.	Change control procedures set in place	1	No set procedures	0
44.	Elapsed time and actual work time estimates	1	one or the other or neither	0
45.	No schedule created	0	Schedule created	1
46.	Schedule not updated	0	Schedule updated	1
47.	Schedule followed	1	Schedule not followed	0
48.	Tasks identification arises as program progresses	0	Detailed level tasks identified prior to program initiation	1
49.	Scope of program understood by all	1	Scope not explicitly defined	0
50.	Quality factors and criteria identified	1	No explicit quality factors defined	0
51.	No project tracking tools used	0	Project tracking tools used	1
52.	CSCIs identified and tasked	1	CSCIs not explicitly identified	0
53.	Expectations are managed via estimations	1	Estimations are made to fit preconceived expectations	0
54.	No cost schedule developed	0	Cost schedule developed	1
55.	No resource schedule developed	0	Resource schedule developed	1
56.	Team members, management know at any time if in budget & schedule	1	Exact budget & schedule status somewhat unclear to at least some	0
57.	Individual program phases are estimated	1	Only top level program estimated	0
58.	Stakeholders/users emphasis understood- quick to field or all complete	1	Program management sets delivery tradeoffs without outside input	0
59.	Testing planned with initial program planning	1	Testing not in initial planning	0
60.	Documentation not considered in initial planning	0	Documentation part of initial planning	1
61.	Hardware considered in estimations	1	Software only considered	0
62.	No formal schedule/cost tracking	0	Formal procedures established for tracking cost and schedule	1
63.	Earned value set up	1	Earned value not used	0
64.	Estimations omit documentation planning	0	Documentation in estimates	1
65.	Training omitted in estimates	0	Training part of estimates	1
66.	Earned value set up, but not tracked	0	Earned value set up and tracked	1
67.	Detailed planning done with incomplete set of requirements	0	Detailed planning done with detailed set of requirements	1
68.	Complete infrastructure support mechanism understood for estimations	1	No consideration of infrastructure done for estimations	0
69.	Team possibilities considered for planning of program	1	No consideration for outside teaming possibilities	0
70.	Work Breakdown Structure (WBS) set up	1	No WBS completed	0

Estimation/Planning Management pg 2 of 2 score [ ] **+ pg 1 of 2 score** [ ] **= TOTAL SCORE** [ ] **Enter QMM scoresheet blk b.**

Program Name_____ Date_____

Pair choice section THREE: (People Management) choose most applicable term of the two for each row (page 1 of 2):

Human Resources

1.	Program team members have clearly defined, segmented roles	0	Work responsibilities are shared	1
2.	formal team building procedures are used	1	no formal team building emphasized	0
3.	program manager flexible regarding work hours	1	program manager maintains strict standards for work hours	0
4.	Big picture conveyed to all team members by program management	1	Program management focuses on the partitioned tasks with team	0
5.	People issues dealt with primarily through indirect methods (email, memo, etc)	0	People issues dealt with primarily through direct methods (face-to-face)	1
6.	training is required and planned on a regular basis	1	training is ad hoc	0
7.	each team member is educated on and understands overall program and their roles	1	team members only know their respective areas	0
8.	consideration for team members' career goals are reflected in assignments	1	team members must adapt to tasks that are assigned	0
9.	team members assignments and responsibilities are mostly dictated by PM	0	assignments and responsibilities are discussed and agreed upon with PM	1
10.	management leads in problem solving	0	management facilitates and lets team lead in problem solving	1
11.	management welcomes problems as challenges and opportunities	1	management views problems as obstacles and grounds for punishment	0
12.	team members participate in performance evaluations of peers	1	personnel evaluations are strictly PM responsibility	0
13.	management reinforcement feedback sparse and inconsistent, if any	0	management provides timely reinforcement feedback for positive behaviors	1
14.	management provides basic needs of office facilities fairly well	1	office facilities are a drawback to working in the program	0
15.	working conditions are fairly comfortable, time off policy "flexible"	1	working conditions and time off policy is inconsistent and difficult at times	0

Communication:

16.	communications primarily written (email, memo, etc.)	1	communications primarily verbal (face-to-face)	1
17.	detailed instructions: oral presentation, follow-up email	1	email or memo only	0
18.	formal communication protocol	1	informal communications	0
19.	external vertical communications restricted	0	external vertical communication allowed	1
20.	coders notebook, weekly accomplishment reports required	1	not required	0
21.	user-coder relationship established, encouraged, and mediated	1	user-coder interaction minimized	0
22.	meetings structured to minimize wasted time	1	meetings unstructured and open ended	0
23.	meetings have agenda, objectives, and conclude with action items	1	meeting agenda fluid and open ended	0
24.	program management and coder communication face to face	1	program management and coder communication primarily email	0
25.	program team updated regularly regarding organizational & program status	1	meetings infrequently scheduled	0
26.	open communications is encouraged	1	communication through chain of command only is encouraged	0
27.	program manager accessible for discussions	1	program manager difficult to get an appointment to see	0
28.	Program management (PM) is viewed as separate from team	0	PM mixes with team frequently	1
29.	management regularly holds team meetings	1	meetings are sporadic	0
30.	meetings are structured with definite goals and objectives	1	meetings are informal	0
31.	Program management is generally easy to reach and talk to	1	PM is usually hard to get a hold of and difficult to talk to	0
32.	team-program manager relationship adult-adult	1	team-program management relationship parent-child	0
33.	schedules are spontaneous and poorly communicated	0	schedules must be fixed and rigidly followed and formally reported	1
34.	work is seen as complex processes involving team working together	1	work broken into pieces with minimal team member interaction	0
35.	action items sometimes are not followed through	0	action items communicated and followed through thoroughly	1
36.	team members require frequent clarifications by PM for assigned tasks	0	team members rarely require clarifications by PM for assigned tasks	1

Program Name _____ Date _____

Pair choice section THREE: (People Management) choose most applicable term of the two for each row (page 2 of 2):

Leadership:

37.	Long range organizational vision	1	Short term program and immediate work focus	0
38.	Lead through personal attention to others	1	Action-oriented leadership approach	1
39.	Run as much of the organization as possible	0	Let team make decisions as much as possible	1
40.	Direct and domineering style	0	Encourage independence in others	1
41.	Traditional leaders respect hierarchy	0	Do what needs to be done	1
42.	Win cooperation rather than demand it	1	Tough-minded with others	0
43.	Act strongly and forcefully in the field of ideas	0	Prefer to lead other independent types while seeking autonomy for self	1
44.	Consults with team members to find solutions to problems	1	Consults team members to get validation of PM's predetermined solutions	0
45.	Keep people well informed	1	Only as much knowledge as necessary for their work	0
46.	Make things happen by focusing on the immediate problems	1	Long range focus and de-emphasize current problems	1
47.	Manage others loosely and prefer minimal supervision	1	Follow traditional procedures and rules conscientiously	0
48.	Leadership, management decisions exclusively by program management	0	Program management makes decisions but gets inputs from team	1
49.	team-program manager relationship adult-adult	1	team-program management relationship parent-child	0
50.	Program management makes decisions but gets inputs from team	0	All program team members responsible for program decisions	1
51.	When a problem arises: management takes over to solve it	0	management lets the team solve the problems	1
52.	Leadership is do as I say, not do as I do	0	Leadership by example	1
53.	Program expectation not influenced by PM	0	Program expectation managed by PM	1
54.	PM gives freedom to team, but does has no mentoring for members	0	PM empowers teams by mentoring members to be leaders	1
55.	Program management waits and sees what happens then plans	0	management plans far in advance	1
56.	Program management reacts to emergencies	0	management is one step ahead of problems	1
57.	Slow to decide on action	1	Take charge readily and often when required	0
58.	Program management is complex, takes much time to understand	0	management is simple, easy to figure out	1
59.	Program management prefers to plunge right in	0	takes time to separate things to be done and order of doing them	1
60.	Program management reacts to needs of the moment	0	methodically follows plans	1

Technical Competency of the program manager:

61.	PM has technical experience particular to the particular s/w program	1	PM relies on team members solely	0
62.	PM participates in technical reviews	1	PM only in non-technical reviews	0
63.	PM participates in making technical decisions when problems arise	1	PM delegates technical questions	0
64.	PM does not get involved discussing technical options	0	PM contributes to technical options being discussed	1
65.	PM does not review technical options and decisions	0	PM reviews technical options and decisions	1
66.	PM actively attempts to keep up-to-date with current technology and standards	1	PM is removed from cutting edge technology issues	0
67.	PM receives technical periodicals and occasionally references applicable articles	1	PM doesn't read periodicals nor references current articles to team	0
68.	PM doesn't have technical background (or education)	0	PM has technical background (or education)	1
69.	Team members avoid PM when they need technical advice	0	Team members generally consider talking to PM regarding technical issues	1

HR [ ] **+ Comm.** [ ] **+ Leadership** [ ] **+ Tech. Competency** [ ] **= People Mgmt. score** [ ] **Enter on blk c.**

Program Name_____ Date_____

Pair choice section Four: (Risk Management (RM)) choose most applicable term of the two for each row (page 1 of 2):

1.	RM is formal and documented	1	RM is informal, if at all	0
2.	A risk management plan exists	1	no risk management plan is developed	0
3.	RM is more of a data call than a useful document	0	RM drives decisions on the program	1
4.	RM is done prior to the program beginning	0	RM is done prior and during program execution	1
5.	RM is only done during the program execution	0	RM is done prior and during program execution	1
6.	risks are generalized through the whole program	0	risks are categorized	1
7.	risk management is done internally, only	0	an outside organization also contributes to the RM process	1
8.	risk is a management function	0	risk is a program team function	1
9.	risk are precisely articulated	1	risks are generalized, if at all	0
10.	each risk has a consequence	1	consequences are generalized, if at all	0
11.	a mitigation strategy is completed for each risk	1	mitigation strategy is generalized, if at all	0
12.	contingency plans are developed for a RM plan	1	contingency plans are ad hoc as problems arise in the program	0
13.	risks are anticipated	1	if problems arise, management will deal with it	0
14.	the program doesn't have any risk	0	programs that do not have risk, have problems	1
15.	risk management is automated	0	risk management may use tools, but depend on human input	1
16.	risks are assigned probabilities	1	probabilities are not relevant for RM	0
17.	all risks are potential problems, relative priorities for risks are not useful	0	risks are weighed relative to other program risks and thus prioritized	1
18.	risk management information is only shared internally	0	risk management information is shared with all stakeholders	1
19.	risk analysis uses ordinal rankings	0	risk analysis uses actual measurements with a mathematical model	1
20.	regret analysis used	1	no regret analysis done	0
21.	attach probabilities to future events	1	no probabilities associated with future events	0
22.	assessing risks with mechanical methods (simple spreadsheets, etc.)	0	risks compared to other risks and sorted	1
23.	risk status tracked	1	not tracked	0
24.	technical risks examined	1	no technical risks examined	0
25.	process risks examined	1	no process risks examined	0
26.	product risks examined	1	no product risks examined	0
27.	stakeholder/user risks examined	1	no examination of stakeholder/user risks	0
28.	checklists used to identify risks	1	no checklists used	0
29.	risks are tracked	1	no tracking or monitoring of risks	0
30.	each risk has an impact	1	no impact analysis of risk	0
31.	each risk has a mitigation plan	1	no individual risk mitigation	0
32.	risks monitored by priority	1	no special attention to track higher priority risks	0
33.	risk assessment is formalized	1	no formal risk assessment	0
34.	risk control is formalized	1	no formal risk control	0
35.	integration risks not considered	0	integration risks examined	1

Risk Management page 1 of 2 score [ ]

Program Name

Date

Pair choice section Four: (Risk Management (RM)) choose most applicable term of the two for each row (page 2 of 2):

36.	risks to cost	1	no cost risks examined	0
37.	unforeseen risks have occurred in program	0	any risk that came up had been identified previously	1
38.	personnel risks examined	1	no personnel risks examined	0
39.	estimation risks examined	1	no estimation risks examined	0
40.	planning risks examined	1	no planning risks examined	0
41.	requirements risks examined	1	no requirements risks examined	0
42.	resource risks examined	1	no resource risks examined	0
43.	risk management plan updated regularly	1	no regular risk management plan updates	0
44.	risks charted	1	risks not charted	0
45.	performance risks examined	1	performance risks not examined	0
46.	program management self risks examined	1	no program management risks examined	0
47.	risk from program constraints examined	1	no program constraint risks examined	0
48.	each category of risks are prioritized	1	no prioritization	0
49.	each category of risks are evaluated for impact	1	no impact analysis performed	0
50.	each category of risks have control strategy	1	no control strategy	0
51.	documentation risks examined	1	no documentation risks examined	0
52.	regret matrix tracked	1	no regret matrix or not tracked	0
53.	communication of risk activities are facilitated	1	no facilitation or promotion of communication of risk activities	0
54.	taxonomy-based questionnaire used to identify risks	1	taxonomy-based questionnaire not used	0
55.	associated hardware risks examined	1	no consideration for hardware risks	0
56.	integration risks examined	1	integration risks not examined	0
57.	communication risks examined	1	communication risks not examined	0
58.	leadership risks examined	1	leadership risks not considered	0
59.	risk avoidance considered for certain risks	1	risk avoidance not considered for risks	0
60.	risk documentation forms used	1	no risk documentation forms used	0
61.	dependency risks examined	1	no dependency risks examined	0
62.	alternatives like risk avoidance considered for high risk items	1	no consideration of risk avoidance	0
63.	documented risk statements use a condition-consequence type format	1	condition-consequence of risk statements not clearly defined	0
64.	no assignment of ownership of risk mitigation action	0	each risk mitigation action is assigned to an individual for resolution	1
65.	calculation of risk exposure made (probability X loss, for each risk)	1	no risk exposure calculations	0
66.	oral communication of risks only	0	risks written in a way that communicates nature and status of factors	1
67.	triggers used to quantify risk conditions present	1	risk conditions present are all subjective	0
68.	risk "czar" in program for monitoring risks	1	no special positions/responsibilities for risk monitoring	0
69.	post-program review completed (scheduled) for unanticipated problems ID	1	no post-program reviews completed or scheduled	0
70.	no schedule risks examined	0	risks to schedule investigated	1

Risk Management pg 2 of 2 score [ ] **+ pg 1 of 2 score** [ ] **= TOTAL SCORE** [ ] **Enter on QMM scoresheet blk d.**

Program Name_____ Date_____

Program Name_____ **YES-NO-N/A Questionnaire Scoring Template** Date_____

No.	Requirements Management Questionnaire	Yes	No	N/A
1	PM chose to have a formal requirements list	1	0	0
2	Requirements recorded in some way	2	-1	0
3	Written requirements were part of some formal document	1	0	0
4	Written requirements were informal	1	2	0
5	At least some requirements were oral only	-2	1	0
6	All stakeholders were identified	2	-1	0
7	All stakeholders participated in the requirements extraction	2	0	0
8	Some stakeholders participated in the requirements extraction	1	0	0
9	Management extracted requirements, no stakeholder involvement	1	2	1
10	Management passed requirements to development team	1	0	0
11	Stakeholders not involved in Management extraction, but approves	-1	0	0
12	Management gets inputs from stakeholders, then develops requirments	1	0	1
13	Developers work informally with users to arrive at requirements	1	0	0
14	Same as 13, but management oversees and formalizes	2	0	0
	If a waterfall or sequential development strategy:			
15	All requirements complete before design	1	-3	0
16	Some requirements left incomplete prior to design	-1	0	0
17	Requirements informal prior to design effort	-1	0	0
18	Requirements serve as input	1	-1	0
19	Length of time for requirements work greater than development work	2	-1	0
20	Requirements developed in parallel to design	-1	1	0
OR	***If a prototype, throwaway, or other development strategy:***			
15	Learn about requirements through development efforts	1	-1	0
16	No coding until all requirements are defined	-3	1	0
17	Requirements formal prior to design effort	-1	0	0
18	Requirements serve as output	1	-1	0
19	Requirements definition work in parallel to development efforts	2	-1	0
20	Requirements developed in parallel to design	1	-1	0
21	Are requirements frozen at some phase	1	-1	0
22	Change management exists	3	-3	0
23	Change management is formal	1	0	0
24	Project strategy is consistent throughout development	1	0	0
25	Requirements are updated	1	0	0
26	Configuration Management (CM) exists	3	-3	0
27	CM is formal	1	0	0
28	Requirements are testable	2	-2	0
29	Requirements testing considered/implemented during extraction	2	0	0
30	Requirements testing plan exists	2	0	0
31	Requirements testing is formal	1	0	0
32	All requirements have priorities	2	-2	0
33	All requirements must be implemented	0	1	0
34	Requirements are tested	1	-1	0
35	All requirements are equally important	0	1	0
36	At least some requirements have priorities	1	0	0
37	All requirements are traceable	1	0	0
38	Traceability not important	0	1	0
39	Each requirement has an author	1	0	0
40	Who authored requirement is not important	0	1	0
41	Initial set of requirements to be implemented, no requirements creep	0	1	0
42	Structured and tracked changes to requirements only	1	-1	0
43	Change is inevitable, changes allowed at all times	-1	1	0
44	Change is inevitable, but changes limited	1	0	0
45	Requirements control funding	1	0	0
46	Requirements history kept	1	-1	0
47	Baseline established for requirements at some point prior to develop	2	-2	0
	TOTAL SCORING			

Enter total score on QMM score sheet block e.

Program Name_____ **YES-NO-N/A Questionnaire Scoring Template** Date_____

No.	Estimation/Planning Questionnaire	Yes	No	N/A
1	A volume product metric used (LOC, # of files, # of screens, pages of doc)	1	0	0
2	Measure used for various product elements (modules, components, CSCI)	1	0	0
3	Product measures made by phase (amt at implementation, LOC changed at unit test)	1	0	0
4	Other product attributes measured (FP, throughput, mem cap, cyclomatic complexity)	1	0	0
5	Product metrics tracked and updated throughout program execution	2	-1	0
6	Event count process metric used (# defects in test, reqmt changes, milestones met)	1	0	0
7	Time measure process metric used (cycle time)	1	0	0
8	Process metrics tracked and updated throughout program execution	2	-1	0
9	Program cost estimations made from product or process metrics	1	0	0
10	Program cost estimations tracked and updated to reflect progress/changes	1	0	0
11	Factor analysis performed on program	1	0	0
12	Program's primary purpose, including major functions and deliverables known	2	-1	0
13	Work breakdown structure developed	2	-1	0
14	Task estimated with realistic expectations of productivity probabilities	1	-1	0
15	Schedules developed based on realistic expectations	1	-1	0
16	Schedules tracked and updated based on new information	1	-1	0
17	Detailed activity lists used for clearly defined completed/not completed tasks	1	-1	0
18	Quality assurance plan or similar to aid in detecting defects early in program	1	-1	0
19	COCOMO estimates performed	1	-1	0
20	CSCI clearly defined and tasked	2	-1	0
21	Estimates completed ad hoc	-2	0	0
22	Gantt charts used and updated	1	-1	0
23	Resource estimations (working hrs, job categories, task activities) done	1	-1	0
24	Earned value established	2	-1	0
25	Earned value tracked throughout program	2	0	0
26	Quality expectations established for product with users and stakeholders	1	-1	0
27	Critical path for program tasks developed and tracked	2	-1	0
28	Meaure of effectiveness (MOE) or Figure of merit established and tracked	1	0	0
29	Estimates are updated routinely	2	-1	0
30	Schedules are updated routinely	2	-1	0
31	Estimations are made by program management (top-down)	1	0	0
32	Estimations are made by program team members (bottom-up)	2	0	0
33	Automated program tracking used	1	0	0
34	PM usually thorough in tracking and reporting schedules and financials	1	-1	0
35	WBS developed only as data call, not used in planning	-1	0	0
36	Earned value used to track program progress	2	-1	0
37	PM insists on prioritizing work reduction as schedule/funding compromised by stakeholders	1	-1	0
38	Estimations are done using both top down and bottoms up approaches	2	-1	0
39	All program team members involved in planning process	2	-1	0
40	Hardware also considered in estimation process	1	-1	0
41	Program history compiled	1	0	0
42	System upgrades (SCR) software changes requests estimated individually	1	-1	0
43	Management duties apart of each team member's responsibilities	-1	1	0
44	PM dictates schedules to program team	-1	0	0
45	Code reviews planned in schedule	1	-1	0
46	Defined tangible milestones established for program tasks	2	-1	0
47	Test planning done at the start of the program	1	-1	0
48	Estimations are completed by those performing the tasks	1	-1	0
49	Sensitivity analysis performed for program choices	1	-1	0
50	Software deployment planning completed	1	-1	0
	TOTAL SCORING			

Enter total score on QMM score sheet block f.

Program Name_____ **YES-NO-N/A Questionnaire Scoring Template** Date_____

No.	People Management Questionnaire	Yes	No	N/A
1	PM is accessable in person by each team member	1	0	0
2	PM is accessable via email by each team member	1	0	0
3	PM is accessable via phone by each team member	1	0	0
4	PM not only considers a person's suitability, not also desire to be on a team	1	0	0
5	PM consults with each team member regarding their career goals	1	0	0
6	PM regularly holds meetings to inform team of program progress	2	-1	0
7	PM solicits opinions from team members before making decisions	2	-1	0
8	PM lets teams make decisions affecting their work	1	0	0
9	PM frequently makes decisions without any consultation with members	-2	2	0
10	PM understands the technology/language of the program	1	0	0
11	PM is able to communicate with other the technical issues in the program	1	-1	0
12	PM prioritizes problems or conflicts within the program	1	0	0
13	PM assists team members in developing/advising of career path	1	-1	0
14	PM empowers program members to recommend hiring new team members	1	-1	0
15	PM empowers program members to recommend firings of other members	1	-1	0
16	PM specifically assigns work to each program member	1	-1	0
17	PM sets communication protocol to be followed	1	0	0
18	PM allows unrestricted communications	1	0	0
19	PM readily makes tough decisions	1	-1	0
20	PM takes control in difficult/ problem areas	1	0	0
21	PM looks ahead to new programs, new upgrades of existing program	1	0	0
22	PM maintains regular communications with all stakeholders	2	-1	0
23	PM maintains regular communications with users	2	-1	0
24	PM encourages program team communication with users	1	-1	0
25	PM encourages program team communication with stakeholders	1	-1	0
26	PM facilitates horizontal communication within program	1	-1	0
27	PM facilitates communication during integration	1	-1	0
28	PM holds meetings without clear objectives listed prior to meeting	-1	2	0
29	PM must approve all decisions within the program	-1	1	0
30	PM must approve all interactions with stakeholders	-1	1	0
31	PM must approve all interactions with users	-1	1	0
32	PM makes all presentations to stakeholders/users	0	1	0
33	PM is considered "flexible" in terms of program members personal issues	1	0	0
34	PM, at least occasionally, schedules/promotes outside work team activities	1	0	0
35	PM is readily willing to listen to program problems and complaints	1	-1	0
36	PM takes action to resolve program problems and complaints	1	-1	0
37	PM is generally respected by stakeholders, users, and organization	1	-1	0
38	PM sometimes fails to grasp important technical issues in program	-1	1	0
39	PM recruits program team members from outside organization	1	-1	0
40	PM directs what needs to be done and directs how to do it	-1	1	0
41	Program personnel have clearly defined specific tasks	0	1	0
42	Although individual's tasks are specific, each exposed to the "bigger picture"	2	-1	0
43	PM has clearly defined his/her expectations for each individual	2	-1	0
44	PM delegation of duties is usually seemless in execution	1	0	0
45	PM acts as facilitator to solving personnel conflicts	2	-1	0
46	PM attempts to motivate individuals on the program team	2	-1	0
47	PM clearly separates technical from managerial roles for individuals	0	1	0
48	PM directs how he/she expects the task to be accomplished	0	1	0
49	PM directs what needs to be done, but does not direct how	2	-1	0
50	PM attempts to spotlight individuals in the program for positive exposure	2	-1	0
	TOTAL SCORING			

Enter total score on QMM score sheet block g.

Program Name_____ **YES-NO-N/A Questionnaire Scoring Template** Date_____

No.	Risk Management Questionnaire	Yes	No	N/A	
1	Risk Management (RM) is specifically an activity in the program	4	-4	0	
2	RM is formal and documented	3	-3	0	
3	A specific RM plan exists	2	-2	0	
4	RM is required in the program, but not used during the program	-1	1	0	
5	RM is done prior to the program execution	1	0	0	
6	RM is done by an outside entity to the development	1	0	0	
7	RM is done internally only	0	1	0	
8	RM is both internally performed and externally assessed	1	-1	0	
9	RM planning occurs during or after major milestones in the program	1	-1	0	
10	Risk Assessment is only a management function	0	1	0	
11	RM is informal or non existent	-1	1	0	
12	There is a RM plan, but it is not updated or tracked	1	0	0	
13	Risks are only generalized	-1	0	0	
14	Each risk is delineated	1	0	0	
15	Each risk has a consequence	1	0	0	
16	Each risk has a likelihood rating of some sort	1	0	0	
17	Each risk has a mitigation strategy	1	0	0	
18	Risk Management is automated	1	0	0	
19	Risks are tracked	2	-2	0	
21	Regret analysis performed	2	0	0	
22	RM drives decisions in the program	3	-2	0	
23	Risks have probabilities	1	0	0	
24	Risk Management is ad hoc	-3	0	0	
25	RM information is shared with all stakeholders (as appropriate)	1	0	0	
26	Risks are weighed relative to other program risks	1	0	0	
27	Risk Assessment is a program team activity	1	0	0	
28	Risk Assessment done prior to program start	2	-1	0	
29	Risk Assessment includes personnel risk	1	-1	0	
30	RM uses tools, but depends on human decisions	2	-1	0	
31	Risk Assessment includes cost risks	1	0	0	
32	Risk Assessment includes schedule risks	1	0	0	
33	Risk Assessment includes technology risks	1	-1	0	
34	Risk Assessment is briefed organization structure above program manager	1	-1	0	
35	Risk Assessment includes requirements risks	1	-1	0	
36	Risk Assessment includes user risks (too little involvement of user)	1	0	0	
37	Risk Assessment includes documentation risks	1	0	0	
38	Risk Assessment includes integration risks	1	-1	0	
39	Risk Assessment includes interface risks (non-standard)	1	-1	0	
40	Risk Assessment includes continuing requirements change (feature creep)	1	-1	0	
41	Risk Assessment includes dependent projects/programs risks	1	0	0	
42	Documentation proof exists to demonstrate following risk management plan	1	0	0	
43	High risk have measured tracking (high profile status)	1	0	0	
44	Organizational history used to search for risks	1	0	0	
45	Other organizational checklists used for risk assessment	1	0	0	
46	Internal organizational checklists used for risk assessment	1	0	0	
47	Risk Assessment information contributed to internal or other database	1	0	0	
48	Risk Assessment includes internal organization risks	1	0	0	
49	Risk Assessment includes stakeholder risks	2	-1	0	
50	No risk management needed; program is straightforwarded & understood	-3	3	0	
	TOTAL SCORING				

Enter total score on QMM score sheet block h.

Program:

QMM Summary Score Sheet

QMM Scoresheet		Part One		Part Two	Total		Importance		Weighted
Category		Score		Score	Score		Coefficient		Score
Requirements Management	a		e		0.00	X	0.92	=	0.00
Est./Planning Management	b		f		0.00	X	0.67	=	0.00
People Management	c		g		0.00	X	1.86	=	0.00
Risk Management	d		h		0.00	X	0.55	=	0.00

QMM SCORE	0.00

Max. QMM score possible	**528.00**
Min. QMM Score possible	**-130.86**
QMM percentage score	**19.86%**

Objective/Subjective view of the overall success of program on a scale of 0 to 10
(0 being total failure, 10 being perfect program total success)
Program:
Success Score:

APPENDIX B. RESEARCH DATA

This appendix contains the survey responses to each question for all survey participants. The participants are identified by the letter of the program with a dash followed by a P for the program manager and a number for the individual development team members. Each table has the corresponding QMM survey section title at the top and the number of the question is in the left most column. Individual responses to the questions are indicated with a "1" in the appropriate box. The abbreviations used in the tables are the following:

Lt. - indicates the answer selected is the left-hand answer on the pair-choice survey row
Rt. - indicates the answer selected is the right-hand answer on the pair-choice survey row
yes - indicates the answer selected is the yes column on the yes/no survey
no - indicates the answer selected is the no column on the yes/no survey
n/a - indicates the answer selected is the not applicable column on the yes/no survey

Part I Pair-Choice: Requirements Management (Page 1 of 2)

	A-P		A-1		B-P		B-1		C-P		C-1		D-P		D-1		D-2		E-P		E-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
1.		1	1		1		1		1		1		1		1		1			1		1
2.	1		1		1		1		1		1		1		1		1		1			1
3.	1		1				1		1		1		1		1		1		1			1
4.		1	1		1		1		1		1		1		1		1			1	1	
5.		1	1		1			1		1		1		1		1	1			1		1
6.	1			1	1		1		1		1			1		1	1			1		1
7.	1		1		1			1	1		1		1		1		1		1		1	
8.	1		1		1		1		1		1		1		1		1			1		1
9.	1			1		1		1		1		1		1		1		1	1			1
10.		1	1		1		1		1		1		1		1		1			1		1
11.	1			1		1		1		1		1	1		1			1	1		1	
12.	1			1	1		1		1		1		1		1		1		1			1
13.		1	1		1			1	1		1		1			1	1			1		1
14.		1	1		1		1		1		1		1		1		1			1	1	
15.		1	1		1			1	1		1		1		1		1			1		1
16.	1		1		1		1			1		1		1		1		1	1		1	
17.	1		1		1		1		1		1			1	1		1		1			1
18.	1		1		1		1		1		1		1		1		1		1		1	
19.		1		1		1		1		1		1		1		1		1		1		1
20.	1		1			1		1		1		1		1	1			1	1		1	
21.		1	1		1		1		1		1		1		1		1			1		1
22.		1		1	1		1		1		1		1		1		1			1	1	
23.	1		1		1		1		1		1		1		1		1		1		1	
24.		1		1		1		1		1	1		1			1	1		1		1	
25.	1		1			1	1		1		1		1		1		1		1		1	
26.	1		1			1		1		1		1		1		1		1		1		1
27.		1		1	1		1		1		1		1			1	1		1		1	
28.	1		1			1	1	1		1		1		1		1		1	1			1
29.		1		1	1		1		1		1			1	1		1			1		1
30.		1	1		1		1		1		1		1		1		1			1	1	
31.		1		1	1		1		1		1			1	1			1		1	1	
32.		1	1		1		1				1		1		1		1			1	1	
33.		1		1	1		1		1		1		1		1		1		1		1	
34.	1		1		1		1			1	1		1			1	1		1		1	

Part I Pair-Choice: Requirements Management (Page 2 of 2)

	A-P		A-1		B-P		B-1		C-P		C-1		D-P		D-1		D-2		E-P		E-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
ANSWER THIS BLOCK OF QUESTIONS ONLY IF A SEQUENTIAL OR WATERFALL APPROACH IS USED FOR DEVELOPMENT																						
35.			1		1		1				1						1					
36.			1		1		1				1						1					
37.				1	1		1				1						1					
38.				1	1		1				1						1					
39.			1			1		1			1							1					
40.				1		1		1				1						1				
41.				1		1	1					1						1				
42.			1			1		1				1					1					
43.			1			1		1			1							1					
44.			1		1		1				1						1					
45.				1	1		1				1						1					
46.				1	1		1				1						1					
47.			1			1	1				1							1					
48.			1		1		1				1							1				
49.				1		1		1				1					1					
50.				1		1		1				1						1				
ANSWER THIS BLOCK OF QUESTIONS ONLY IF A PROTOTYPING, THROWAWAY, SYNCHRONIZE & STABILIZE, OR OTHER STRATEGY IS USED																						
35.		1							1					1		1			1			1
36.	1								1				1		1				1		1	
37.	1									1			1		1				1		1	
38.		1								1			1			1				1		1
39.	1									1				1	1					1		1
40.	1								1					1		1			1		1	
41.		1							1				1			1				1		1
42.		1								1				1		1				1		1
43.	1								1				1		1				1		1	
44.	1								1				1			1			1		1	
45.	1								1				1		1				1		1	
46.		1								1			1			1				1		1
47.		1							1				1		1				1			1
48.	1								1				1		1				1		1	
49.		1								1				1	1					1		1
50.	1								1				1		1				1		1	

Part I Pair-Choice: Requirements Management (Page 1 of 2)

	F-P		F-1		G-P		G-1		H-P		H-1		I-P		I-1		J-P		J-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
1.	1		1		1		1		1		1			1		1	1		1	
2.	1		1		1		1		1		1		1			1	1		1	
3.	1		1		1		1						1			1			1	
4.		1		1	1			1	1		1			1		1	1		1	
5.		1		1	1			1		1		1	1		1			1		1
6.	1		1		1		1		1				1			1	1		1	
7.	1		1		1		1		1		1		1			1	1		1	
8.	1		1		1		1		1		1			1		1	1		1	
9.		1	1			1		1		1		1	1		1			1		1
10.	1		1		1		1					1	1		1		1		1	
11.		1	1		1		1		1		1		1		1			1	1	
12.	1		1		1			1	1		1		1		1		1			1
13.		1	1		1		1		1			1	1			1	1		1	
14.	1		1		1			1	1		1		1		1		1		1	
15.		1	1		1		1			1	1			1		1	1		1	
16.		1	1		1		1			1	1			1	1			1	1	
17.	1		1		1		1		1		1			1	1			1	1	
18.	1		1		1		1		1		1		1		1		1		1	
19.		1		1		1		1		1		1		1		1	1			1
20.		1	1		1			1		1	1			1	1		1			1
21.	1		1			1			1		1			1		1		1	1	
22.		1	1			1		1	1		1			1		1	1			1
23.	1		1			1	1		1		1		1		1		1		1	
24.		1	1			1		1	1			1		1		1	1			1
25.	1		1		1		1		1		1		1			1	1		1	
26.	1			1		1		1	1		1			1		1		1		1
27.		1		1		1		1	1		1			1		1	1		1	
28.	1			1	1		1			1		1	1		1		1		1	
29.		1	1		1		1		1		1			1		1	1		1	
30.		1	1		1		1		1		1			1		1	1		1	
31.		1	1		1			1	1		1			1		1	1		1	
32.	1		1		1		1		1		1			1		1	1		1	
33.		1	1			1		1		1		1	1		1		1		1	
34.	1		1		1		1		1		1		1		1			1	1	

Part I Pair-Choice: Requirements Management (Page 2 of 2)

	F-P		F-1		G-P		G-1		H-P		H-1		I-P		I-1		J-P		J-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
ANSWER THIS BLOCK OF QUESTIONS ONLY IF A SEQUENTIAL OR WATERFALL APPROACH IS USED FOR DEVELOPMENT																				
35.	1		1		1		1								1		1		1	
36.	1		1		1		1								1		1			1
37.	1		1			1		1							1		1		1	
38.		1		1		1		1								1	1			1
39.		1	1		1			1								1	1			1
40.		1		1		1		1							1			1		1
41.		1		1		1									1			1	1	
42.	1			1		1		1							1			1		1
43.		1		1		1		1								1		1		1
44.	1		1			1	1									1	1		1	
45.		1	1			1		1								1		1		1
46.		1	1			1		1								1	1			1
47.	1		1		1		1								1		1			1
48.		1		1	1			1							1		1			1
49.		1		1		1	1								1			1		1
50.	1			1		1		1								1	1			1
ANSWER THIS BLOCK OF QUESTIONS ONLY IF A PROTOTYPING, THROWAWAY, SYNCHRONIZE & STABILIZE, OR OTHER STRATEGY IS USED																				
35.										1		1		1						
36.									1		1		1							
37.									1		1		1							
38.										1		1		1						
39.									1			1		1						
40.										1		1		1						
41.									1			1		1						
42.										1		1		1						
43.									1		1		1							
44.										1	1		1							
45.										1	1		1							
46.										1	1		1							
47.									1		1		1							
48.									1		1			1						
49.									1			1		1						
50.									1		1		1							

Part I Pair-Choice: Estimation/Planning Management (Page 1 of 2)

	A-P		A-1		B-P		B-1		C-P		C-1		D-P		D-1		D-2		E-P		E-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
1.	1		1		1		1		1			1	1		1		1			1	1	
2.		1		1	1		1		1			1		1		1	1			1		1
3.	1			1		1		1		1	1		1		1			1	1		1	
4.	1		1		1		1		1			1		1		1	1			1	1	
5.		1		1		1		1		1		1		1	1			1	1			1
6.		1		1		1		1		1		1		1	1			1	1			1
7.	1		1		1		1		1			1	1		1		1		1		1	
8.		1	1			1	1			1	1			1	1			1	1			1
9.		1	1			1		1		1	1			1	1			1		1		1
10.	1		1		1		1			1		1	1			1	1		1			1
11.	1		1			1		1		1		1		1	1			1	1		1	
12.	1		1			1		1		1	1			1	1			1	1			1
13.	1			1	1		1		1			1		1	1		1		1		1	
14.		1		1	1		1		1			1		1		1	1			1		1
15.		1		1	1		1		1		1			1		1	1			1		1
16.		1		1	1			1		1		1		1		1				1		1
17.		1		1	1		1		1			1		1		1	1			1		1
18.	1			1	1		1		1			1	1			1	1			1	1	
19.		1		1	1		1		1			1		1		1	1			1		
20.	1			1		1	1		1			1	1			1	1			1	1	
21.	1		1			1		1		1	1		1		1			1	1			
22.		1	1		1		1			1	1			1	1			1		1	1	
23.		1	1		1			1		1	1			1		1	1			1		1
24.	1		1			1		1	1		1		1			1		1	1			1
25.		1		1			1			1		1		1	1					1	1	
26.		1		1		1		1		1	1			1	1		1		1			1
27.	1		1		1		1		1			1		1	1		1			1	1	
28.	1			1	1		1		1		1		1		1		1		1		1	
29.	1		1			1		1		1		1		1		1		1		1		1
30.	1			1	1		1		1		1		1		1		1		1		1	
31.	1					1		1		1	1		1			1	1		1			1
32.	1		1		1		1			1	1		1			1	1		1		1	
33.	1			1		1		1		1	1			1	1		1			1		1
34.	1			1	1		1		1			1	1			1	1		1		1	
35.		1		1	1			1		1		1		1		1	1			1		1

Part I Pair-Choice: Estimation/Planning Management (Page 2 of 2)

	A-P		A-1		B-P		B-1		C-P		C-1		D-P		D-1		D-2		E-P		E-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
36.		1		1	1		1		1			1	1			1	1		1		1	
37.	1			1		1	1		1		1			1	1		1		1		1	
38.		1		1	1		1		1			1	1		1		1			1		1
39.	1			1		1	1		1		1		1		1			1	1		1	
40.	1		1		1		1		1			1	1			1	1			1	1	
41.	1			1		1		1		1	1			1	1			1	1		1	
42.		1	1		1		1		1			1	1		1		1			1	1	
43.	1			1	1		1		1		1		1		1		1			1	1	
44.	1		1		1		1		1			1		1		1	1		1		1	
45.		1		1		1		1		1		1		1		1		1		1		1
46.		1		1		1		1		1		1		1	1			1		1		1
47.	1		1		1		1			1		1	1			1	1		1		1	
48.	1		1		1			1		1	1		1		1			1	1		1	
49.	1			1	1		1			1		1	1		1		1		1			1
50.		1		1	1		1		1			1		1		1	1			1		1
51.		1		1		1	1			1		1	1			1		1		1	1	
52.		1		1	1		1		1		1			1		1	1		1		1	
53.	1			1	1		1		1			1	1			1	1			1	1	
54.		1		1		1		1		1		1	1			1		1		1		1
55.		1		1		1		1		1	1		1			1		1		1		1
56.	1			1	1			1		1		1		1		1	1			1		1
57.	1			1	1		1		1		1		1			1	1		1		1	
58.	1		1		1		1		1			1	1		1		1		1		1	
59.	1		1		1		1		1		1		1		1		1			1	1	
60.	1			1		1		1		1		1		1	1			1		1		1
61.	1		1		1		1		1		1		1		1		1			1		1
62.		1		1		1		1		1		1		1	1			1		1		1
63.		1		1	1					1		1	1			1	1			1		1
64.	1			1		1		1		1	1			1		1		1		1		1
65.	1		1			1		1		1		1		1		1		1		1		1
66.				1		1			1					1	1			1	1			
67.	1		1			1		1		1	1		1		1			1	1		1	
68.	1		1		1		1		1			1	1			1	1		1		1	
69.		1	1		1		1		1		1			1		1	1		1			1
70.	1		1		1		1		1			1		1	1		1			1	1	

Part I Pair-Choice: Estimation/Planning Management (Page 1 of 2)

	F-P		F-1		G-P		G-1		H-P		H-1		I-P		I-1		J-P		J-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
1.		1	1		1		1		1		1		1			1	1		1	
2.		1		1		1	1		1			1		1		1		1		1
3.	1		1		1			1		1		1	1		1		1			1
4.		1		1	1		1		1		1			1		1	1			1
5.		1	1			1		1		1		1		1	1			1		1
6.		1	1		1			1		1		1		1	1			1		1
7.	1		1		1		1		1		1			1		1	1		1	
8.	1		1		1		1		1		1				1				1	
9.	1			1		1		1		1	1			1		1		1		1
10.	1		1		1		1		1		1			1		1		1	1	
11.	1		1		1		1		1		1			1	1			1		1
12.	1		1		1		1		1		1		1		1			1	1	
13.		1	1		1			1		1	1			1	1		1		1	
14.		1		1	1			1		1		1		1		1		1	1	
15.		1		1	1		1		1		1			1		1		1		1
16.		1		1	1			1		1		1		1		1		1		1
17.		1		1	1		1		1			1		1		1		1		1
18.		1		1	1		1		1		1			1		1	1		1	
19.		1		1	1		1		1			1		1		1		1		1
20.		1		1	1		1		1		1		1			1	1		1	
21.		1		1		1		1	1			1		1	1			1		1
22.		1		1		1	1			1		1		1		1		1		1
23.		1	1			1		1		1	1			1		1		1		1
24.	1		1		1			1	1		1		1		1			1		1
25.		1	1			1	1		1			1		1		1				1
26.		1	1		1			1	1		1					1	1			1
27.	1			1	1		1			1	1			1		1		1	1	
28.	1		1			1	1		1		1		1		1		1		1	
29.		1		1		1		1	1			1		1		1		1	1	
30.		1		1	1		1		1		1		1		1			1	1	
31.		1		1	1			1		1	1			1		1				1
32.	1			1	1		1		1		1		1		1		1		1	
33.		1	1		1			1	1			1		1		1		1		1
34.		1		1	1		1		1		1		1			1		1	1	
35.		1		1	1			1	1			1				1	1		1	

Part I Pair-Choice: Estimation/Planning Management (Page 2 of 2)

	F-P		F-1		G-P		G-1		H-P		H-1		I-P		I-1		J-P		J-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
36.		1		1	1		1		1		1		1			1	1		1	
37.		1	1			1		1	1		1		1			1	1			1
38.		1		1	1		1		1			1		1		1	1		1	
39.	1			1		1	1		1			1	1		1			1	1	
40.		1		1		1	1			1	1			1		1	1			1
41.	1		1			1		1		1		1	1		1		1			1
42.		1		1	1			1	1		1			1		1		1	1	
43.		1	1		1			1	1		1		1			1	1			1
44.		1		1	1		1		1		1			1	1			1	1	
45.		1		1		1		1		1		1		1		1		1		1
46.		1	1			1		1		1		1		1		1		1		1
47.	1			1		1	1		1			1		1		1	1		1	
48.	1		1		1		1		1		1		1		1		1			1
49.	1		1			1	1		1		1		1			1	1			1
50.		1	1		1		1		1			1		1		1	1		1	
51.	1			1		1		1		1		1	1		1			1		1
52.		1	1		1			1	1		1			1		1	1		1	
53.		1		1		1		1	1		1			1	1		1			1
54.	1		1			1		1		1		1	1		1			1		1
55.	1		1			1		1		1		1		1	1			1	1	
56.		1		1		1		1	1			1		1		1	1			1
57.		1		1	1		1		1		1		1			1	1		1	
58.		1		1		1	1		1			1	1			1	1		1	
59.		1	1		1		1		1		1			1		1	1		1	
60.		1				1		1		1		1	1		1			1		1
61.	1		1		1		1			1	1			1	1		1		1	
62.	1			1		1		1		1		1	1		1			1		1
63.		1		1		1	1		1		1			1		1	1		1	
64.		1	1			1		1	1			1		1		1		1		1
65.	1		1			1		1	1			1	1		1			1		1
66.	1		1		1			1		1		1						1	1	
67.		1	1			1		1	1		1		1		1			1		1
68.		1		1	1		1		1		1		1			1				1
69.		1		1	1		1		1			1	1			1	1		1	
70.		1		1	1		1		1		1			1		1	1		1	

Part I Pair-Choice: People Management (Page 1 of 2)

	A-P		A-1		B-P		B-1		C-P		C-1		D-P		D-1		D-2		E-P		E-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
1.	1		1			1		1	1		1			1	1		1		1			1
2.		1		1	1			1		1		1		1		1	1			1		1
3.	1		1		1		1		1		1		1		1		1		1		1	
4.	1		1		1		1		1		1		1			1	1		1		1	
5.		1		1		1		1		1		1		1	1			1		1	1	
6.		1		1	1		1		1			1	1			1	1			1		1
7.	1		1		1		1		1			1	1			1	1		1			1
8.		1		1	1			1	1		1		1			1	1			1	1	
9.	1			1	1		1			1		1		1		1		1	1			1
10.		1		1		1		1		1		1		1		1		1		1		1
11.	1		1		1		1		1		1		1			1	1		1			1
12.		1		1		1		1		1		1		1		1		1		1		
13.		1	1			1		1		1		1		1	1			1		1	1	
14.		1		1	1		1		1		1			1		1		1	1			1
15.	1		1		1		1		1		1		1			1	1		1		1	
16.		1		1		1		1		1	1			1	-1			1		1	1	
17.	1		1		1		1		1		1		1			1		1	1			1
18.		1		1		1		1	1			1		1		1	1			1		1
19.		1		1		1		1	1			1	1		1			1	1			1
20.	1		1		1		1		1		1			1		1	1			1		1
21.	1			1		1		1	1		1		1			1		1		1		1
22.	1			1	1		1		1			1	1			1	1			1		1
23.	1			1	1		1		1			1	1			1	1			1	1	
24.	1		1		1		1		1		1		1		1		1		1		1	
25.	1		1		1		1		1		1		1			1	1			1	1	
26.	1		1		1		1		1		1		1			1	1		1		1	
27.	1		1		1		1		1		1		1		1		1		1		1	
28.		1	1			1		1		1		1		1	1		1			1		1
29.	1		1		1		1		1		1			1		1	1			1		1
30.	1		1		1			1	1			1		1		1	1			1	1	
31.	1		1		1		1		1		1		1		1		1		1		1	
32.	1		1		1		1		1		1		1			1	1		1		1	
33.	1		1			1		1	1		1		1		1			1	1		1	
34.	1			1	1		1		1		1		1		1		1			1		1
35.	1		1			1		1		1	1			1	1			1	1		1	
36.		1		1		1		1		1		1		1		1		1		1		1

Part I Pair-Choice: People Management (Page 2 of 2)

	A-P		A-1		B-P		B-1		C-P		C-1		D-P		D-1		D-2		E-P		E-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
37.		1	1		1		1			1		1		1		1		1		1		1
38.		1		1		1	1			1		1		1	1			1		1		1
39.		1	1			1		1		1		1		1		1		1	1			1
40.		1	1			1		1		1		1		1		1	1			1		1
41.		1		1		1		1		1		1		1		1		1		1		1
42.	1			1	1		1		1		1		1		1			1	1			1
43.		1		1		1	1			1		1		1		1	1			1	1	
44.	1			1	1		1		1		1		1		1		1		1		1	
45.	1			1	1		1		1		1		1			1	1			1	1	
46.	1		1			1	1		1		1		1		1		1		1		1	
47.	1		1		1		1		1		1		1		1		1		1		1	
48.		1		1		1		1		1		1		1	1		1			1		1
49.	1		1		1		1		1		1		1			1	1		1		1	
50.	1		1		1		1		1		1		1		1		1		1		1	
51.		1	1			1		1		1		1		1		1		1	1		1	
52.		1		1		1		1		1		1		1	1			1		1	1	
53.		1		1		1		1		1		1	1			1		1		1	1	
54.	1		1			1		1		1	1			1	1		1		1		1	
55.		1		1		1		1		1		1		1		1		1	1			1
56.	1		1			1		1	1		1			1	1			1	1		1	
57.		1		1		1		1		1		1		1		1		1		1		1
58.		1		1	1		1		1		1		1		1		1			1		1
59.		1	1			1		1		1		1		1	1			1		1	1	
60.	1		1			1		1		1	1		1		1		1		1		1	
61.	1			1	1		1		1		1			1		1		1	1		1	
62.	1			1	1		1		1		1		1			1		1	1		1	
63.	1			1	1		1		1		1		1			1		1	1		1	
64.	1			1		1		1		1		1		1	1		1			1		1
65.		1		1		1		1		1		1		1	1			1		1		1
66.	1			1	1		1		1		1		1			1		1	1		1	
67.	1			1	1		1			1		1	1			1		1	1		1	
68.		1		1		1		1		1		1		1	1			1		1		1
69.		1	1			1		1		1		1		1	1		1			1		1

Part I Pair-Choice: People Management (Page 1 of 2)

	F-P		F-1		G-P		G-1		H-P		H-1		I-P		I-1		J-P		J-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
1.		1	1		1		1		1			1	1			1	1		1	
2.		1		1	1			1		1	1			1		1		1		1
3.	1		1		1		1		1		1		1		1		1		1	
4.	1		1		1		1		1			1		1		1	1		1	
5.	1		1			1		1		1		1		1	1			1		1
6.		1		1		1		1		1	1			1		1	1			1
7.	1			1	1		1		1			1	1			1	1		1	
8.		1	1			1			1		1			1		1	1		1	
9.		1	1		1			1		1		1		1	1		1		1	
10.	1		1			1	1			1		1		1		1	1			1
11.	1		1		1		1		1		1			1		1	1		1	
12.		1		1		1		1		1		1				1		1		1
13.		1	1			1		1		1		1		1	1			1	1	
14.		1	1		1		1		1		1			1		1	1			1
15.	1		1			1	1		1		1		1		1		1		1	
16.		1	1			1		1		1	1		1		1			1	1	
17.	1		1		1		1		1		1			1		1	1		1	
18.		1		1		1		1		1		1		1		1		1		1
19.		1		1	1			1		1		1		1	1			1		1
20.		1		1		1	1		1		1			1		1		1		1
21.	1			1		1	1		1		1		1			1		1	1	
22.	1		1		1			1	1		1		1			1	1		1	
23.	1			1	1		1		1		1		1			1		1		1
24.	1		1			1	1		1		1		1			1	1		1	
25.			1		1		1		1		1		1			1	1		1	
26.	1		1			1	1		1		1		1			1	1		1	
27.	1		1		1		1		1		1		1		1		1		1	
28.		1		1	1			1	1			1	1		1			1		1
29.	1		1		1		1		1		1		1			1	1			1
30.		1		1	1		1		1		1			1		1	1		1	
31.	1		1		1		1		1		1		1		1		1			1
32.	1			1	1		1		1		1			1		1	1		1	
33.		1	1			1		1		1		1	1		1			1		1
34.	1		1		1		1		1		1			1		1	1		1	
35.		1	1		1			1	1		1		1		1			1	1	
36.		1		1		1		1		1		1		1		1		1		1

Part I Pair-Choice: People Management (Page 2 of 2)

	F-P		F-1		G-P		G-1		H-P		H-1		I-P		I-1		J-P		J-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
37.	1		1			1	1		1			1	1			1	1		1	
38.		1	1		1			1		1		1	1		1		1		1	
39.		1	1			1		1		1		1		1	1			1		1
40.	1		1			1		1		1		1		1	1			1		1
41.		1		1		1	1			1		1		1		1		1	1	
42.	1		1			1	1		1		1		1			1	1		1	
43.	1		1			1		1		1	1			1	1			1	1	
44.	1		1		1		1		1		1		1			1	1			1
45.	1		1		1		1		1		1		1			1		1		1
46.	1		1		1		1			1	1		1		1		1			1
47.	1		1		1		1		1		1		1		1		1		1	
48.		1	1			1		1		1		1		1	1			1		1
49.	1			1	1		1		1		1			1		1	1		1	
50.	1		1		1		1		1		1			1		1	1		1	
51.		1	1		1		1			1		1		1		1		1		1
52.		1	1			1		1		1		1		1	1			1		1
53.		1		1		1		1		1		1		1		1		1		1
54.		1		1	1			1		1		1	1		1			1	1	
55.	1		1			1		1		1	1			1	1			1		1
56.	1		1		1			1	1		1		1		1			1	1	
57.		1	1			1		1		1	1		1		1			1	1	
58.		1		1		1		1		1	1		1			1	1			1
59.	1			1	1		1			1	1			1		1	1			1
60.	1		1		1		1		1		1		1		1		1		1	
61.	1		1			1		1		1	1			1		1	1		1	
62.	1		1		1		1		1		1		1			1	1		1	
63.	1		1		1			1		1		1		1		1	1		1	
64.		1	1			1		1	1			1		1		1		1		1
65.		1		1		1		1		1		1	1		1			1		1
66.	1		1			1	1		1			1		1		1	1		1	
67.	1		1		1		1		1			1	1			1	1		1	
68.		1		1		1		1	1			1		1		1		1		1
69.		1		1		1		1	1			1		1	1			1		1

Part I Pair-Choice: Risk Management (Page 1 of 2)

	A-P		A-1		B-P		B-1		C-P		C-1		D-P		D-1		D-2		E-P		E-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
1.	1			1	1		1			1		1		1	1		1			1		1
2.	1		1		1		1			1		1		1	1		1			1		1
3.	1		1			1		1	1		1			1	1			1	1			1
4.	1		1		1		1			1		1		1		1		1		1		1
5.		1				1		1		1		1		1		1		1		1		1
6.	1		1			1		1	1			1		1		1		1	1		1	
7.	1		1			1	1			1	1		1		1			1	1		1	
8.	1		1			1	1			1	1			1	1			1		1	1	
9.		1		1	1		1			1		1	1		1		1			1		1
10.		1		1	1		1			1		1		1		1	1			1		1
11.		1		1	1		1			1		1		1		1	1			1		1
12.		1		1	1		1			1		1		1		1	1			1		1
13.	1		1		1		1			1	1		1			1	1			1		1
14.		1		1		1		1		1		1		1		1		1		1		1
15.		1		1		1		1		1		1		1		1		1		1		1
16.		1		1	1		1		1			1		1		1	1		1			1
17.	1		1			1		1		1	1			1		1		1		1		1
18.	1			1		1		1		1	1			1		1		1		1		1
19.	1		1		1		1		1		1		1		1		1		1		1	
20.		1		1	1		1			1		1		1	1					1	1	
21.		1		1	1		1		1			1		1		1	1			1	1	
22.	1		1			1		1		1	1			1	1		1			1		1
23.		1		1	1		1			1		1		1		1	1			1	1	
24.	1		1		1		1		1		1		1		1		1			1	1	
25.	1			1	1		1		1			1	1			1	1			1		1
26.	1		1		1		1		1		1		1		1		1			1	1	
27.		1	1		1		1		1			1	1			1	1			1		1
28.		1	1		1		1			1		1	1			1	1			1		1
29.		1		1	1		1			1	1		1		1		1			1	1	
30.		1	1		1		1		1		1		1			1	1			1	1	
31.		1	1		1		1		1			1		1	1		1			1		1
32.		1		1	1		1			1		1	1		1		1			1	1	
33.		1	1		1		1			1		1		1		1	1			1		1
34.		1		1	1		1			1		1		1		1	1			1		1
35.		1	1			1		1		1		1		1		1		1	1			1

Part I Pair-Choice: Risk Management (Page 2 of 2)

	A-P		A-1		B-P		B-1		C-P		C-1		D-P		D-1		D-2		E-P		E-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
36.	1		1		1		1		1		1		1		1		1			1	1	
37.	1		1		1			1	1		1		1		1		1		1		1	
38.	1			1	1		1			1	1		1			1	1		1		1	
39.	1		1		1			1		1		1	1		1		1			1	1	
40.	1		1		1			1		1		1	1			1	1			1	1	
41.		1	1		1		1		1		1		1			1	1			1	1	
42.	1		1		1		1		1			1	1		1		1		1		1	
43.		1		1	1		1			1		1		1		1		1		1		1
44.		1	1		1		1			1		1		1	1		1			1		1
45.		1		1	1		1		1			1	1		1		1			1	1	
46.		1		1	1		1			1		1	1			1				1	1	
47.		1	1		1		1		1			1	1		1		1			1	1	
48.		1		1	1		1			1		1	1		1		1			1		1
49.		1	1		1		1		1			1	1		1		1			1	1	
50.		1		1	1		1			1		1		1		1	1			1		1
51.		1		1	1		1		1			1		1		1	1			1		1
52.		1		1	1		1			1		1		1		1				1		1
53.		1		1	1		1		1		1			1		1	1			1	1	
54.		1		1	1			1		1		1		1		1		1		1		1
55.	1		1		1		1		1		1		1		1		1			1	1	
56.	1			1	1		1		1		1		1		1		1			1	1	
57.		1		1	1		1			1		1		1		1	1			1	1	
58.		1		1	1		1			1		1	1			1	1			1		1
59.		1	1		1		1		1			1	1			1	1			1	1	
60.		1	1		1			1		1		1		1	1		1			1		1
61.		1	1		1		1			1	1		1			1	1			1	1	
62.	1		1		1		1		1			1	1		1		1			1	1	
63.		1		1	1		1		1			1		1		1	1			1		1
64.		1	1			1		1		1	1			1	1			1	1		1	
65.				1	1		1			1		1		1	1		1			1		1
66.	1			1		1		1		1		1		1		1		1	1		1	
67.		1		1	1			1	1			1	1			1	1					1
68.		1		1	1		1			1		1		1		1		1		1		1
69.	1		1		1				1			1		1		1		1		1		1
70.		1		1		1		1		1	1		1		1			1	1			1

Part I Pair-Choice: Risk Management (Page 1 of 2)

	F-P		F-1		G-P		G-1		H-P		H-1		I-P		I-1		J-P		J-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
1.		1	1			1		1	1		1			1		1	1			1
2.		1	1			1	1		1		1			1		1	1		1	
3.	1		1		1			1		1		1				1		1	1	
4.	1		1			1	1			1		1				1	1		1	
5.		1	1		1					1		1			1			1	1	
6.	1		1		1			1		1		1			1			1		1
7.	1		1		1		1			1		1				1	1		1	
8.		1	1		1		1			1		1		1	1		1		1	
9.		1		1		1			1		1			1		1	1			1
10.	1			1		1		1	1		1			1		1	1			1
11.		1		1		1		1	1		1			1		1	1			1
12.		1		1		1		1	1		1			1		1	1			1
13.		1		1		1	1		1		1			1		1	1			1
14.		1	1			1		1		1		1		1		1		1		1
15.		1		1		1		1		1		1				1		1		1
16.		1		1		1	1			1	1					1	1			1
17.	1			1	1			1		1		1			1			1		1
18.	1			1		1	1			1		1				1		1	1	
19.	1		1		1		1		1		1				1			1	1	
20.		1	1		1					1		1				1		1		1
21.		1		1	1		1		1		1					1	1			1
22.		1	1		1		1		1			1				1		1	1	
23.		1		1		1		1	1		1					1	1			1
24.		1		1	1		1		1		1			1	1		1		1	
25.		1		1	1			1	1		1			1		1	1		1	
26.		1		1	1		1		1		1			1		1	1		1	
27.		1		1	1			1	1		1			1		1	1		1	
28.		1	1		1			1		1		1		1		1		1	1	
29.		1	1			1		1	1		1			1		1	1			1
30.		1	1		1		1		1		1			1		1	1		1	
31.		1	1			1		1	1		1			1		1	1		1	
32.		1	1			1	1		1		1			1		1	1		1	
33.		1	1			1		1	1		1			1		1		1		1
34.		1		1		1		1	1		1			1		1	1			1
35.	1		1			1		1		1		1	1			1		1		1

Part I Pair-Choice: Risk Management (Page 2 of 2)

	F-P		F-1		G-P		G-1		H-P		H-1		I-P		I-1		J-P		J-1	
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
36.	1			1	1			1	1		1			1		1	1			1
37.	1		1		1		1		1		1		1		1			1	1	
38.		1		1	1			1	1		1			1		1	1		1	
39.		1		1	1			1	1					1		1	1			1
40.		1		1	1		1		1					1		1	1		1	
41.		1		1	1		1		1		1			1	1		1		1	
42.		1		1	1		1		1		1			1		1	1		1	
43.		1		1		1		1	1		1					1	1			1
44.		1		1		1		1	1		1			1		1	1			1
45.		1		1	1			1	1		1			1		1	1		1	
46.		1		1		1		1	1			1		1		1	1		1	
47.		1		1	1			1	1			1		1		1	1			1
48.		1		1		1	1		1		1			1		1	1		1	
49.		1		1	1		1		1		1			1		1	1			1
50.		1		1		1	1		1		1			1		1	1			1
51.		1		1		1		1	1		1			1		1	1		1	
52.		1		1		1		1		1		1		1		1				1
53.		1		1	1			1	1		1			1		1		1		1
54.		1		1		1		1		1		1		1		1		1		1
55.	1			1	1		1		1		1		1		1		1			1
56.	1			1	1		1		1		1			1		1	1		1	
57.		1		1	1			1		1		1		1		1	1		1	
58.		1		1	1			1	1			1		1		1	1			1
59.		1		1	1		1		1		1			1		1	1		1	
60.		1		1		1		1	1		1			1		1	1			1
61.		1		1	1			1	1		1			1		1	1			1
62.		1		1	1		1		1		1			1		1	1			1
63.		1	1			1		1	1			1		1		1	1			1
64.	1		1		1		1			1		1			1			1	1	
65.		1		1		1		1	1		1			1		1	1			1
66.	1			1	1			1		1		1			1			1	1	
67.		1		1		1		1		1	1					1	1			1
68.		1		1		1		1	1		1			1		1	1		1	
69.		1		1	1			1	1			1		1		1	1			1
70.	1		1			1	1			1		1		1		1		1		1

Part II Yes/No: Requirements Management

	A-P			A-1			B-P			B-1			C-P			C-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.		1		1			1			1			1			1		
2.	1			1			1			1			1			1		
3.		1		1			1			1			1			1		
4.	1				1			1			1			1			1	
5.	1			1				1			1			1			1	
6.	1			1			1			1			1			1		
7.	1			1			1			1			1				1	
8.	1			1			1			1			1			1		
9.		1			1			1			1			1			1	
10.	1			1			1			1			1				1	
11.		1			1			1			1			1			1	
12.	1			1				1		1			1			1		
13.	1				1			1			1		1				1	
14.	1				1			1		1			1			1		
If a waterfall or sequential development strategy:																		
15.				1			1			1							1	
16.					1			1			1					1		
17.					1			1			1						1	
18.				1			1			1						1		
19.					1			1		1							1	
20.					1			1			1						1	
If a prototype, throwaway, or other development strategy:																		
15.	1												1					
16.		1												1				
17.		1											1					
18.	1												1					
19.		1											1					
20.		1												1				
21.		1		1			1			1			1			1		
22.	1				1		1			1			1			1		
23.		1		1			1			1			1			1		
24.	1			1			1			1			1			1		
25.	1			1			1			1			1			1		
26.	1			1			1			1			1			1		
27.		1		1			1				1		1			1		
28.	1			1			1			1			1			1		
29.		1		1			1			1			1			1		
30.	1			1			1			1			1			1		
31.		1		1			1			1			1			1		
32.		1			1		1			1			1			1		
33.		1		1				1		1				1			1	
34.		1		1			1			1			1			1		
35.	1			1				1			1			1			1	
36.		1		1			1			1			1				1	
37.		1		1			1			1			1			1		
38.	1				1			1			1			1			1	
39.		1			1		1				1		1			1		
40.	1			1				1			1			1				
41.		1		1			1			1			1				1	
42.		1		1			1			1			1			1		
43.	1				1			1			1			1			1	
44.		1		1			1			1			1			1		
45.		1			1		1					1		1		1		
46.	1			1			1			1			1			1		
47.	1			1			1			1			1			1		

Part II Yes/No: Requirements Management

	D-P			D-1			D-2			E-P			E-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.	1			1			1			1			1		
2.	1			1			1			1			1		
3.	1			1			1			1			1		
4.		1			1			1		1				1	
5.	1				1			1		1			1		
6.		1		1			1				1			1	
7.		1		1			1				1			1	
8.	1				1				1	1			1		
9.		1			1			1			1		1		
10.		1		1			1				1		1		
11.		1			1			1			1		1		
12.		1		1			1				1		1		
13.	1				1			1		1			1		
14.	1			1				1			1			1	
If a waterfall or sequential development strategy:															
15.							1								
16.								1							
17.								1							
18.							1								
19.								1							
20.								1							
If a prototype, throwaway, or other development strategy:															
15.	1			1						1				1	
16.		1			1						1			1	
17.	1			1							1			1	
18.		1		1						1			1		
19.	1			1						1			1		
20.	1			1						1			1		
21.	1				1		1				1			1	
22.	1			1			1			1			1		
23.	1			1			1				1		1		
24.		1		1			1				1			1	
25.	1			1			1			1			1		
26.	1			1			1			1			1		
27.	1			1			1				1		1		
28.	1			1			1			1			1		
29.		1		1				1			1		1		
30.	1			1			1				1		1		
31.		1		1			1				1		1		
32.	1			1			1				1		1		
33.		1		1			1				1			1	
34.		1		1			1			1			1		
35.		1			1			1			1			1	
36.	1			1			1			1			1		
37.	1			1			1				1		1		
38.		1			1			1			1			1	
39.	1			1			1				1			1	
40.		1			1			1		1				1	
41.		1			1		1				1			1	
42.	1				1		1				1		1		
43.	1			1				1		1			1		
44.		1		1				1			1			1	
45.	1			1				1			1			1	
46.	1			1			1				1		1		
47.	1			1			1			1			1		

Part II Yes/No: Requirements Management

	F-P			F-1			G-P			G-1			H-P			H-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.	1			1			1			1			1			1		
2.	1			1			1			1			1			1		
3.	1			1			1			1			1			1		
4.		1			1			1			1			1			1	
5.	1				1		1				1			1			1	
6.	1			1				1		1				1			1	
7.		1			1			1			1			1			1	
8.	1			1			1			1			1			1		
9.		1			1			1			1				1		1	
10.	1			1			1			1					1	1		
11.	1				1		1				1				1		1	
12.		1		1			1			1					1		1	
13.	1			1			1				1				1		1	
14.	1				1			1			1				1	1		
If a waterfall or sequential development strategy:																		
15.		1			1			1		1								
16.		1		1			1				1							
17.		1			1			1			1							
18.	1				1		1			1								
19.		1			1			1				1						
20.		1			1		1				1							
If a prototype, throwaway, or other development strategy:																		
15.														1		1		
16.														1			1	
17.													1			1		
18.													1			1		
19.													1			1		
20.													1			1		
21.	1			1			1			1			1			1		
22.		1		1			1			1			1			1		
23.		1		1				1			1		1			1		
24.	1			1			1			1			1				1	
25.	1			1			1			1			1			1		
26.	1			1			1			1			1			1		
27.	1			1			1				1		1			1		
28.	1			1			1			1			1				1	
29.		1			1		1					1	1				1	
30.	1			1			1			1			1			1		
31.		1		1			1				1		1			1		
32.		1		1			1			1				1			1	
33.	1				1			1		1				1		1		
34.	1			1			1			1			1			1		
35.		1			1			1			1		1			1		
36.		1			1		1			1			1				1	
37.	1			1			1			1			1			1		
38.		1			1			1			1			1			1	
39.		1		1				1			1		1			1		
40.	1				1		1				1			1			1	
41.		1			1			1		1				1			1	
42.	1			1				1		1			1			1		
43.	1			1			1				1			1		1		
44.		1			1		1			1			1				1	
45.	1			1				1			1			1			1	
46.	1			1			1			1			1			1		
47.	1			1			1			1			1			1		

Part II Yes/No: Requirements Management

	I-P			I-1			J-P			J-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.		1			1		1			1		
2.	1			1			1			1		
3.	1				1		1			1		
4.		1			1			1			1	
5.		1		1				1			1	
6.	1				1		1			1		
7.		1			1		1				1	
8.	1			1			1			1		
9.		1			1			1			1	
10.		1			1		1				1	
11.		1		1				1			1	
12.		1			1			1		1		
13.	1				1			1			1	
14.		1			1		1			1		
If a waterfall or sequential development strategy:												
15.					1						1	
16.				1						1		
17.					1						1	
18.					1					1		
19.				1						1		
20.				1							1	
If a prototype, throwaway, or other development strategy:												
15.							1					
16.								1				
17.								1				
18.								1				
19.								1				
20.							1					
21.		1			1		1			1		
22.		1			1		1			1		
23.		1			1		1				1	
24.	1				1		1			1		
25.	1			1			1			1		
26.	1			1			1			1		
27.	1			1			1				1	
28.		1			1		1			1		
29.		1			1		1			1		
30.		1			1		1			1		
31.			1		1		1			1		
32.		1		1			1			1		
33.		1		1				1		1		
34.	1			1			1			1		
35.		1			1			1			1	
36.	1				1		1			1		
37.		1			1		1			1		
38.		1		1				1			1	
39.		1			1		1			1		
40.	1				1			1			1	
41.		1			1			1		1		
42.		1			1		1			1		
43.		1		1				1			1	
44.	1				1		1			1		
45.	1			1				1		1		
46.		1		1			1				1	
47.		1			1		1			1		

Part II Yes/No: Estimation/Planning Management

	A-P			A-1			B-P			B-1			C-P			C-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.		1			1		1			1			1				1	
2.		1			1		1			1			1				1	
3.		1		1			1			1			1				1	
4.		1		1			1			1			1				1	
5.	1				1		1			1			1				1	
6.		1			1		1			1			1				1	
7.	1				1		1			1			1				1	
8.		1			1		1			1				1			1	
9.		1			1		1			1				1			1	
10.	1			1			1			1			1				1	
11.		1			1		1						1				1	
12.	1			1			1			1			1			1		
13.	1			1			1			1			1			1	1	
14.	1				1		1			1			1				1	
15.	1				1		1			1			1				1	
16.	1			1			1			1			1			1		
17.	1			1			1			1			1				1	
18.	1				1		1			1			1			1		
19.		1				1	1				1			1			1	
20.	1				1		1			1			1			1		
21.	1			1				1			1			1		1		
22.	1				1		1			1			1			1	1	
23.	1			1			1			1			1				1	
24.		1		1			1			1				1			1	
25.		1		1			1			1				1			1	
26.	1			1			1			1				1			1	
27.	1			1			1			1			1				1	
28.		1		1					1		1			1			1	
29.	1				1		1			1				1			1	
30.	1			1			1			1			1				1	
31.	1			1			1			1				1		1		
32.	1			1			1			1			1			1		
33.		1			1		1			1				1			1	
34.	1			1			1			1			1				1	
35.		1			1			1			1			1		1		
36.		1			1		1			1				1			1	
37.	1			1			1			1					1		1	
38.	1			1			1			1			1			1		
39.	1				1		1			1			1			1		
40.	1			1			1			1			1			1		
41.		1		1			1			1			1			1		
42.	1				1			1		1			1			1		
43.		1			1		1				1		1				1	
44.		1		1				1		1				1			1	
45.		1			1		1			1			1			1		
46.	1			1			1			1			1			1		
47.		1		1			1			1			1			1		
48.	1			1			1			1			1			1		
49.		1			1				1	1			1				1	
50.	1				1		1			1			1				1	

Part II Yes/No: Estimation/Planning Management

	D-P			D-1			D-2			E-P			E-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.		1			1		1				1			1	
2.		1			1		1				1			1	
3.		1			1		1				1			1	
4.		1			1		1				1		1		
5.		1			1		1				1		1		
6.		1		1			1			1			1		
7.		1		1			1			1			1		
8.		1			1		1			1			1		
9.		1			1		1				1		1		
10.	1			1			1				1			1	
11.		1		1			1				1		1		
12.	1			1			1			1			1		
13.		1			1		1				1		1		
14.	1			1			1			1			1		
15.	1			1			1			1			1		
16.	1				1		1			1			1		
17.	1				1		1			1				1	
18.		1			1		1				1		1		
19.		1			1						1			1	
20.		1		1			1				1		1		
21.	1			1				1		1				1	
22.	1			1			1			1			1		
23.		1			1		1			1			1		
24.	1				1		1				1			1	
25.	1				1		1				1			1	
26.	1				1		1				1			1	
27.		1			1		1				1		1		
28.		1			1		1				1			1	
29.	1				1		1			1			1		
30.	1			1			1			1			1		
31.		1			1		1				1			1	
32.	1			1			1			1			1		
33.		1			1		1				1			1	
34.	1				1		1				1		1		
35.	1			1				1			1			1	
36.		1			1		1				1			1	
37.		1			1			1			1			1	
38.	1			1			1			1			1		
39.	1			1			1			1			1		
40.	1					1	1				1		1		
41.	1				1		1				1			1	
42.	1				1		1			1			1		
43.		1			1		1			1			1		
44.		1		1				1			1			1	
45.		1			1		1			1			1		
46.		1			1		1			1			1		
47.		1		1			1				1		1		
48.	1			1			1			1			1		
49.		1			1				1		1		1		
50.		1			1		1				1		1		

Part II Yes/No: Estimation/Planning Management

	F-P			F-1			G-P			G-1			H-P			H-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.		1			1		1				1		1			1		
2.		1			1		1				1		1			1		
3.		1			1			1			1		1			1		
4.	1				1		1				1		1			1		
5.		1			1		1				1		1			1		
6.		1			1			1			1		1			1		
7.		1			1		1				1		1			1		
8.		1			1		1				1		1			1		
9.		1			1		1				1			1		1		
10.		1			1			1		1				1			1	
11.		1			1			1			1		1				1	
12.	1			1			1			1			1			1		
13.		1			1		1			1			1			1		
14.	1			1			1			1				1			1	
15.	1			1			1			1				1			1	
16.	1			1			1			1			1			1		
17.		1			1		1				1		1			1		
18.		1			1		1				1		1				1	
19.		1			1				1		1		1			1		
20.		1			1		1				1		1			1		
21.	1				1			1			1			1			1	
22.		1			1		1			1			1			1		
23.	1			1			1			1			1			1		
24.		1			1			1		1			1			1		
25.		1			1			1		1			1			1		
26.		1			1		1			1			1			1		
27.		1			1		1			1			1			1		
28.		1			1		1				1			1			1	
29.		1			1		1			1			1			1		
30.	1			1			1			1			1			1		
31.	1			1				1			1			1		1		
32.	1				1		1			1			1			1		
33.		1			1			1			1		1			1		
34.	1			1			1			1			1			1		
35.		1			1			1			1			1			1	
36.		1			1			1		1			1			1		
37.	1			1			1			1			1				1	
38.	1				1			1		1			1			1		
39.	1			1				1			1		1			1		
40.	1			1			1			1			1			1		
41.		1			1				1		1		1				1	
42.		1			1			1			1		1			1		
43.		1			1		1				1		1				1	
44.	1				1		1				1			1		1		
45.	1				1			1		1				1		1		
46.	1				1		1			1				1		1		
47.		1		1				1		1				1			1	
48.	1			1			1			1			1			1		
49.		1			1			1			1			1			1	
50.	1				1		1				1			1			1	

Part II Yes/No: Estimation/Planning Management

	I-P			I-1			J-P			J-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.		1			1			1		1		
2.		1			1			1			1	
3.		1			1		1				1	
4.		1			1		1			1		
5.			1		1		1			1		
6.		1			1		1			1		
7.		1			1		1				1	
8.			1		1		1			1		
9.			1		1			1		1		
10.			1		1			1			1	
11.		1			1			1			1	
12.	1			1			1			1		
13.		1		1			1			1		
14.		1			1			1		1		
15.		1			1			1		1		
16.	1				1		1			1		
17.	1				1			1			1	
18.		1			1		1			1		
19.		1			1			1		1		
20.		1			1		1			1		
21.	1			1				1			1	
22.		1			1		1			1		
23.	1			1			1			1		
24.		1			1		1			1		
25.			1		1		1			1		
26.		1			1		1			1		
27.		1			1			1		1		
28.		1			1			1			1	
29.	1				1			1		1		
30.	1			1			1			1		
31.		1		1				1		1		
32.	1				1		1				1	
33.		1			1			1		1		
34.	1				1		1			1		
35.			1	1				1			1	
36.		1			1		1			1		
37.	1				1				1		1	
38.	1				1		1			1		
39.	1				1			1			1	
40.		1		1			1				1	
41.	1				1			1			1	
42.	1				1		1			1		
43.	1				1			1			1	
44.	1			1				1		1		
45.	1			1			1			1		
46.		1		1			1			1		
47.		1			1		1			1		
48.	1			1			1				1	
49.		1			1			1			1	
50.	1				1		1			1		

Part II Yes/No: People Management

	A-P			A-1			B-P			B-1			C-P			C-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.	1			1			1			1			1			1		
2.	1			1			1			1			1			1		
3.	1			1			1			1			1			1		
4.	1			1			1			1			1			1		
5.	1				1		1			1			1			1		
6.	1			1			1			1			1			1		
7.	1			1			1			1			1			1		
8.	1			1			1			1			1			1		
9.		1			1			1			1			1			1	
10.	1				1		1			1			1			1		
11.	1			1			1			1			1			1		
12.	1				1		1			1			1			1		
13.		1			1		1			1			1			1		
14.	1			1			1				1		1			1		
15.		1			1			1		1					1		1	
16.	1				1			1		1			1				1	
17.		1			1		1				1			1			1	
18.	1			1				1		1			1			1		
19.	1				1		1			1			1			1		
20.	1				1		1			1			1			1		
21.	1			1			1			1			1			1		
22.	1			1			1			1			1			1		
23.	1			1			1			1			1			1		
24.	1				1		1			1			1			1		
25.	1				1			1		1			1			1		
26.	1			1				1		1			1			1		
27.	1				1		1			1			1			1		
28.		1			1			1		1				1		1		
29.		1		1				1			1			1			1	
30.		1		1			1				1			1			1	
31.		1		1				1			1			1			1	
32.		1		1				1		1				1			1	
33.	1			1			1			1			1			1		
34.	1				1			1			1			1			1	
35.	1			1			1			1			1			1		
36.	1			1			1			1			1			1		
37.	1			1			1			1			1			1		
38.		1		1				1			1			1			1	
39.	1			1			1			1			1				1	
40.		1			1			1			1			1			1	
41.	1			1			1			1			1			1		
42.	1			1			1			1			1			1		
43.	1				1		1			1			1				1	
44.	1				1		1			1			1				1	
45.	1			1			1			1					1	1		
46.	1				1		1			1			1			1		
47.		1		1				1				1	1				1	
48.		1			1			1			1		1				1	
49.	1			1			1				1		1			1		
50.	1			1			1			1			1			1		

Part II Yes/No: People Management

	D-P			D-1			D-2			E-P			E-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.	1			1			1			1			1		
2.	1			1			1			1			1		
3.	1			1			1			1			1		
4.	1			1					1		1				1
5.			1		1				1		1				1
6.			1		1		1				1		1		
7.	1				1		1			1			1		
8.	1					1	1			1			1		
9.		1			1			1			1			1	
10.	1				1		1			1			1		
11.	1				1		1			1			1		
12.	1			1			1			1			1		
13.			1			1		1			1				1
14.			1			1			1		1			1	
15.			1			1			1		1			1	
16.			1		1				1	1				1	
17.		1			1		1				1			1	
18.	1					1	1			1			1		
19.	1			1			1				1		1		
20.	1			1			1			1			1		
21.	1				1		1				1		1		
22.	1				1		1			1			1		
23.	1			1			1			1			1		
24.	1					1		1			1		1		
25.	1					1		1			1			1	
26.	1			1			1			1			1		
27.	1			1			1			1			1		
28.		1				1		1		1				1	
29.		1				1	1				1			1	
30.		1				1	1				1			1	
31.		1				1	1				1			1	
32.		1			1		1				1			1	
33.	1					1	1			1			1		
34.	1			1			1				1			1	
35.	1			1			1			1			1		
36.	1			1			1			1			1		
37.	1				1		1			1			1		
38.		1		1			1				1			1	
39.			1			1		1			1			1	
40.			1		1		1			1				1	
41.			1	1			1			1			1		
42.	1			1			1			1			1		
43.			1			1	1			1					1
44.			1			1	1			1			1		
45.			1			1		1			1			1	
46.	1					1		1		1			1		
47.	1					1	1			1			1		
48.			1			1	1				1		1		
49.	1					1	1			1				1	
50.	1			1			1				1		1		

Part II Yes/No: People Management

	F-P			F-1			G-P			G-1			H-P			H-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.	1			1			1			1			1			1		
2.	1			1					1			1	1			1		
3.	1			1			1			1			1			1		
4.	1			1			1			1			1			1		
5.	1				1			1				1	1			1		
6.	1			1			1			1			1			1		
7.	1			1			1			1			1			1		
8.	1				1		1			1			1			1		
9.		1			1			1			1			1			1	
10.	1			1			1			1				1		1		
11.	1			1			1			1				1		1		
12.	1			1			1			1			1			1		
13.		1		1					1			1	1			1		
14.	1			1			1					1	1			1		
15.		1			1		1					1		1		1		
16.	1			1			1			1				1			1	
17.		1			1		1				1		1				1	
18.	1			1				1		1				1		1		
19.	1			1			1			1			1			1		
20.	1			1			1			1				1		1		
21.	1			1			1			1			1			1		
22.	1			1			1			1			1			1		
23.	1			1			1			1			1			1		
24.	1				1		1			1			1				1	
25.		1			1		1				1		1				1	
26.		1		1			1				1		1			1		
27.	1			1			1			1			1			1		
28.		1		1				1		1			1			1		
29.	1			1				1			1			1		1		
30.	1			1				1			1			1			1	
31.	1			1				1			1			1		1		
32.	1				1			1			1			1			1	
33.	1			1			1			1			1			1		
34.	1				1		1			1			1			1		
35.	1			1			1			1			1			1		
36.	1			1			1			1			1			1		
37.	1			1			1			1			1			1		
38.		1			1		1				1		1				1	
39.	1				1		1			1			1			1		
40.	1			1			1				1		1				1	
41.	1			1			1			1			1			1		
42.	1			1			1			1			1			1		
43.	1			1			1			1			1			1		
44.	1				1			1		1			1				1	
45.	1				1		1			1			1			1		
46.	1				1		1			1			1			1		
47.	1			1			1			1			1			1		
48.	1			1				1			1		1				1	
49.		1			1		1			1			1			1		
50.	1				1		1			1			1			1		

Part II Yes/No: People Management

	I-P			I-1			J-P			J-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.	1			1			1				1	
2.	1			1			1			1		
3.	1			1			1			1		
4.		1			1		1			1		
5.		1			1		1				1	
6.	1				1		1				1	
7.	1				1		1			1		
8.	1				1		1			1		
9.		1		1				1		1		
10.		1			1		1			1		
11.	1				1		1			1		
12.	1			1			1			1		
13.		1			1		1				1	
14.	1				1		1			1		
15.	1				1			1			1	
16.		1			1		1			1		
17.		1			1			1			1	
18.	1			1			1			1		
19.		1			1		1			1		
20.		1			1		1			1		
21.	1				1		1				1	
22.		1		1			1				1	
23.		1		1			1				1	
24.	1			1			1			1		
25.	1				1		1			1		
26.	1				1		1				1	
27.			1		1		1				1	
28.		1			1		1			1		
29.		1		1			1			1		
30.		1			1			1		1		
31.		1			1			1		1		
32.		1		1				1			1	
33.		1			1		1			1		
34.		1			1		1				1	
35.	1				1		1			1		
36.	1				1		1				1	
37.	1				1		1			1		
38.	1			1				1			1	
39.	1				1		1			1		
40.		1			1			1			1	
41.	1			1				1			1	
42.	1				1				1		1	
43.		1			1		1			1		
44.		1			1		1				1	
45.	1				1		1				1	
46.		1			1		1			1		
47.	1				1			1		1		
48.		1		1				1			1	
49.	1				1		1				1	
50.		1			1		1			1		

Part II Yes/No: Risk Management

	A-P			A-1			B-P			B-1			C-P			C-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.	1			1			1			1			1				1	
2.	1			1			1			1				1			1	
3.	1			1			1			1				1			1	
4.	1			1				1			1			1		1		
5.	1			1			1			1				1			1	
6.		1			1			1			1			1			1	
7.	1			1				1		1			1			1		
8.		1			1		1			1				1			1	
9.	1				1			1		1				1			1	
10.	1			1				1			1			1		1		
11.	1				1			1			1		1			1		
12.	1			1				1			1			1			1	
13.	1			1				1			1			1		1		
14.		1		1			1			1			1				1	
15.		1		1			1			1			1				1	
16.		1			1		1			1			1				1	
17.		1		1			1			1			1				1	
18.		1			1			1			1			1			1	
19.		1			1		1			1				1			1	
21.		1			1		1			1				1			1	
22.		1		1			1			1			1				1	
23.		1			1		1			1				1			1	
24.	1			1				1			1		1			1		
25.		1		1			1			1			1			1		
26.		1		1			1			1			1				1	
27.		1			1		1			1			1				1	
28.	1			1			1			1				1			1	
29.	1				1		1			1				1			1	
30.	1			1			1			1				1				1
31.	1			1			1			1			1			1		
32.	1			1			1			1			1				1	
33.	1			1			1			1			1				1	
34.		1		1			1			1			1				1	
35.		1		1			1			1			1				1	
36.		1		1			1			1			1				1	
37.		1		1			1			1			1				1	
38.	1				1		1			1			1				1	
39.	1			1			1			1			1				1	
40.		1			1		1			1			1				1	
41.		1			1		1			1			1				1	
42.		1			1		1			1				1			1	
43.		1			1		1			1			1				1	
44.	1				1		1				1			1			1	
45.		1			1			1			1			1		1		
46.		1		1			1			1				1			1	
47.		1			1		1			1				1			1	
48.		1			1		1			1				1			1	
49.		1			1		1			1				1			1	
50.		1			1			1			1			1			1	

Part II Yes/No: Risk Management

	D-P			D-1			D-2			E-P			E-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.	1			1			1				1		1		
2.		1		1			1				1			1	
3.		1		1			1				1			1	
4.		1		1				1		1					1
5.	1			1			1				1		1		
6.		1		1				1			1			1	
7.	1				1		1			1			1		
8.		1		1			1				1		1		
9.	1				1		1				1			1	
10.		1		1				1		1				1	
11.		1		1				1		1				1	
12.		1			1			1			1		1		
13.		1			1			1		1			1		
14.	1			1			1				1			1	
15.		1		1			1			1				1	
16.		1		1			1				1			1	
17.		1		1			1				1			1	
18.		1			1			1			1			1	
19.	1			1			1				1		1		
21.		1			1				1		1		1		
22.	1			1			1				1		1		
23.	1				1		1			1				1	
24.	1			1				1		1			1		
25.	1			1			1			1			1		
26.	1				1		1			1			1		
27.	1				1		1			1			1		
28.	1				1		1				1		1		
29.		1			1		1			1			1		
30.		1		1			1				1			1	
31.		1		1			1			1			1		
32.	1				1		1			1			1		
33.	1				1		1			1			1		
34.		1		1			1				1		1		
35.	1				1		1			1			1		
36.	1				1		1			1			1		
37.		1			1		1			1				1	
38.	1			1			1			1				1	
39.	1			1			1			1				1	
40.	1				1		1			1				1	
41.	1			1			1			1				1	
42.		1		1			1				1			1	
43.		1		1			1				1		1		
44.		1			1			1			1			1	
45.		1		1				1			1			1	
46.		1		1			1				1			1	
47.		1			1		1				1			1	
48.	1				1		1			1				1	
49.	1			1			1			1				1	
50.		1			1			1			1			1	

Part II Yes/No: Risk Management

	F-P			F-1			G-P			G-1			H-P			H-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.		1			1		1				1		1			1		
2.		1		1				1		1			1			1		
3.		1		1				1		1			1			1		
4.		1		1				1			1			1			1	
5.		1			1		1			1			1			1		
6.		1			1			1			1			1		1		
7.	1			1			1			1				1			1	
8.		1			1			1			1			1		1		
9.		1			1		1				1			1		1		
10.	1			1				1		1			1				1	
11.	1			1			1				1			1			1	
12.	1			1			1				1			1			1	
13.	1			1			1			1				1			1	
14.		1			1			1			1		1			1		
15.		1		1				1			1		1			1		
16.		1		1				1		1			1			1		
17.		1		1				1		1			1			1		
18.		1			1			1			1		1				1	
19.		1			1			1			1		1			1		
21.		1			1		1				1			1			1	
22.		1		1			1			1			1			1		
23.		1			1			1		1			1			1		
24.	1			1			1				1			1			1	
25.		1		1			1				1		1			1		
26.		1			1		1			1			1			1		
27.		1			1			1			1		1			1		
28.		1			1			1		1				1		1		
29.		1			1		1				1		1			1		
30.		1		1			1				1		1			1		
31.		1			1		1			1			1			1		
32.		1		1			1			1			1			1		
33.		1		1			1			1			1			1		
34.		1			1			1				1		1		1		
35.		1		1				1		1				1		1		
36.		1			1		1				1		1				1	
37.		1			1			1			1		1			1		
38.		1		1			1			1			1			1		
39.		1			1		1				1			1		1		
40.		1		1			1				1		1			1		
41.		1			1		1				1		1			1		
42.		1		1				1			1		1			1		
43.		1			1		1				1		1			1		
44.		1			1		1				1		1				1	
45.		1			1			1			1		1				1	
46.		1		1				1		1			1				1	
47.		1			1			1			1		1			1		
48.		1			1			1			1		1				1	
49.		1		1				1			1		1				1	
50.	1					1		1			1			1			1	

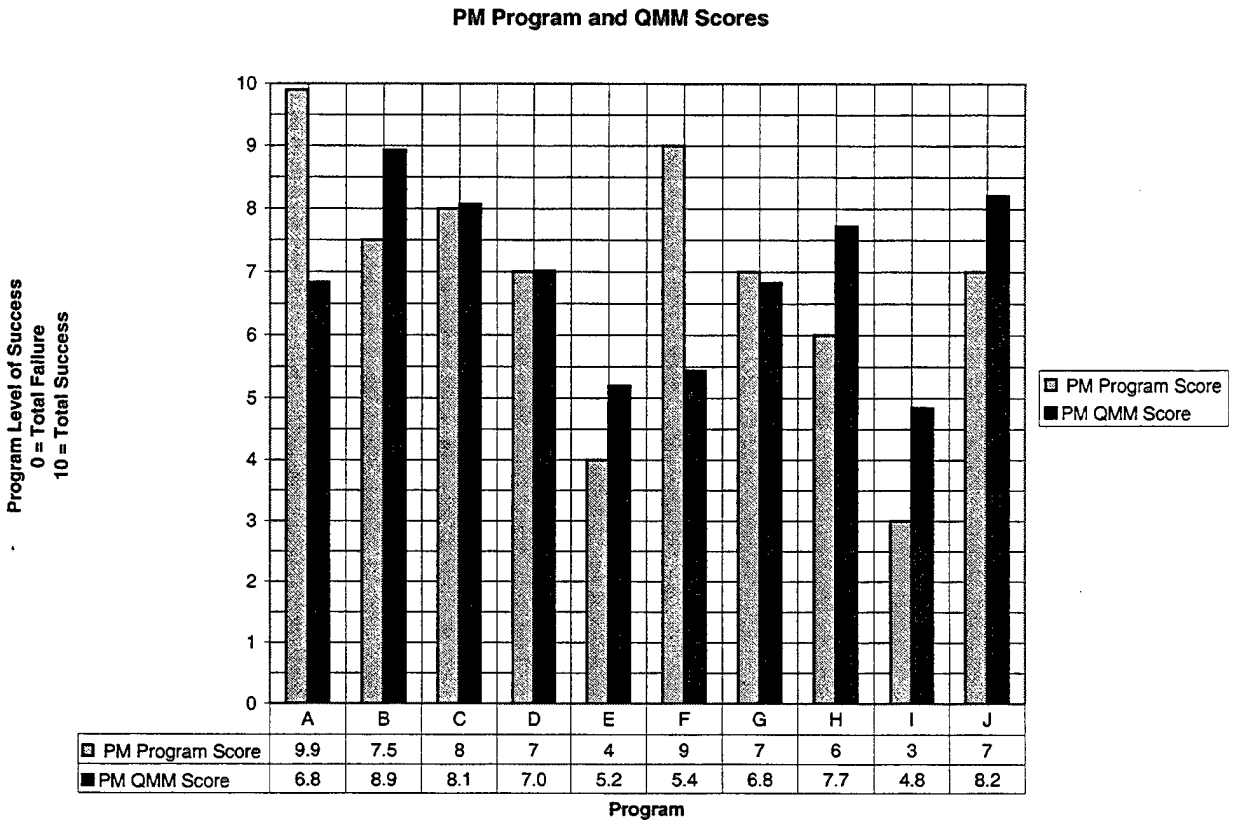
Part II Yes/No: Risk Management

	I-P			I-1			J-P			J-1		
	yes	no	n/a	yes	no	n/a	yes	no	n/a	yes	no	n/a
1.		1			1		1			1		
2.		1			1			1			1	
3.		1			1			1		1		
4.			1		1			1		1		
5.			1		1		1				1	
6.		1			1			1			1	
7.			1		1		1			1		
8.		1			1			1			1	
9.		1			1		1				1	
10.		1		1				1		1		
11.		1			1		1			1		
12.			1		1			1		1		
13.	1			1				1		1		
14.		1			1		1				1	
15.		1			1		1			1		
16.		1			1		1			1		
17.		1			1		1			1		
18.		1			1			1		1		
19.		1			1		1				1	
21.		1			1			1		1		
22.		1			1		1				1	
23.		1			1		1			1		
24.	1			1				1			1	
25.		1		1			1				1	
26.		1			1		1				1	
27.		1			1		1				1	
28.		1			1		1				1	
29.		1			1		1				1	
30.			1		1		1			1		
31.		1			1		1			1		
32.		1			1		1			1		
33.		1			1		1			1		
34.		1			1		1				1	
35.		1			1		1			1		
36.		1		1			1				1	
37.		1			1		1				1	
38.		1			1		1			1		
39.		1			1		1				1	
40.		1			1		1				1	
41.		1			1		1			1		
42.		1			1		1				1	
43.		1			1		1				1	
44.		1			1			1			1	
45.		1			1			1			1	
46.		1			1			1		1		
47.		1			1		1			1		
48.		1			1		1			1		
49.		1			1		1				1	
50.		1		1				1			1	

THIS PAGE INTENTIONALLY LEFT BLANK

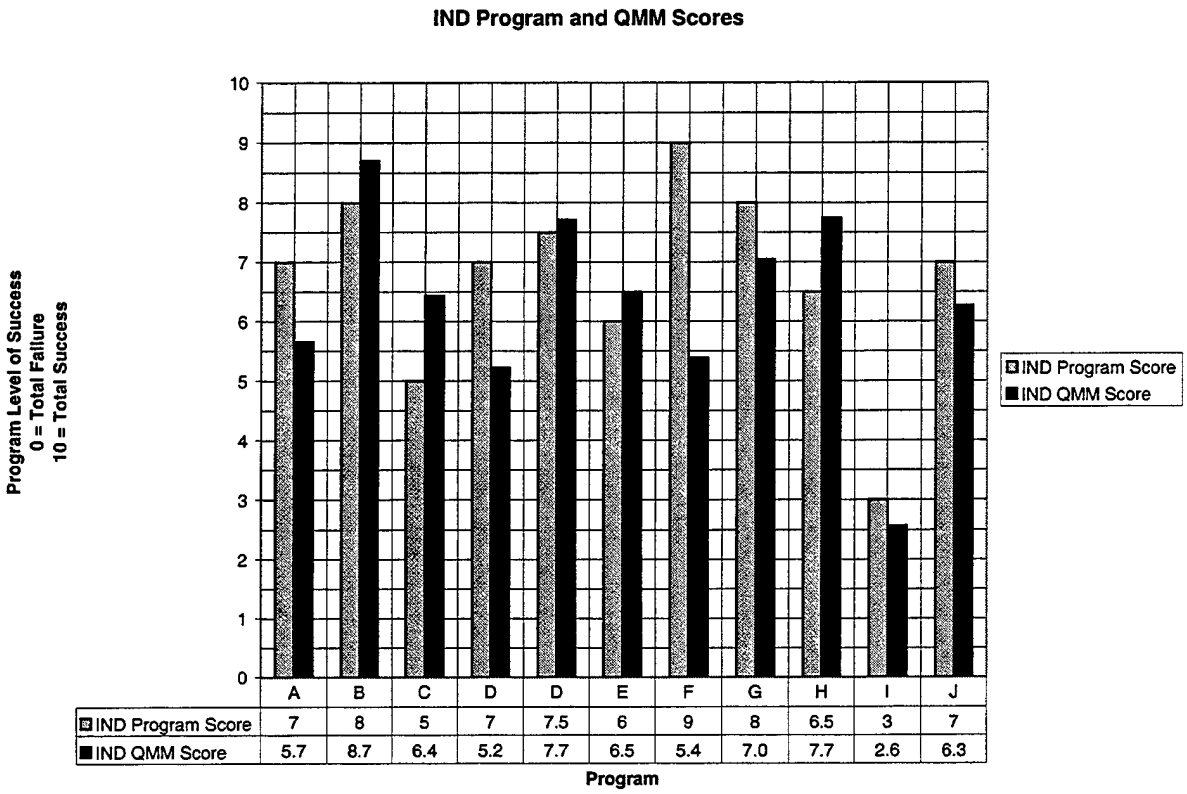
APPENDIX C. BAR CHARTS OF THE RESEARCH DATA

This appendix contains bar charts of the research data.



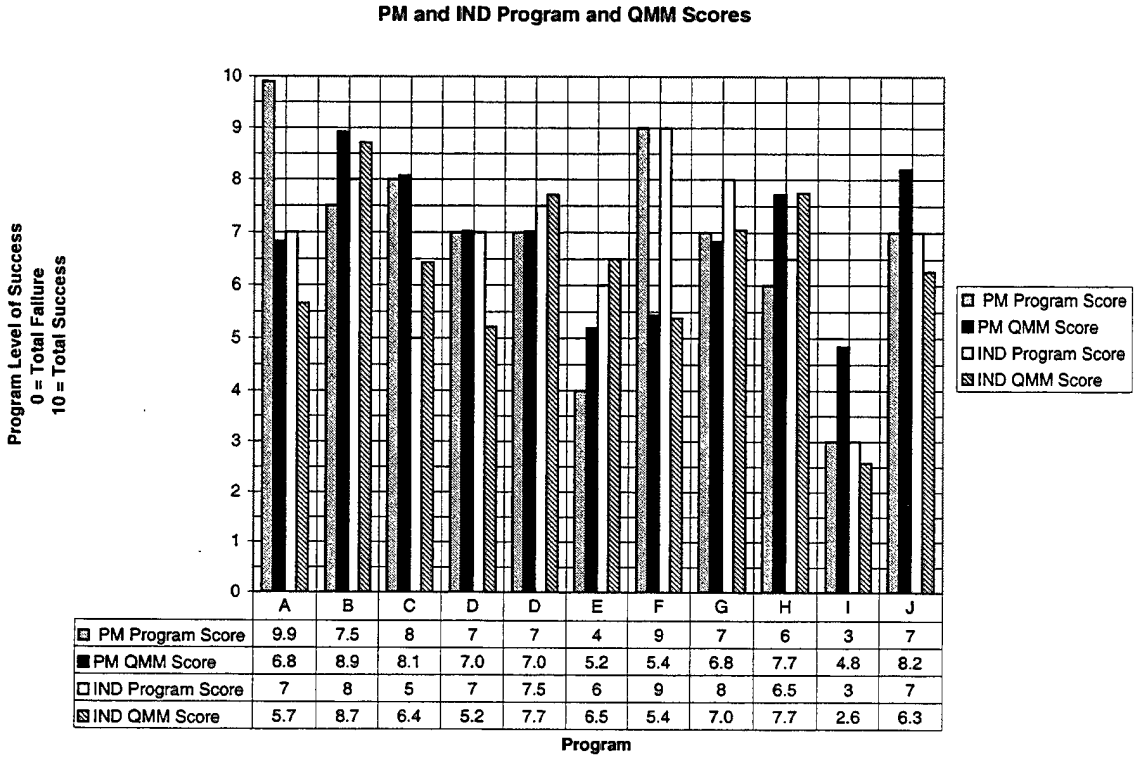
	A	B	C	D	E	F	G	H	I	J
PM Program Score	9.9	7.5	8	7	4	9	7	6	3	7
PM QMM Score	6.8	8.9	8.1	7.0	5.2	5.4	6.8	7.7	4.8	8.2

Figure C1. Program Manager Overall Program Scores and QMM Percentage Scores



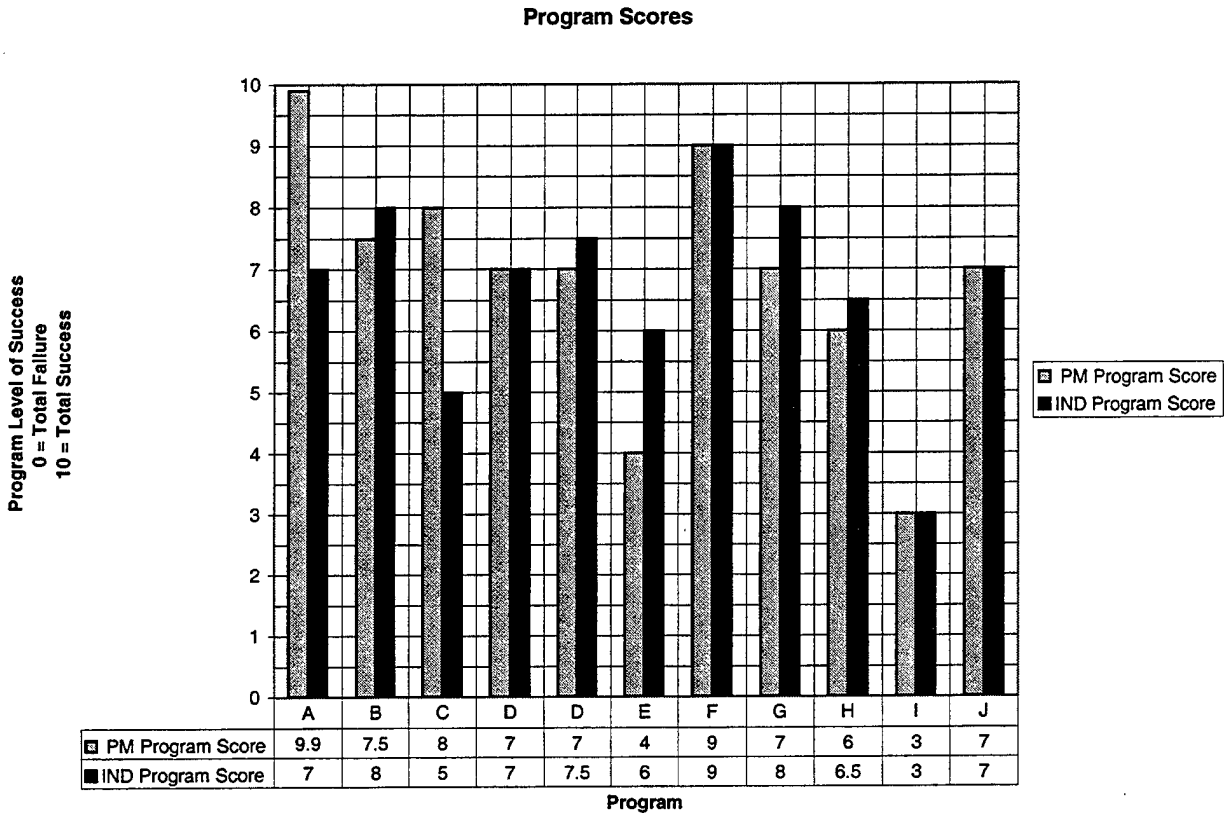
	A	B	C	D	D	E	F	G	H	I	J
IND Program Score	7	8	5	7	7.5	6	9	8	6.5	3	7
IND QMM Score	5.7	8.7	6.4	5.2	7.7	6.5	5.4	7.0	7.7	2.6	6.3

Figure C2. Individual Development Team Member Overall Program Scores and QMM Percentage Scores



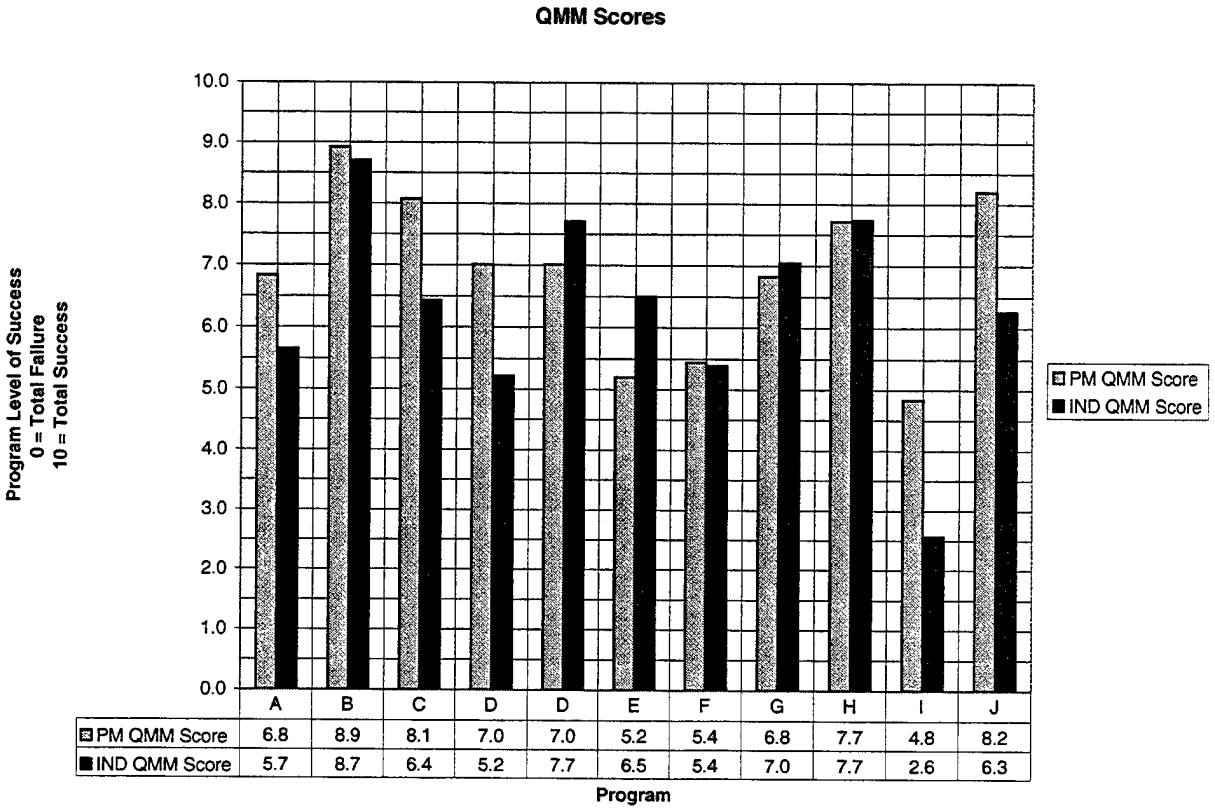
	A	B	C	D	D	E	F	G	H	I	J
PM Program Score	9.9	7.5	8	7	7	4	9	7	6	3	7
PM QMM Score	6.8	8.9	8.1	7.0	7.0	5.2	5.4	6.8	7.7	4.8	8.2
IND Program Score	7	8	5	7	7.5	6	9	8	6.5	3	7
IND QMM Score	5.7	8.7	6.4	5.2	7.7	6.5	5.4	7.0	7.7	2.6	6.3

Figure C3. Program Manager and Individual Development Team Member Overall Program Scores and QMM Percentage Scores



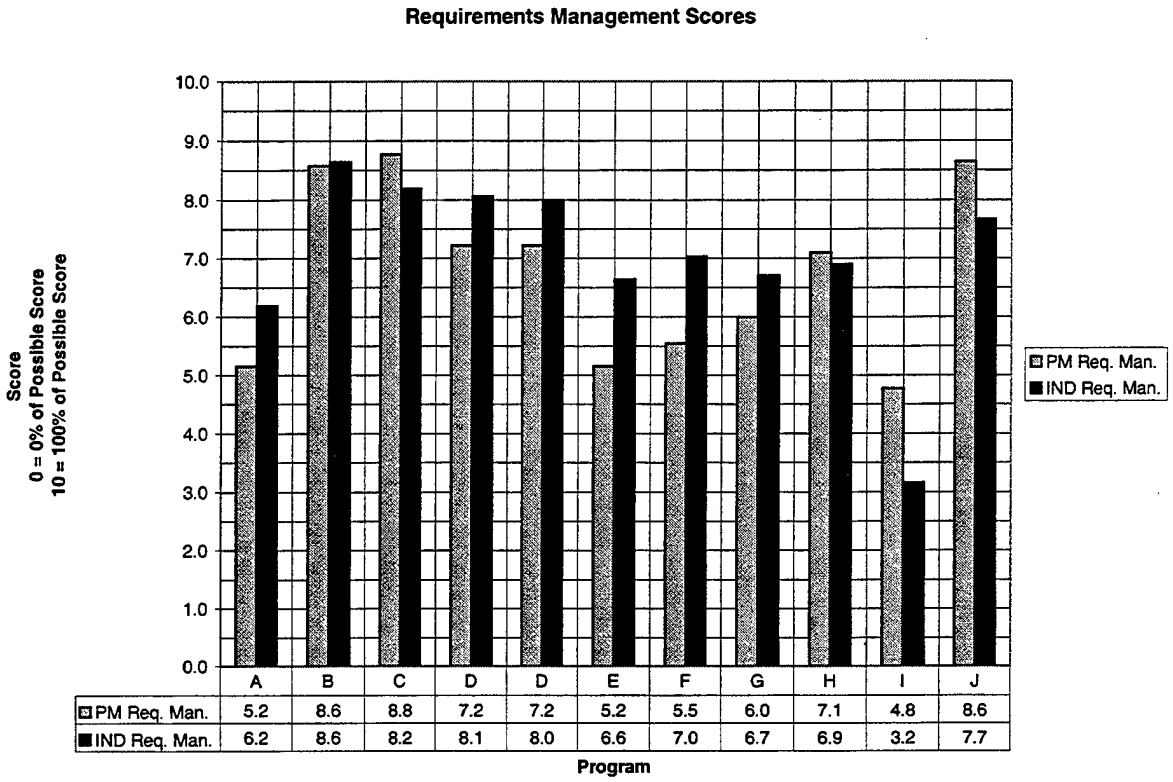
	A	B	C	D	D	E	F	G	H	I	J
PM Program Score	9.9	7.5	8	7	7	4	9	7	6	3	7
IND Program Score	7	8	5	7	7.5	6	9	8	6.5	3	7

Figure C4. Program Manager and Individual Development Team Member Overall Program Scores



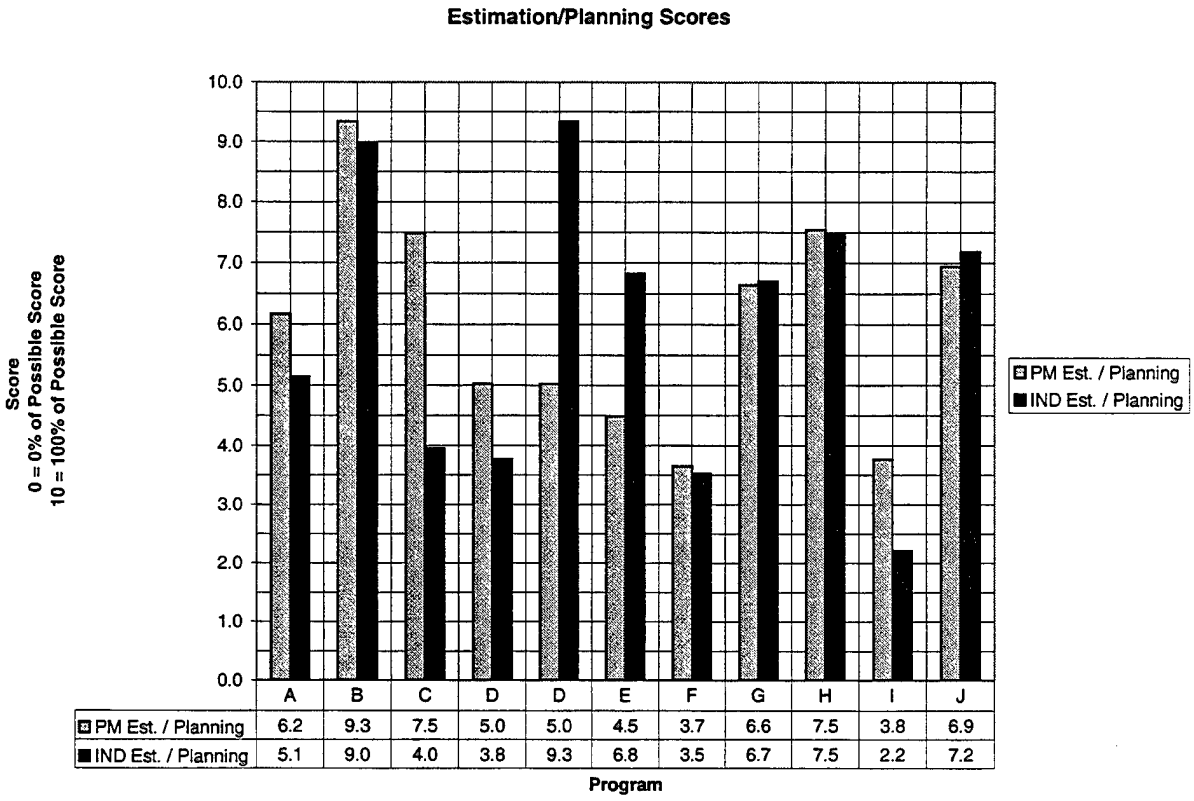
	A	B	C	D	D	E	F	G	H	I	J
PM QMM Score	6.8	8.9	8.1	7.0	7.0	5.2	5.4	6.8	7.7	4.8	8.2
IND QMM Score	5.7	8.7	6.4	5.2	7.7	6.5	5.4	7.0	7.7	2.6	6.3

Figure C5. Program Manager and Individual Development Team Member QMM Percentage Scores



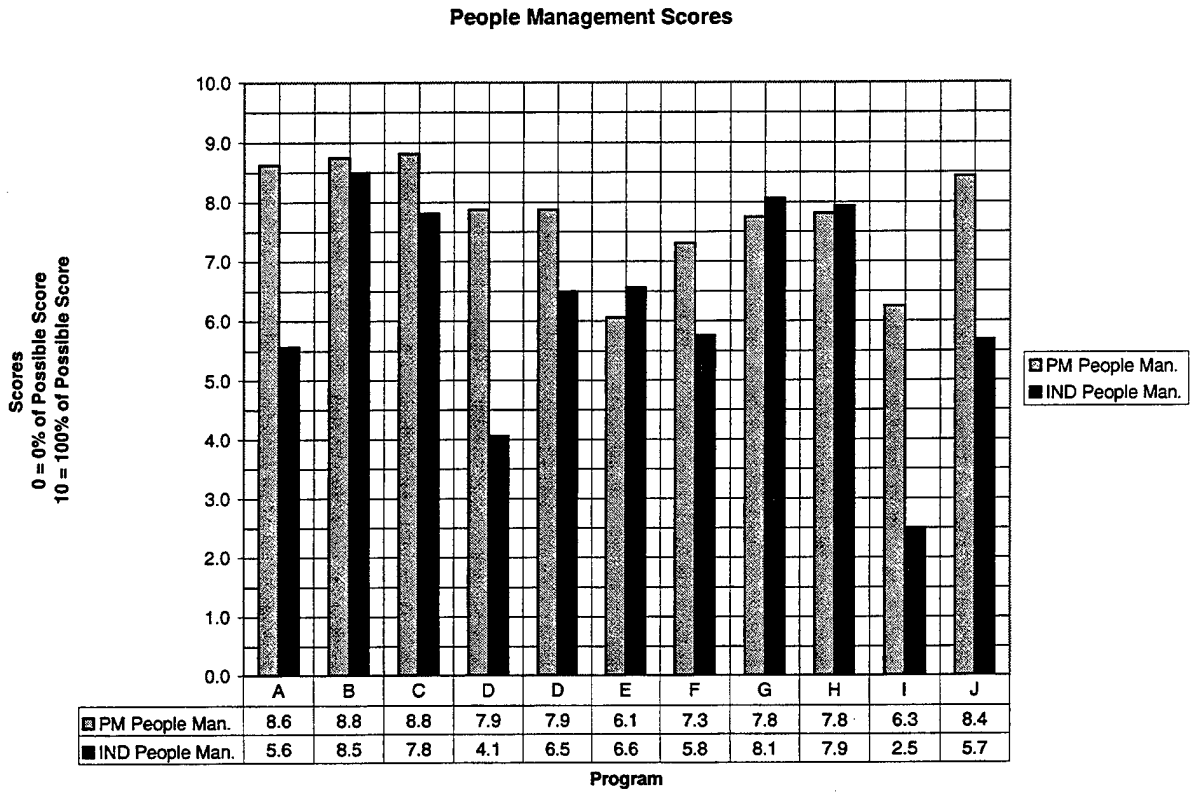
	A	B	C	D	D	E	F	G	H	I	J
PM Req. Man.	5.2	8.6	8.8	7.2	7.2	5.2	5.5	6.0	7.1	4.8	8.6
IND Req. Man.	6.2	8.6	8.2	8.1	8.0	6.6	7.0	6.7	6.9	3.2	7.7

Figure C6. Program Manager and Individual Development Team Member Requirements Management Scores



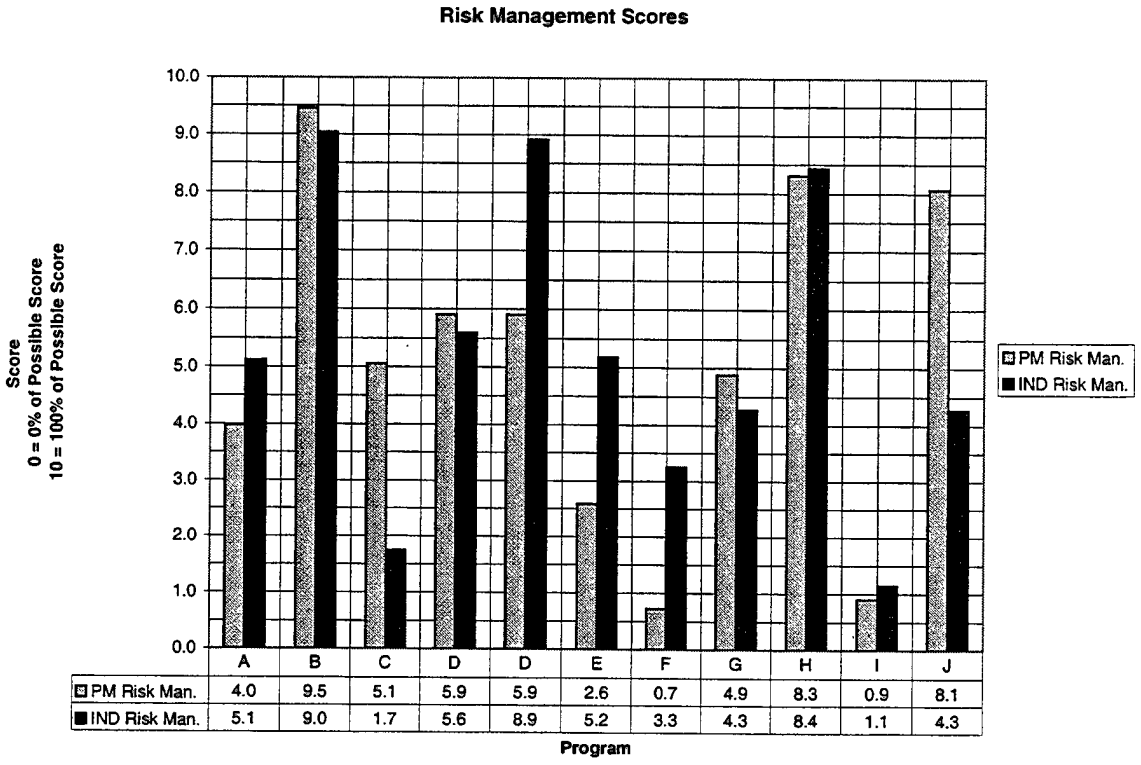
	A	B	C	D	D	E	F	G	H	I	J
PM Est. / Planning	6.2	9.3	7.5	5.0	5.0	4.5	3.7	6.6	7.5	3.8	6.9
IND Est. / Planning	5.1	9.0	4.0	3.8	9.3	6.8	3.5	6.7	7.5	2.2	7.2

Figure C7. Program Manager and Individual Development Team Member Estimation/Planning Management Scores



	A	B	C	D	D	E	F	G	H	I	J
PM People Man.	8.6	8.8	8.8	7.9	7.9	6.1	7.3	7.8	7.8	6.3	8.4
IND People Man.	5.6	8.5	7.8	4.1	6.5	6.6	5.8	8.1	7.9	2.5	5.7

Figure C8. Program Manager and Individual Development Team Member People Management Scores



	A	B	C	D	D	E	F	G	H	I	J
PM Risk Man.	4.0	9.5	5.1	5.9	5.9	2.6	0.7	4.9	8.3	0.9	8.1
IND Risk Man.	5.1	9.0	1.7	5.6	8.9	5.2	3.3	4.3	8.4	1.1	4.3

Figure C9 Program Manager and Individual Development Team Member Risk Management Scores

REFERENCES

1. Osmundson, J., "Class Notes from Naval Postgraduate School Course IS4300, Software Project Management," 1999.

2. Boehm, B. W., *Software Engineering Economics*, Prentice-Hall, Inc., 1981.

3. Fabian-Isaacs, C., and Robinson, E., "The Project Management Puzzle," *Software Development*, March, 1999.

4. Jensen, R. W., "Don't Forget About Good Management," *Crosstalk-The Journal of Defense Software Engineering*, August 2000.

5. Weinberg, G. M., *Quality Software Management, Congruent Action*, vol. 3, Dorset House Publishing, 1994.

6. Curtis, B., Hefley, W., Miller, S., "People Capability Maturity Model" Technical Report Number CMU/SEI-95-MM-02, Software Engineering Institute, Carnegie Mellon University, September 1995.

7. Machniak, Martin J., "Development of a Quality Management Metric (QMM) Measuring Software Program Management Quality," Masters thesis, Naval Postgraduate School, Monterey California, December 1999.

8. Nogueira de Leon, J., C., A Formal Model for Risk Assessment in Software Projects, Ph.D. dissertation, Naval Postgraduate School, Monterey, California, September 2000.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center 2
   8725 John J. Kingman Road, Suite 0944
   Ft. Belvoir, VA 22060-6218

2. Dudley Knox Library 2
   Naval Postgraduate School
   411 Dyer Road
   Monterey, CA 93943-5101

3. Chairman, Code CS 1
   Naval Postgraduate School
   Monterey, California 93943-5100

4. Dr. Luqi, CS/Lq 1
   Computer Science Department
   Naval Postgraduate School
   Monterey, CA 93943-5100

5. Dr. Man-Tak Shing, Code CS/Sh 1
   Computer Science Department
   Naval Postgraduate School
   Monterey, CA 93943-5100

6. Dr. Valdis Berzins, Code CS/Be 1
   Computer Science Department
   Naval Postgraduate School
   Monterey, CA 93943-5100

7. Dr. J. Bret Michael, Code CS/Mj 1
   Computer Science Department
   Naval Postgraduate School
   Monterey, CA 93943-5100

8. Dr. John Osmundson, Code OC/Os 1
   C4I Academic Group
   Naval Postgraduate School
   Monterey, CA 93943-5100

9. Martin J. Machniak 1
   160 Shadow Glen Court
   El Cajon, CA 92019

10. Mary Alice Grossman 3
42906 47th Street West
Lancaster, CA 93536

11. Mr. David A.Wheeler 1
Computer and Software Engineering Division
Institute for Defense Analyses
1801 N. Beauregard Street
Alexandria, VA 22311-1772