1998

Good Software Development Processes Lead to Harmonious Project Teams Which in Turn Lead to Effective Project Performance

Rweyunga Kazaura
Edith Cowan University

Edith Cowan University

Copyright Warning

RWEYUNGA KAZAURA

A thesis submitted in partial fulfillment of the requirements for

the degree of

Bachelor of Science (Computer Science) Honours

Faculty of Science, Technology and Engineering
School of computer, Information and Mathematical Sciences

Edith Cowan University

January 1998

Supervisor: Stuart Hope

USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

GOOD SOFTWARE DEVELOPMENT PROCESSES LEAD TO HARMONIOUS PROJECT TEAMS WHICH IN TURN LEAD TO EFFECTIVE PROJECT PERFORMANCE

BY

RWEYUNGA KAZAURA

EDITH COWAN UNIVERSITY
LIBRARY/ARCHIVES
USE OF THESES

DECLARATION

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that of the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Rweyunga Kazaura

30th January 1998

ACKNOWLEDGEMENT

I would like to take this opportunity to thank all my family and friends who encouraged and helped me in one way or another to conduct my research and finally complete my thesis. Special thanks go to my father, mother and the rest of my family for supporting me. Also to my supervisor, Stuart Hope, who gave up a lot of his time giving me brilliant ideas and kept me on track. Julian Terry provided constructive criticisms that shattered my complacency and led to the revising of my research questions.

My friend Lyn Zinenko did a great job of reminding me from time to time to hit the books instead of the pub, however I do recommend the pub or any other form of social activity when hallucinations set in. Lyn also assisted by proof reading my thesis before the final draft was submitted to my supervisor. I would also like to thank Paul Halfpenny for suggesting revisions in my introduction.

The acknowledgement list is extensive and it will take me time to list all the individuals, however I thank everyone who supported me in one way or another from the start to the completion of my thesis.

The modern world relies on computers in almost every facet of life. With the explosion of Information Technology, software development has become an important process. However, from the beginning, this process has suffered and continues to suffer from a number of problems. If these problems are not rectified, they can jeopardise projects and lead to project failure.

Project failure results in a project being delivered:

- *without satisfying the functional and non-functional requirements requested by the user or customer*
- *beyond the agreed schedule and/or*
- *over budget.*

Research indicates that practising good software development processes (SDPs) can override these problems or at least minimise their impact, however the human element of group dynamics cannot be ignored. Demanding disciplined SDPs will lead to project team harmony and this will result in the improvement of product quality, productivity, time to market and customer satisfaction.

This research established the relationship between the practice of good SDPs and team harmony and showed that good software development processes lead to harmonious project teams which in turn leads to effective project performance. Team harmony included the presence of constructive conflict and showed that the management of

destructive conflict could minimise its impact or even channel it into constructive outcomes.

The subjects of this research were third year undergraduate computer science students at Edith Cowan University involved in a year-long software engineering project. Data was collected through questionnaires and an interview and later analysed using the Spearman's rank correlation against the project team final marks.

The outcome of this study is that good software development processes do indeed lead to harmonious project teams, which in turn lead to effective project performance and favourable outcomes.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

The modern world relies on computer technology for survival since the technology is global, networked and is based on information. (Isaacson, 1997, p. 26). In recent decades a large body of knowledge has been produced based on various methods, techniques and ongoing research relating to the improvements in software development project outcomes. There now exists extensive literature in the areas of software development processes (SDPs), project management, configuration management, quality assurance and project estimation, to name just a few. Considerable time has been spent on these processes in software development to enhance project successes. Despite some specifically relevant research, the relationship between team harmony and successful SDPs has not yet been concretely established. While many good SDPs have been clearly defined and established (Deephouse, Mukhopadhyay, Goldenson & Kellner, 1996), harmony, as an influencing factor in effective project performance is less clearly defined.

The aim of my research has been to isolate successful SDPs in order to identify the role of harmony in these projects so that the following thesis statement can be tested, that "good software development processes lead to harmonious project teams which in turn lead to effective project performance". Team harmony discussed in this study suggested the presence of constructive conflict and showed that the management of destructive conflict could minimise its impact or even channels it into favourable outcomes.

The research was based on the 1997 third year undergraduate Bachelor of Science (Computer Science) students at Edith Cowan University who were involved in an ongoing, whole year, software engineering project. The objective of the project was to give students the opportunity to develop and maintain software systems as a practical exercise in an environment designed to simulate the real world. The unit co-ordinator established six teams of ten to twelve members each, by using members' two previous years' course average marks as the only determinant in the formation of teams. The unit co-ordinator mandated the software development environment which encompasses the integrated suite from the Oracle Corporation including its relational database management system, CASE and application development tools. These development products were installed in a client/server manner using PCs, a Novell server and the database residing under AIX on an IBM RISC 6000. (Terry & Hope, 1998).

Research documented by Brown, Klastorin & Valluzzi (1990), Deephouse, Mukhopadhyay, Goldenson & Kellner (1996), Mullin & Hope (1996) and Eldridge (1997) established a link between software development processes and project outcomes. This research extended this link by introducing team harmony as another variable in determining project outcomes.

This study focused on the activities, behaviour and outcomes of the project teams. Data was collected through questionnaires, an interview and university records, including semester project marks and the final project marks. Questionnaires and interview focused mainly on software processes and team conflicts. The questionnaires were administered twice, midway through first semester (April 1997) and the end of second

semester (November 1997). This data was analysed in conjunction with project teams' end-results to formulate conclusions.

The motivation to conduct this research emanated from previous experience in a similar project at Edith Cowan University in 1996. While members of those teams were enthusiastic and determined to succeed, conflict and mismanagement affected the outcomes. In an effort to explore factors contributing to the successful outcome of software development processes, team harmony, as an extension of the concept of harmony explored by previous researchers, was isolated as influential. Consequently, this research was instigated to extend previous research in this area by incorporating the influence of team harmony in conjunction with software development process on project outcomes.

CHAPTER 2

THE PROBLEM

Software project failure is costing the software industry dearly, not only in monetary terms but also in credibility. Millions of dollars are spent annually and in the United States alone, close to $200 billion each year is utilised on the development, purchase and maintenance of computer software. (Pressman, 1992, p. 18)

Software developers need to overcome numerous hurdles in order to meet project deadlines, budgets and customer requirements. Because of the sensitivity of modern systems such as those used by NASA, American Department of Defence, countries which rely on nuclear power, etc., the ramifications of software failure can be apocalyptic.

Ariane 5 rocket flight 501 is an example of software project failure. The incident occurred on the 4th of June 1996 after the launcher veered off its flight path, broke up and exploded. This chain of events was caused by the complete loss of guidance and attitude information, which was due to the specification and design errors in the software of the inertial reference system. (Bowen, 1996).

Ongoing research and available literature suggest ways to overcome, or at least reduce, the rates of software project failure. However the link between team-harmony and good software development practice has not been addressed as a factor influencing project outcomes. This research directly addresses this link.

2.1 BACKGROUND TO THE STUDY

Despite rapid advances in technology, software developers are experiencing high project failure rates. Sallis, Tate and MacDonell (1995, p. 50) suggest that "... the main reasons for project failure have to do with people and are mainly managerial or organisational behaviour problems". Pressman (1992, p. 19) supports Sallis et al. (1995) by further suggesting that the software crisis have been most commonly caused by human failings. "Middle- and upper-level managers with no background in software are often given responsibility for software development" (Pressman, 1992, p. 19). While these are generally a major contributing factor of software crisis, they cannot be isolated from the entire SDP as the cause. In fact, the whole SDP must be disciplined and managed effectively to induce concordance within project teams before the failure rate can be lowered. (Pressman, 1997).

The software development processes studied include:

- *the system development life cycle (SDLC) phases which comprise:*
  - *system feasibility*
  - *software plans and requirements*
  - *product & detailed design*
  - *coding*
  - *integration*
  - *implementation, and*
  - *operation & maintenance*

  [adopted from Sallis et al. (1995, p. 9)]
- *project management*
- *risk analysis and management*

- *configuration management*
- *project estimation and*
- *interaction with the customers.*

The above processes have been formalised in models such as the SPICE (ISO/IEC, 1995), Trillium (The Trillium Model, 1997) and the Capability Maturity Model (Paulk, Curtis, Chrissis & Weber, 1993 and Saiedian & Kuzara, 1995). These models are discussed in more detail below in section 3.4.

The Oxford dictionary (1995, p. 544) defines "harmony" as "... a state of agreement in feelings, interests, opinions..." In addition to the literal interpretation, this research considered team cohesion, co-operation, unity and motivation as characteristics of a harmonious project team. The glossary provides a definition of harmony which was fashioned from existing research to fit the framework of this study. (Amason, Hochwarter, Thompson & Harrison (1995), Brown, Klastorin & Valluzzi (1990) and Firth (1991))

Deephouse, Mukhopadhyay, Goldenson and Kellner (1996) indicate that performance in software development has several dimensions. This research concentrated on the dimensions discussed by Deephouse et al. (1996), namely software quality and meeting targets, including schedules and budgets. This study relied on Boehm & McCabe's measures of software quality reported in Pressman (1997), which include:

- *correctness*
- *reliability*
- *efficiency*
- *integrity*

- *usability*
- *maintainability*
- *flexibility*
- *testability*
- *reusability, and*
- *interoperability*

2.2 SIGNIFICANCE AND PURPOSE OF THE STUDY

While well known literature relates SDPs directly to the project performance, this research looks into another variable, that is "team harmony", which is the result of practising good SDPs. An attempt was made to outline the processes required to enhance project performance by highlighting those SDPs in priority order, and linking them with resultant team harmony. This is accomplished by the use of SPICE, CMM and Trillium models, previously mentioned, as methods for software process assessment. This research is considered significant to the software engineering profession as it introduces a new perspective of team harmony as a factor to overcome or minimise project failure rate.

2.3 RESEARCH QUESTIONS

This study was guided by and answers the following questions:

- *What is harmony?*
- *What are good software development processes?*
- *In what priority order should SDPs be practised?*
- *What factors contribute to team harmony?*
- *How can the link between good SDPs and team harmony be measured?*
- *Does harmony make a difference to the project outcome?*

2.4 THEORETICAL FRAMEWORK

The questions from the interview and questionnaires were analysed by first calculating the project teams' mean score for each question. These scores were later correlated against the project teams' results to see if there was any evidence to support the research hypothesis, "good software development processes lead to harmonious project teams which in turn lead to effective project performance".

The statistical method adopted to check for any correlation between the project team mean score for each question and the project team result, is known as Spearman's Rank Correlation. Spearman's rho, as it is also called, is named after C. Spearman, who introduced this method into psychological work and is represented by r_s. (Kendall & Gibbons, 1990, p. 8).

A correlation is a unit-less number that takes a value between –1.0 and +1.0. A value of 0.0 indicates no correlation exists between the two variables. A value close to +1.0 suggests a near perfect positive correlation i.e. as one variable increases, the other will increase in unison. A value near –1.0 indicates a near perfect negative correlation i.e. as one variable increase, the other will decrease.

Spearman's correlation is a non-parametric statistical measure that describes only the sample as any of the parametric assumptions can be violated. It relies on a much less restrictive set of assumptions about the data.

Spearman's rank correlation is an estimate of Pearson's correlation but without the restrictions. (STDAS Help System, 1997). In this study, strong Spearman's correlation are determined by considering the values between -1.0 and -0.7 for a strong negative correlation and values between 0.7 and 1.0 for a strong positive correlation.

2.5 LIMITATIONS ON THE STUDY

2.5.1 Duration

The duration of the project was one academic year. The students were required to complete the first part of their projects which included requirements specification and the system design during the first semester, February to May 1997. The second part which comprised the coding, testing and demonstration of the products was scheduled for completion during the second semester, July to November 1997. The project deadline was set by the unit co-ordinator and was non-negotiable. This constraint showed the weakness of the software development environment in a simulated practical academic exercise as opposed to the real world environment.

2.5.2 Students' Involvement

This research was not part of student assessment and therefore made no contribution to the participants' academic records. However, project leaders were asked to participate in order to encourage other team members to contribute to the research. Voluntary involvement had a major impact on the research as students who showed no interest in the research did not contribute towards meaningful results.

2.5.3 Industry Experience

Students involved in the project came from diverse backgrounds and with differing experience. Most of the students came straight from secondary school and therefore had no prior software industry experience. However, there were some part-time students in the project groups who had been, or still were employed in the software industry. Team members with prior software industry experience had an advantage in performance over teams comprising of inexperienced members. This uneven distribution of experience had an impact on the research. This will be discussed in more details in Chapters 5 and 6 below.

2.5.4 Customer Interaction

Students had an equal interaction time with the end product's customer and all groups interacted with the customer simultaneously. These meetings were arranged by the unit co-ordinator and occurred only five times, all during the first semester. Many groups were uncomfortable with this arrangement and in reality required more meetings especially during the second semester when the products were expected to be functional. However, it was understood that because of the strict deadline the project groups were facing, some restrictions regarding their software development process were necessary. This customer interaction limitation had a major impact on the research.

2.6 ETHICAL CONSIDERATION

2.6.1 Confidentiality

The data collected through questionnaires and interview was strictly confidential in that no team or individual was capable of being recognised. The interview and questionnaire papers were shredded immediately after the evaluation took place. The summary spreadsheet maintaining the project analysis data generated from the evaluation of the questionnaires and interview were kept in a diskette which was safely locked in a well-secured briefcase.

2.6.2 Student Assessment

As mentioned in section 2.5.2, this research was an entirely voluntary exercise for the students involved in the software engineering project. The research did not in any way contribute to participants' academic assessments.

CHAPTER 3

REVIEW OF RELEVANT LITERATURE

A great deal of literature relating to the improvement of project outcomes exists. While it focuses on areas such as good SDPs and harmony as influences on project outcomes, harmony is defined as a singular concept. This research introduced a new dimension of group dynamics, that is "team harmony". This was defined as a group of characteristics incorporating traditional descriptive views of harmony, such as agreement and a feeling of well being, as well as processes that contribute to team harmony such as communication and conflict and how they influence project outcomes. As the main focus of this research was the link between SDPs and group harmony, the general literature review explored works that touched on how good SDPs and individual aspects of harmony affected productivity.

3.1 SPECIFIC STUDIES SIMILAR TO THE CURRENT STUDY

Improving project performance has been the core of many previous studies. One such study was undertaken by Brown, Klastorin and Valluzzi (1990). They observed members of fourteen project teams comprising two to four members each, a total of 44 participants, who tackled the same complex computer-simulated project. These researchers administered a survey four times during the project lifetime. These surveys revealed that initial ratings of group attributes were accurate predictors of later success. (Brown et al., 1990, p. 117).

Brown et al. (1990, p. 123) discovered that "... teams which ultimately performed well, began with lower opinions of their respective groups than did teams which ultimately did not perform well." Brown et al. (1990) concluded their study by noting that:

> The results of this research run counter to the commonly held belief that groups with positive characteristics (i.e. harmony and camaraderie) will be the most effective ones. The research suggests, instead, that getting along too well, especially in the beginning, may keep a group from becoming sufficiently task oriented. (p. 123)

However, while Brown et al. (1990) consider harmony as a liability to successful project outcomes, their study has only considered harmony resulting from interpersonal relationships and not from any other source.

While Brown et al. (1990) focused on group dynamics as the core of successful project performance, Deephouse, Mukhopadhyay, Goldenson and Kellner (1996) considered the relationship between software process and project performance, as the vital

ingredient. Their study was based on a survey of senior practitioners at the 1993 Software Engineering Process Group National Meeting which described "... an explanatory study that assesses the effectiveness of some process in common use. The processes studied are project planning, design reviews, cross functional teams, process training, prototyping and communication with users." (Deephouse et al., 1996, p. 189).

Based on the survey results, certain practices were identified to be consistently associated with favourable outcomes. These were project planning and cross-functional teams. Other practices appeared to have little impact on project outcomes.

While there may be variables between previous research and the current research, the major focus remained the improvement of project outcomes. Variables such as:

- *subjects*
- *environment*
- *scope & complexity of the project*
- *project deadlines and*
- *the availability and quality of software*

could affect this study's major premise. This was that harmony and good SDPs work in tandem to produce successful project outcomes and could not operate in isolation. This study showed that good SDPs were a major source of group harmony which in turn reinforced effective project performance. Group harmony and good SDPs have a symbiotic relationship that fostered successful project outcomes.

3.2 LITERATURE RELATING TO HARMONY AND PERFORMANCE

Numerous debates about make-up and behaviour of effective teams tended to be contradictory. Some studies suggested that harmony[1] did not necessarily lead to effective project outcomes. Brown, Klastorin & Valluzzi (1990) suggested two general points of views. "One perspective suggests that groups having "positive" characteristics will perform well" (Brown et al., 1990, p. 117). Their definition of positive characteristics included " ... cohesiveness, co-operation, drive, esprit de corps, harmony, etc ... An opposing perspective viewed what had been considered "positive" group characteristics as actually detracting from group performance" (Brown et al., p. 117).

In other literature, harmony was broken down into a series of distinct units. Sallis, Tate and MacDonell (1995, p.43) state "... in almost any group endeavour, communication and co-ordination within each group is of vital importance if the development process is to be carried through to a successful conclusion." These researchers defined harmony as communication and co-ordination. They noted that as the team size of a project team grew, effective lines of communication became increasingly more difficult to maintain. Sallis et al. (1995) discussed these communication complexities with the comparison of a manageable team of three people who would only generate three lines of

[1] This type of harmony lacks conflict. It has neither constructive nor destructive conflicts. This type of group harmony is sometimes called "groupthink" and is discussed later on in the study.

communication, and a team of eight people who would generate twenty-eight lines of communication. Sallis et al. (1995, p.43) adopted the following formula that determined the total lines of communication as the team size increased, "... if lines of communication are required between every individual in a group of *n* people, then there is a total of $n(n-1)/2$ separate interaction paths." They pointed out that it was almost impossible to effectively maintain such a network of communication lines and refered to this as the "conflict of understanding."

Supporting this concept of communication network complication, Whitten (1990, p. 47) reinforced the importance of communication "In software development projects, the inability of people to communicate effectively with one another represents one of the most common obstacles to the achievement of high product quality and high productivity." Both Sallis et al. (1995) and Whitten (1990) suggested that the problem of complex communication network between team members resulted in group disharmony and lower productivity.

Ratcliff (1987, p. 286) supported Sallis et al. (1995) and Whitten (1990) by focusing on more severe problems, such as lack of co-ordination, control and integration across the whole software development effort that emerged when the project or the number of staff involved was larger. Ratcliff (1987) suggested a team framework that would be required to structure staff into effective workgroups. He believed that a team approach was necessary in order to create a disciplined, successful work environment for software personnel. Ratcliff (1987, p. 288) recommended team sizes of no more than eight members, particularly programming teams. This, he believed, minimised communication problems and fostered group working.

As well as the number of communication lines and team sizes, Matsubara (1991) discussed other communicational factors which could hinder a group's productivity. He stated, "Day-to-day project management consists of human-related activities among project personnel, it is largely affected by the social systems and culture of the people involved." (Matsubara, 1991, pp. 41-42).

Sallis et al. (1995), Whitten (1990), Ratcliff (1987) and Matsubara (1991) all suggested that the problem of communication was exacerbated by the social and cultural backgrounds of the people involved. They outlined several attributes that could be the seeds of conflict within a project team and could affect a team's productivity if they were not well confined. They suggested that the major consequence of conflicts was the risk they posed to the entire project, leading to project failure.

On the contrary, one of the less acknowledged factors of harmony isolated by other researchers was the positive effect of conflict. Traditionally, views of conflict tended to suggest that conflict had a negative influence and should be avoided at all costs. However some researchers focused on conflict as a subset of harmony and suggested that conflict created harmony and improved productivity.

Amason, Hochwarter, Thompson & Harrison (1995) believed that conflict was a necessary part of harmony. They discussed two types of conflict, A-type (Affective) that was described as destructive and C-type (Cognitive) that was described as constructive. These researchers stated that the key to successful outcomes was the understanding and the use of constructive conflict and the avoidance of destructive conflict. Amason et al. (1995) defined C-type conflict as issue-oriented criticism which had the potential to improve the team's performance and productivity. While A-type conflict was defined as "... disagreements over personalized, individually oriented matters..." Amason et al. (1995, p. 24), that is it attacked the individual rather than the task in hand.

On one hand, a team that generated C-type conflicts would improve its quality of decision making by facilitating frank communication and open consideration of different alternatives which allowed the integration of different skills of team members. On the other hand, A-type conflict lowered team effectiveness by provoking hostility, distrust, cynicism and apathy among team members. This created continuous demotivation of group members resulting in low productivity and low product quality. (Amason et al., 1995, p. 23).

Without referring to different types of conflict, Firth (1991) reinforced the importance of constructive conflict. Firth (1991) noted that, "Conflict can rip your organisation apart" and gave a brief account of the effects of conflict which included the creation of walls between employees, leading to poor performance and sometimes resignation of competent employees. Firth (1991) also suggested that conflict did not necessarily need to be the foundation of project teams' demotivation and ineffectiveness (p. 3).

Instead she stated that "Within conflict there are seeds for growth of ideas" (Firth, p. 3) and explained that conflict could cause project team members to see the same thing in different ways and have alternative views which end-up being useful contributions to the project or to the organisation. According to Firth (1991) avoiding conflict was not the answer to improving project team performance.

Janis (cited in Brown, Klastorin & Valluzzi, 1990, p.117) also reinforced the need for conflict by suggesting that, avoidance of all conflicts created the phenomenon of "groupthink". "Janis suggested that cohesive, close-knit groups may make serious errors in judgement because they rejected constructive criticism and overlooked important details in an effort to maintain unanimity" (Brown et al., 1990, p. 117). Firth (1991) and Amason, Thomson, Hochwarter & Harrison (1995) have also concluded that practising a "getting along well at all costs" philosophy could lead to group members overlooking potential problems as they seek at avoiding conflict, and that in reality, conflict was an important and necessary component of project group interaction.

Krug (1995, p. 18-19) suggested that conflict was a step in the natural development of a team and could not be avoided. He discussed four phases of development that he labelled:

- *Orientation to task*
- *Intragroup conflict*
- *Development of group cohesion*
- *Functional role of relatedness*

While Krug's research stemmed from civil engineering groups, it was relevant to software engineering groups as both disciplines relied on teams within an overall organisation. Krug (1995) stressed the management of conflict as the core of success, and suggested that ground rules to provide a code of conduct, and a mechanism or procedure for resolving group conflicts was an integral part of this management. Krug (1995) stated that groups, at the commencement of the project, should conduct basic activities such as introductions that included description of previous similar technical work, expectations and perceived roles of both leaders and members, time frames and objectives with planned outcomes.

Krug (1995) believed that an acceptance of idiosyncrasies would come about from intragroup conflict, and only then would the team be productive. He noted that groups that had no conflicts initially experienced difficulties later. Krug saw conflict as part of consensus, which he interpreted as harmony. However, it was interesting to note that Hackman (cited in Bolman and Deal, 1992, p. 36) stated:

> Groups that started well and achieved some early wins often triggered a self-sustaining upward spiral in performance. Groups that got off on the wrong foot often fell into a negative performance rut; their efforts to dig themselves out put them deeper in the mud.

Another facet of harmony isolated by researchers was the diversity in the composition of groups. Bantel and Jackson (1989) researched the field of banking, however these findings could readily be transferred to software engineering groups. These researchers investigated the effect of personal characteristics of leaders on decisions. They defined leaders as top management teams, not solitary decision-makers, and isolated various demographical characteristics within the various groups.

Their findings revealed that banks headed by highly educated managers from diverse backgrounds displayed a higher level and diversity of expertise and found that these qualities were beneficial to complex problem solving.

Bolman and Deal (1995) presented an interesting concept in the search for harmony and effectiveness. They isolated four common frames in group-work, namely:

- *Structural*
- *Human resources*
- *Political and*
- *Symbolic*

They stressed that while all four were important to the efficient working of a team, the symbolic and political frames were often ignored, thus leaving the team with a void and bringing about failure.

Bolman et al. (1995) stated that managers relied on structural and resource perspectives, and under-utilised political frames which involved power and conflict, and symbolic frames which embodied elements of flow, spirit and magic. They suggested that the

structural frame was most often linked to effectiveness as a manager, however the symbolic frame was linked to the best leader. Thus, they found that the best managers were rarely the best leaders.

Bolman and Deal's research subjects were a group of people (Eagle Group) who, with scant resources and limited support, produced a "state of the art" computer. They noted that analytical reasoning as to the success of the team was not applicable, their success stemmed from a cohesive culture rather than a hierarchy of power.

Bolman et al. (1995) isolated several symbolic tenets from the experiences of the Eagle Group that they believe contributed to the team's success. These include:

- *the manner of becoming a team member: mutual choice marked by a special ritual such as signing up*
- *diversity: each member had unique talent and style; the group paid a little attention to rules, but rather found romance and drama in everyday events and followed examples rather than commands*
- *specialised language: words, phrases, metaphors that foster cohesion and commitment, and shapes, bonds and reflects a team's culture that sets it apart from outsiders*
- *stories carrying the history and values of the group while reinforcing its identity*
- *humour and play to reduce tension*
- *rituals and ceremony that reinforce values, neutralise spirit and bond individuals to the team and to one another, and*
- *informal cultural roles which contributes to team culture*

Bolman et al. (1995) suggested that "The essence of high performance is spirit" (p. 43) and "Peak performance emerges as a team discovers its soul." (p. 44).

Researchers disagreed as to what actually constituted harmony, however the majority of works appeared to agree that harmony, however defined, had a marked influence on the outcome of the project.

3.3 *LITERATURE RELATING TO SDPs AND PERFORMANCE*

While some writers focused on human interaction as the foundation of effective process, others suggested that it is the process itself that affects the outcome. Deephouse, Mukhopadhyay, Goldenson and Kellner (1996) surveyed a group of 339 experienced software engineers in an effort to assess whether effective utilisation of SDPs influences the outcomes of projects. The processes included in the survey were familiar to all respondents, and applicable to most projects. They were:

- *project planning*
- *software process stability*
- *process training*
- *cross functional teams*
- *design reviews*
- *prototyping co-ordination with users and customers.*

While their key findings supported their hypothesis, they concluded that good SDPs were not the sole contributors to successful outcomes. Other variables such as the complexity of application, stability of requirements, capabilities of team members and availability and quality of software tools affected outcomes.

They also noted that:

- *effective planning appears important in meeting targets, such as schedules & budgets and product quality*
- *process training improves planning effectiveness*
- *cross functional teams determine product quality as well as improving planning effectiveness*

- *effective planning and cross functional teams improve product quality partly by reducing the amount of rework*

contributed to the success of the project as did the factoring-in of rework-effort. When rework-effort was not pre-planned, targets became unstable causing major organisational problems. These results were considered across a range of project characteristics including large & small, military & civilian, and new development & maintenance.

Rakos (1990) investigated the failure of small and medium sized projects. He divided the process into three particular areas of pit falls, namely:

- *failure at the start. He blamed poor planning at this stage. He stated the "Planning is knowing ahead of time where you are going, how you are going to get there, and how you will be able to prove you are there." (p. 2)*
- *failure in the development stages. Areas included in this stage were the lack of proper documentation in analyses and design, poor management, a lack of understanding of the developmental tools available, a lack of walk-throughs and reviews and a lack of development standards.*
- *failure at the end. He blamed budget or time overruns and poor debugging for these failures. He suggests that often cancelling a project at this stage and beginning again is the most sensible way of tackling these failures.*

Rakos (1990) accorded project success to proper planning and control. He stated that written planning which defined what was to be delivered and how it was to be accomplished was mandatory. Measurable acceptance criteria were necessary as well as close monitoring during the developmental stage. Overall, Rakos determined that a

professional approach was necessary in that developers should be disciplined in the use of developmental tools.

In exploring the question of " ... what contributes to successful software development projects..." Mullin and Hope (1996) focused on 36 project teams in an undergraduate computer science course. They tracked the teams for three years in the controlled environment of a university. The measure of success was functionality and usability of the developed product. Their findings revealed, among other things, that while team processes emerged as a significant factor as the project matures, methodology was indicated as a significant contributor to the outcome. Other factors had a marked effect on the project as it progressed. These included team cohesion and team size. They noted that team cohesion reduced as the project matured. Teams with higher cohesion became complacent about their performance and the teams with low cohesion but high competitiveness were more effective. These findings supported the research by Brown, Klastorin & Valluzzi (1990).

Also, initially a large team was a positive attribute as it allowed a greater work pool, in the later stages small teams fared better as there were less complex team issues which brought about higher motivation and effectiveness.

Mullin and Hope (1996) also identified variables that were omitted from their study, but which they considered relevant to the effectiveness of the project performance. These were:

- *leadership*
- *motivation*

- *anxiety*
- *cultural heterogeneity*
- *technical skills*
- *depth of understanding of the processes*
- *industry experience*

They concluded that the most significant contributing factors to the success of the projects were testing and the time spent on processes. Other consistent contributors were the quality and quantity of project management, time expended by each team member, the quality of the development environment and the adherence to software engineering processes.

It is interesting to note that Mullin and Hope (1996) appeared to recognise the link between good SDPs and team harmony and the effect that these factors had on the outcome of the project.

3.4 LITERATURE ON METHODOLOGY

SPICE was the methodology used by examiners to evaluate good SDPs and assess the students' project outcomes and project marks. Only part of the model, appropriate to the process assessment of undergraduate software engineering projects, was extracted by the unit co-ordinator to develop the university's projects marking guide.

SPICE was derived from various sources including the Software Engineering Institute's CMM, Trillium and the ISO 9000 series. These models are discussed in the sections below.

3.4.1 Capability Maturity Model

Unless a different source is explicitly designated, the specific quotations concerning the CMM are from the Software Engineering Institute's (SEI) Technical Reports (1993). The Software Engineering Institute (SEI) at Carnegie Mellon University with assistance from Mitre responded to the federal government's request when they begun developing a process maturity framework in November 1986. The initial purpose of the process maturity was to provide the federal government with a method for assessing the capability of their software contractors.

After four years of experience with the software process maturity framework and the preliminary version of the maturity questionnaire, the SEI evolved the software process maturity framework into a fully defined model. This model

provided organisations with more effective guidance for establishing process improvement programs than was offered by the maturity questionnaire.

Through the knowledge acquired from software process assessments and extensive feedback from both industry and government, an improved version of the process maturity framework was produced called the Capability Maturity Model (CMM).

The CMM is made up of five levels and each level defines various characteristics of the organisation's development process. From the report, it was suggested that maturity levels build onto each other and cannot be skipped. Organisations could only expect failure if they omitted any stage of the process. The levels have been described as follows:

3.4.1.1 Level 1 - Initial (Ad hoc/ Chaotic)

This is the starting level of any organisation which is sometimes referred as the failed level. It clearly represents an immature organisation. It has been characterised as "ad hoc" and sometimes even "chaotic" with unpredictable cost, schedule and quality performance.

Actions required to progress:

To improve the process and advance to level 2, organisations must act upon the following:

- *project planning and scheduling*
- *estimate the size and cost of the projects*
- *track performance, and*
- *incorporate change control & quality assurance.*

This will lay the foundation for level 2.

3.4.1.2 Level 2 – Defined (Intuitive)

This level " ... is characterised by the effective use of software project management policies and processes so that organisations may 'repeat successful practices developed in earlier project'". There is a reasonable control on schedules and the costs are under greater control while quality and functionality are monitored. Any problems found are reported and dealt with appropriately.

Actions required to progress:

To achieve level 3, organisations need to develop process standards and definitions and assign process resources. They must establish the following:

- *requirements*
- *design*
- *inspection, and*
- *test methods.*

3.4.1.3 Level 3 - Defined (Qualitative)

This level is characterised by a well-defined process consisting of measurable tasks and products. There is also improvement in quality performance, however quality is still unpredictable.

Actions required to progress:

Organisations need to establish process measurements and quantitative quality goals to move to level 4.

3.4.1.4 Level 4 - Managed (Quantitative)

This level is characterised by reasonable statistical control over product quality. "The process capability of Level 4 organisations can be summarised as measured and operating within measurable limits". (Sallis et al., 1995, p. 106).

Actions required to progress:

To achieve level 5, organisations need to justify the economies of scales for technological investments, the quantitative productivity plans and tracking and the instrumented process environment.

3.4.1.5 Level 5 - Optimising (Improvement)

The focus in this level is on continuous measured process improvement and optimisation. It is characterised by a quantitative basis for continued capital investment in technology and continued emphasis process methods for error prevention.

3.4.2 Trillium Model

Trillium is another model used by the examiners in evaluating the students' projects. The information on Trillium, provided in this section, has been referenced from one main source, the mirror site of the University of Houston Clear Lake.

Trillium is the result of a partnering project between Bell Canada, Northern Telecom and Bell-Northern Research. It is mainly used by Bell Canada to assess the product development and support capability of prospective and existing suppliers of telecommunications or information technology-based products. However, Trillium can also be used as a reference benchmark in an internal capability improvement program.

The Trillium model is based on the SEI-CMM and it incorporates the following standards:

- *ISO 9001: 1994 International Standard*
- *ISO 9000-3: 1991 Guideline*
- *Bellcore TR-NWT-000179 Issue 2, June, 1993*
- *Bellcore TA-NWT-001315 Issue 1, December, 1993*
- *relevant parts of the Malcolm Baldrige National Quality Award, 1995 Award Criteria*
- *IEEE Software Engineering Standards Collection, 1993 Edition, and*
- *the IEC Standard Publication 300: 1984*

The Trillium scale spans levels 1 through 5. The levels can be characterised in the following way:

3.4.2.1 Level 1 – Unstructured

The development process is ad hoc. Projects do not meet set targets including quality and schedule. There are very high risks to the project and success is based on individuals rather than an organisational infrastructure.

3.4.2.2 Level 2 – Repeatable and Project Oriented

Strong project management planning and control ensures project success with an emphasis on requirements management, estimation techniques and configuration management. However there is medium risk exposure.

3.4.2.3 Level 3 – Defined and Process Oriented

At this level, the processes are defined and utilised at the organisational level, although project customisation is still permitted. Processes are controlled, monitored and improved. Training and internal process auditing are incorporated as per ISO 9001 standard leading to low risk exposure.

3.4.2.4 Level 4 – Managed and Integrated

Automated tools, process change management and defect prevention programs are integrated into the process for continuous process improvement. The risk level is lower than the previous levels 1, 2 and 3.

3.4.2.5 Level 5 – Fully Integrated

Formal methodologies are used simultaneously with the utilisation of organisational repositories for development history and process effectiveness. At this level, risk exposure is at the lowest level.

The model consists of capability areas, roadmaps and practices. There are eight capability areas within the Trillium model with each capability area containing practices at multiple Trillium levels. Each capability area incorporates one or more roadmaps.

To achieve a Trillium level, an organisation must satisfy a minimum of 90% of the criteria in each of the 8 Capability Areas. The levels cannot be skipped, thus levels 3, 4 and 5 require the achievement of all the lower levels.

3.4.3 SPICE (ISO/IEC 15504)

While the CMM (Paulk, Curtis, Chrissis & Weber, 1993), discussed previously, is the best known current model for process improvement and assessment, Rout (1995) suggested other players in the telecommunications field who have been developing their own process assessment methods. They included British Telecom, Bell Canada, Northern Telecom, BNR and Bellcore[2].

Rout (1995, p. 57) pointed out that the development and acceptance of a proposal to develop an international standard was initiated by the UK ministry of Defence, through the Defence Research Agency. The reasons for this international standard were the increasing number of assessment approaches available, and the increasing use of the technique in commercial-sensitive areas.

Organisations using existing and/or developing new assessment methods had indicated a willingness to provide resources for the development of the new standard. "As a result, the standards working group charged with the work authorized the establishment of a dedicated project team, known by the acronym SPICE..." (Rout, 1995, p. 58).

The main source of information concerning SPICE, as a model, is the detailed description in the set of the ISO/IEC (1995) Technical Reports. Unless a different source is mentioned, the specific quotations concerning SPICE are from that reference.

[2] See section 3.4.2 for further detail on the subject

SPICE was derived from various sources including the CMM, Trillium and the ISO 9000 series which are related sets of standards concerned with quality systems. These include:

- *ISO 9001: 1994*
- *ISO 9000-3: 1991*
- *ISO 9004-4: 1993*

  (all the above are defined in section 2.4)
- *ISO/IEC 12207-1: 1994 Software Life Cycle Process*
- *ISO/IEC 12119: 1995 Software products – Evaluation and test, and*
- *ISO/IEC 9126: 1991 Software quality characteristics.*

All the above sources have been the main inspiration for this ISO initiative.

Sallis et al. (1995, p. 117) outline the goals of SPICE as its independence of development methodology, application domain, cultural differences and organisational size. SPICE is designed to satisfy the needs of acquirers, suppliers and assessors and their individual requirements from within a single source.

The major components of SPICE, as outlined by the SPICE Organisation Project are:

- *a model for process management*
- *a guideline to*
  - *conducting software process assessment and*
  - *process improvement*
- *rating process*
- *assessment instrument*

The SPICE model is guided by the use of base practices which are software engineering or management activities that directly addresses the purpose of a particular process and contributes to the creation of its output. The model categorises processes into five process categories that are displayed in the table below.

Table 1 - Five Process Categories

Process category	**Brief description**
Customer-Supplier	Processes that directly impact the customer
Engineering	Processes that specify, implement, or maintain a system and software product
Project	Processes that establish the project, and co-ordinate and manage its resources
Support	Processes that enable and support the performance of the other processes on the project
Organization	Processes that establish the business goals of the organization and develop process, product, and resource assets which will help the organization achieve its business goals

[Source: ISO/IEC Part 1, 1995, p. 20]

SPICE is made up of six capability levels. The model description, as reproduced from ISO/IEC Part 2 (1995, p. 9) is as follows:

3.4.3.1 Level 0 – Incomplete (Not-Performed)

This level has no common features. There are no easily identifiable work products or outputs of the process in that there is general failure to perform the base practices in the process.

3.4.3.2 Level 1 – Performed-Informally

At this level, some practices of the process are generally performed. However, the performance of these practices may not be planned and tracked. Performance depends on individual knowledge and effort and there are identifiable work products for the process.

3.4.3.3 Level 2 – Managed (Planned-and-Tracked)

Performance of the base practices in the process is planned and tracked. Performance according to specified procedures is verified and there is conformance in standards and requirements of the work products. The primary distinction from the Performed-Informally Level is that the performance of the process is planned and managed and progressing towards a well-defined process.

3.4.3.4 Level 3 – Established (Well-Defined)

At this level, base practices are performed according to a well-defined process using approved, tailored versions of standard and documented processes. The primary distinction from the Planned-and-Tracked Level is that the process at this level is well planned and managed using an organisation-wide standard process.

3.4.3.5 Level 4 – Predictable (Quantitatively-Controlled)

Detailed measures of performance are collected and analysed. This leads to a quantitative understanding of process capability and an improved ability to predict performance. Performance is objectively managed. The quality of work products is quantitatively known. The primary distinction from the Well-Defined Level is that the defined process is quantitatively understood and controlled.

3.4.3.6 Level 5 – Optimising (Continuously-Improving)

Quantitative process effectiveness and efficiency goals (targets) for performances are established, based on the business goals of the organisation. Continuous process improvement against these goals is enabled by quantitative feedback from performing the defined processes and from piloting innovative ideas and technologies. The primary distinction from the Quantitatively-Controlled Level is that the defined process and the standard process undergo continuous refinement and improvement, based on a quantitative understanding of the impact of changes to these processes.

CHAPTER 4

RESEARCH DESIGN

This section discusses in more detail the subjects used in this research as well as the working environment. Methodologies used for data collection and analysis are also discussed. The link between the research design and the research questions outlined in section 2.3 is presented.

4.1 DESIGN OF THE STUDY

This study was triggered by previous studies conducted by Terry & Hope (1998), Mullin & Hope (1996) and Eldridge (1997). The similarities between this study and previous studies are outlined in the following sections.

4.1.1 Objective and Outcome

Terry & Hope (1998) stated that the objective of the theory and practice of the ECU software engineering units was to demand that students should apply the work practices equivalent to teams in software organisations operating at SEI-CMM's level two.[3] "... heavy emphasis is placed on project management and control, team working, requirements management, configuration management and quality management." Terry et al. (1998).

4.1.2 Students & Resources

Students involved in this survey were undergraduate computer science third year students studying the same course at the same university, however some groups were located in different campuses. The software development environment provided by the university was shared equally by all the groups and was controlled by the unit co-ordinator.

[3] CMM is discussed further in section 3.4.1.

"The software engineering application is specified by an external client ... over several weeks." (Mullin & Hope, 1996, p. 120). The groups had an equal access to the client and were able to ask and note down questions and comments during the client interaction sessions where the client specified the new system requirements.

4.1.3 Study Mode & Team Formation

Students undertaking the project were both full-time and part-time students and were randomly assigned to groups depending on their course averages. Mullin & Hope (1996) state the purpose of this constraint is to neutralise the most significant factor in the productivity of a software team, the personnel.

" ... each project team has a collective course average within 1-2% of the others." Mullin et al. (1996, p. 120)

4.1.4 Method

The source of research data from all the studies was through the use of questionnaires and interviews. This study applied data collection methods used in previous studies similar to this study although some necessary modifications were made to suit the current study.

Although the studies were similar in some aspects, they differed in the project development factors believed to hinder the improvement of software project outcomes. Mullin & Hope (1996) studied "An application of quantitative techniques to the question of what contributes to a successful software development project." while

Eldridge (1997) focused on whether or not project management ensured successful software development. On the other hand, this study looked at harmony as a result of practising good SDPs, as an improvement to project outcomes.

4.2 RESEARCH SUBJECTS

As mentioned previously, the subjects of this study were Edith Cowan University's third year undergraduate computer science students undertaking a year-long Software Engineering project. The project has been in progress for almost four years and its purpose is to build an auto Software Engineering Environment, a true case tool.

4.2.1 The Project Teams

Teams were formed from students studying in three of the five Edith Cowan campuses, namely: Bunbury, Mount Lawley and Joondalup campuses. Only these three campuses offered the Software Engineering unit. As the location of Bunbury campus caused difficulties because of the distances involved, the research utilised Mt Lawley and Joondalup campus project students as subjects.

The criterion used by the unit co-ordinator to allocate student to teams was the students' course averages. However, while "The project teams select their leader in a democratic fashion and can change leaders if required" (Mullin & Hope, 1996, p. 120), there was the possibility for a group or groups to have a self appointed leader(s).

In the past years, the groups consisted of 4 to 6 individuals (Eldridge, 1997, p. 50). However, the 1997 size was almost doubled, comprising 9 to 12 individuals. Initially there were six groups from Mt Lawley campus and one from Joondalup. However, midway through the first semester, the number of groups decreased by one in Mt Lawley due to students not fulfilling the academic requirements for the unit, withdrawals from the unit and other personal factors. The new total number of project teams involved in the study was six.

Each group was allocated a supervisor whom they met once a week for half an hour to discuss their group's progress and other relevant matters involving the project. The staff supervisors did not assume the project management or system architect roles, instead, students performed those activities and learnt through their mistakes. This improved their productivity (Terry & Hope, 1998).

4.2.2 The Project Format

In the past years, examiners reviewed the projects twice, at the end of the first and second semesters respectively. During the first semester starting February each year, students were required to submit the process and product documentation for assessment by two examiners, while presentation of software products to a panel along with the submission of all project documentation were the requirements for the second semester (Hope & Terry, 1998). However, the assessment method changed for 1997. The project was reviewed three times in the first semester and twice, including the final presentation, in the second semester in an attempt to improve the efficiency and productivity of the project teams. This was intended to provided more formal guidance to students

compared to previous years where the only briefing was through the end of semester briefing questionnaire (Hope & Terry, 1998).

The products delivered throughout the year included:

- *software requirements specification*
- *detailed design documents*
- *design implementation*
- *testing*
- *user and technical manuals*
- *project file consisting of the project plans, time sheets, meetings, project reports, roles and responsibilities matrices*
- *configuration management*
- *risk management, and*
- *standards*

4.2.3 Software Development and its Environment

The first year, 1994, students developed a Software Project Administration and Management (SPAM) module and were free to select their development environment. However, in years 2, 3 and 4 the environment was mandated to be the Oracle suite of products and installed in a client/server manner using PCs as terminals, a Novell server for the development tools and the database residing under AIX on an IBM RISC 6000. (Mullin & Hope, 1996, p.121).

In 1995 the project teams built a new module, Software Configuration Management (SCM) and named the entire system the Software Management

Tools (SMT). SMT integrates and controls the relationship between SCM and SPAM. An estimation module, consisting of COCOMO (COnstructive COst MOdel) and FPA (Function Point Analysis) techniques, was added into the SMT system in year 3 of the project. The project teams were also required to enhance and maintain the existing system.

In 1997, year 4 of the project, the project teams had the task of enhancing and maintaining all the modules built from year 1 to year 3. The teams were also required to implement additional components to the existing system at the request of the customer. The new components included an e-mail facility and automatic file backup with the intention of creating a paperless office.

4.3 DATA COLLECTION

The 1997 software engineering projects commenced during the last week of February and spanned through to the first week of November. Data was collected in three stages, half way through semester one and the beginning and end of semester two:

- *April – Questionnaire One*
- *August – Interview One*
- *November – Questionnaire Two*

A different type of questionnaire provided by the unit co-ordinator was also incorporated into this study. This questionnaire, section 4.4.4, was administered during the end of both semesters as a project assessment instrument.

Formal reviews conducted by examiners throughout the project were also used as data collection instruments in this study. A total of five process reviews were administered, three reviews for the first semester and two, including the final product presentation, for the second.

Data was gathered from a number of sources which are discussed in more detail in section 4.4.

4.4 DESCRIPTION OF INSTRUMENTS USED

The style of the questions in the questionnaires has been adopted from various sources including Eldridge (1997), Mullin & Hope (1996). However, necessary changes in the format and questioning style were made so that the questions were meaningful in this particular study. The interview questions were constructed mainly from the short answer and questions which were found to provide unsatisfactory information in questionnaire one.

4.4.1 Questionnaire One

This questionnaire was designed to obtain responses from all the students involved in the project regardless of their roles in their teams. The questions were divided into four different categories, including the introductory questions.

The introductory questions targeted general information such as:

- *student name*
- *date of response*

- *study mode*
- *gender*
- *age*
- *number of female members and*
- *team size.*

The purpose of these questions was to ascertain the background of individuals within the team so that any other responses could be identified as a response from a particular student to allow the researcher to track and compare the responses.

Other categories were:

- *project management*
- *project team dynamics, and*
- *conflict related issues*

with questions ranging from open-ended questions to simple ones which required a "yes/no" response. There were 10-questions with a measured scale response, 5-yes/no related questions with a "please specify" to the answer provided and 2-open-ended general questions. Appendix A provides a sample of questionnaire one.

The questions and their purposes were as follows:

- ***How important do you think PM is for the success of your project?***

  This was the only question under the category of project management. It was purposely designed to gain knowledge on whether or not students valued project management as one of the key aspects for the success of their software development projects. Students were

asked to rate the importance of project management on a scale of 1 for very important, 4 neither, 7 very unimportant or 9 for don't know.

- ***How many sub-teams are there in your project team?***

  As the first question in the project teams category, this question was trying to establish how well the project teams were planning on managing their project tasks. These involved maintaining three modules implemented by previous groups together with the tasks of implementing new modules requested by the customer in relation to the sub-teams and the project team size. The question had a scale of 0 for none through to 3 for three sub-teams or others, which was accompanied by "please specify" for further elaboration.

- ***What are your roles/responsibilities in the team/sub-team?***

  This was an open-ended question with a purpose of establishing the individual roles and/or responsibilities of team members in relation to the project team scope of the maintenance and implementation tasks and group size in number.

- ***How long did it take to structure your team?***

  This question had a scale between 1 and 7 representing number of days and an extra option of "others" if the answer did not fall in the scale provided. The purpose was to establish how long a single team spent in days for organising and structuring their project team including the process of electing a project leader and getting to know one another in terms of skills, experience and in any other ways.

- ***How well do you know other members in your team?***

  This question attempted to establish whether or not team members knew each other before the commencement of the software development project. This was important especially in establishing the relationship between how long the team structuring takes place with respect to how well team members knew each other. Students were asked to rate how they knew each other on a scale of 1 for very well, 4 not well, 7 not at all or 9 for don't know.

- ***Do you feel uncomfortable working with any members in your team?***

  Students were supposed to rate how comfortable or uncomfortable it was working with each other on a scale of 1 not at all, 4 neutral, 7 very uncomfortable or 9 for don't know. The question endeavoured to analyse the teamwork atmosphere to sense whether or not there might be any tensions that could lead to group disharmony.

- ***Are you comfortable with your team mix? (Age/Sex/Nationality)***

  This question is an extension of the previous question trying to establish whether the team mix with regards to age, gender and members' background contributed to working together comfortably. The scale was 1 for very comfortable, 4 neutral, 7 very uncomfortable or 9 for don't know.

- ***How did you go about selecting your project leader?***

  This was an open-ended question with an attempt of establishing whether the project leader was democratically elected individual chose himself/herself or any other selecting process used by the team or by the individual. It was important to know this because any future team management or mismanagement falls back to the project leader.

- ***How many deputy project leaders do you have in your team?***

  This question relates to the question on " ... how many sub-teams ... in your project?" with the purpose of establishing the management style followed by the team in respect to the allocation of project tasks and how they are to be managed. The question also attempted to determine how much the project leader shared roles with his/her colleagues. The students were required to respond to the question using a scale of 0 for none through to 3 for three deputy project leaders and there was an option available for "others" including explanations.

- ***Have you had more than one project leader since the beginning of the project?***

  This question was trying to establish whether, from the beginning of the project to the time the questionnaire was administered, the team had more than one project leader. In case the answer to the question was "no" then the participants were required to skip one question,

however, for a "yes" answer the participants were required, in the next question, to give reasons for selecting more than one project leader.

- ***How often does your project team meet?***

  Participants were required to select an appropriate scale between 1 for very often, 7 for occasionally or 9 for don't know as a response to this question. The purpose of the question was to establish whether the team met frequently to discuss task progress & reallocation and any problems encountered together with determining different ways of handling any hurdles encountered during the process.

- ***How well does your team practice the software development processes?***

  These processes have been introduced in section 2.1 above and discussed in detail in Chapter 2: Literature Review. The question attempted to establish whether the members were practising all the necessary processes required when developing software. Participants were required to rate their team's practice of the SDPs on a scale of 1 for very well, 4 for not well, 7 for not practising SDPs at all or 9 for don't know.

- ***How many hours per week do you work on the project?***

  The participants were required to specify the number of hours per week they spend on the software project. The purpose was to observe how many hours each team member and the team as a whole set into the software development project. The scale was between, less than 4, 8, 12 and greater than 16 measured in hours per week.

- ***Do you think your project leader is performing his/her duties well?***

  As the last question in the project team category of questions, this question required a yes/no answer and some reasons regarding the performance of the project leader. The purpose of the question was to establish whether the team members were at ease with the way their project leader performed his/her duties.

- ***Have there been any conflicts in your team so far?***

  This was the first question among the list of questions from the conflict related issues category. It was also a question requiring a yes/no answer with a purpose of establishing whether or not the team had encountered any form of conflict(s).

- ***If, YES, what kind of conflicts were they?***

  This question is an extension of the previous question. It aimed at determining who was involved in the conflict(s) that were encountered by providing participants with four options as follows:

  Between two team members

  Team member against the team

  Team member against the project leader

  Others (allowing participants to specify any other form of conflicts that have not been represented in above categories)

- ***What caused the above conflicts?***

  This is an open-ended question endeavoured to establish the cause of the above conflicts. Participants were required to answer in their own ways any reason(s) that brought about the conflict(s).

- ***Who was involved in handling the conflict(s)?***

  This question attempted to establish who were involved in the handling and resolving of conflicts within the team. It is important to know the extent of team involvement when it comes to dealing with conflicts. The question provided participants with several choices including an option for "others" as follows:

  Project leader

  Team members involved

  Project team

  Others (allowing participants to specify any other form of conflicts that have not been represented in above categories)

- ***Has your project leader been playing a major role in resolving conflicts?***

  A question that required a yes/no answer with the purpose of determining how much the project leader was involved in the management of conflicts within the team. This question is followed by another question that required explanations if the answer to that question was "no". It is important to know the reasons why the project leader was not involved in the handling of conflicts.

- ***Does the conflict affect your team productivity?***

  This was an interesting question especially with regards to team productivity. According to the literature review on conflicts, many researchers suggest conflict can be a major contributor to team demotivation. However, another group of researchers considers conflict to be the road to team productivity if it is well managed. This question required a yes/no answer. The last question of the conflict related issues category and the questionnaire as a whole, required the participants to give reasons as to how or in what way the conflicts affected their productivity.

4.4.2 Interview One

The interview was conducted in the beginning of the second semester and comprised of extended questions of which, some were constructed from the ones in questionnaire one. Two different set of interviews were organised, one focusing on the project leaders alone and another on the rest of the team members. All these interviews were conducted in the period of August with each interview time approximated to be between 10-15 minutes.

The interview questions were divided into similar categories to those in questionnaire one. However, two more categories have been added and different names are used for some categories to make them more meaningful.

The interview comprised of an introductory part that required participants to provide their names, team and responsibilities within the teams. The project leaders were required to provide other information including the team size, number of male and female members and the number of part-time members. The other categories were, team building, team conflicts, team management, software development and others. These categories were composed mostly of open-ended questions requiring detailed response from the participants. Some of the questions were familiar to the participants because they were an extension of questionnaire one that contributed in quick understanding to the question and hence participants provided meaningful answers.

Appendix B is a sample of interview one for both project leaders and other team members. The questions and their purposes are provided below, with the underlined questions targeted only on the project leaders.

- ***How did you become the team leader?***

  This question required the project leader to explain how he/she became leader. It is similar to question 2g of questionnaire one. However, a more detailed discussion was expected from the individual to provide a better background on how they became the team leaders.

- ***How is your team built, structure wise?***

  This was another question meant for the project leaders to establish how their teams were built structure wise. This question required the project leaders to elaborate on how their project teams were built in terms of the tasks they needed to perform to fulfil the project requirements. It also involved detail concepts adopted by the team in the role of sharing responsibilities between the project leader, the deputy project leaders of the sub-teams, if any, and the other team members.

- ***Is your team made up of members from mixed cultures?***

  This question attempted to establish if there were any members of mixed cultures in the teams. Some researchers have mentioned the background and culture of individuals in a team have an impact to the communication aspects of group dynamics. Thus, this question is relevant in the support or opposition of other researchers in the context of this study.

- ***How many hours per week, on average, do you work?***

  The question was posed to all the participants who were required to mention the number of hours they spent working on the project. This question was necessary to make comparisons between the effort spent by individuals working on the project and the outcome of the project.

- ***How many hours per week, on average, does your team work?***

  This question was similar to the last question except it required the project leader to mention the overall hours spent by the rest of the team members on the project.

- ***What skills do members of your team, including yourself, have?***

  This question was trying to establish whether the team members including the project leader possessed the right skills required for the successful completion of the project, functional and quality wise.

- ***Are there any other skills which you think are important but your team doesn't have? Name them:***

  The PLs were required to list the skills they thought were important in software development which their team lacked. This was an important question because it showed the PLs awareness on their teams weakness and therefore would plan the necessary mitigation strategies to reduce the impact of this weakness towards the outcome of the project.

- ***What kind of team composition (considering sex/age/culture, etc.,) would you suggest to increase the performance and reduce conflicts to your team?***

  This question targeted the response from all the participants. The fact that the teams were randomly selected by the unit co-ordinator resulted in group compositions unwelcome by most members. However, this question attempted to establish from the participants, their ideal choice of team composition that they thought would increase their performance and minimise destructive conflicts.

- ***Does your team meet socially? Explain:***

  The PLs were required to explain what sorts of social activities their teams spent time in after working several hours in the project. The purpose of the question was to establish whether team building was part of the team culture.

- ***Have you come across any leadership difficulties and/or team conflicts?***

  This was the first question from the "team conflict" category of questions. The question was asked in two different ways to get separate response from the PLs and the rest of the team members. In both ways, it required a YES/NO response in the first case to ascertain whether the PLs experienced any hurdles during their leadership and in the second to get the same response but from the other members.

- ***What types?***

  The participants were required to mention all the types of conflicts they encountered since the beginning of the project.

- ***How have you managed the difficulties and/or team conflicts within your group?***

  In order to proceed with the project successfully, all the problems and conflicts encountered had to be managed. This question required the PLs to outline and elaborate on the methods and techniques employed within their groups to manage and monitor any form of problems, misunderstandings, etc., before they impacted on the project.

- ***How were the conflicts managed within your group? Explain:***

  This question was similar to the above except it required the response from other team members as to how conflict was managed within their groups.

- ***Which duties do you perform as the project leader?***

  This question marks the beginning of questions falling in the "team management" category. It attempted to establish the duties performed by the PLs in their respective project teams. The rest of the members were asked a similar question that required them to outline their roles and responsibilities in their project teams.

- ***Do you have shared leadership within your team? Explain what you do:***

  This question endeavoured to establish from the PLs if their project teams practised shared leadership and what kind of leadership was shared among the group members.

- ***What scope of the project is your team concentrating on?***

  The PLs were required to outline the project scope that their teams were concentrating on. The reason for this question was to establish how much of the requirement was scoped out by the project teams and what reasons lead to the scaling down of the requirements.

- ***Do you think you will deliver what you have mentioned in 3c? Give reasons:***

  This question targeted the response from the PLs as to whether their project teams would fulfil the scope of requirements mentioned in the previous question and reasons on why they thought they could/couldn't accomplish their goals.

- ***How well do you think your project leader manages the project and its resources? Explain:***

  This question required detailed discussion from the rest of the team members on the performance of their leaders. Team members were required to rate their leaders on a scale of 0-10 were 0 stands for poor performance and 10 for excellent performance.

- ***Is your input, as a member of your team, valued by others? Explain:***

  Participants were required to provide a YES/NO response with reasons for that response.

- ***Does your project leader value other members input? Explain:***

  Participants were required to answer how their PLs valued individual input towards the software development processes. This question was needed in order to establish how group communication was managed.

- ***Can you name, in priority order, which are the most important software development processes your team has been practising?***

  This research was trying to establish how good software development processes lead to harmonious project teams, which in turn leads to effective project outcomes. This question is one of four in the "software development" category of questions. It targeted the response from all participants. Participants were required to outline, in order of priority, all the software development processes practised by their teams.

- ***Do you think you need to practise any other processes? Name them:***

  As an extension of the previous question, the participants were required to outline other software development processes that they deemed important but were not practising due to time constraints or any other factors.

- ***Do you think all the processes you mentioned are important as far as software development is concerned? Explain:***

  Participants were required to state whether all the software development processes they mentioned in the previous questions were important in software development and explain how and why they deem those processes important.

- ***In your own opinion/experience, do you think practising good software development processes helps in reducing team conflicts? Explain:***

  This question required the participants to share their opinion through the experience they gained in the project on whether the practise of good software development processes minimised team conflicts.

- ***Name the factors which you think decrease the performance of your team?***

  This was one of three questions in the "others" category of questions. This was the last category of questions in the interview conducted. The question required the participants to

outline any of the factors they deemed as those which hindered their productivity and decreased their performance.

- ***Name the factors which you think increase the performance of your team?***

  As opposed to the previous question, this question required participants to outline all the factors they considered important and which increased the performance of their teams.

- ***Is there anything else you think is important and would like to add to this interview?***

  Namely:

  This was the last question in the interview and required the participants to, freely contribute on any miscellaneous aspect, especially regarding the project, which was not in one way or another covered during the interview.

4.4.3 Questionnaire Two

Questionnaire two, appendix C, was administered at the end of the second semester, November 1997, that being the end of the software engineering project as a whole. Questionnaire two was designed as an extension of questionnaire and interview one. However, the questions in questionnaire two attempted to obtain information from participants that spanned through the entire software development life cycle, since the inception of the requirements to delivering a functional and acceptable product.

As opposed to the questions that appeared in questionnaire one and interview one which were mostly open ended questions, questionnaire two was designed with questions that participants could respond to by selecting a weighted scale which appeared on almost every question. This scale was almost uniform over the range of questions with the measure of 0 for never/poor, 5 for average/sometimes and 10 for always/excellent. This style of questioning was employed to improve the administration process of the questionnaires and the ease of comprehension of the questions and their respective answers by the participants.

There were two sets of questionnaire two, one particularly for project leaders and the second targeting response from the rest of the team members. These questionnaires consisted of questions that were categorised in five different groups including the personal details group. Other groups were software development process, group dynamics, conflict-related issues and the general category of questions.

The personal details question comprised of questions requiring participants to identify themselves by name, date when the questionnaire was administered, study mode, participants' sex, the team they belonged and their roles and responsibilities within their teams.

The questionnaire two questions, as can be seen in appendix C and their purposes were as follows, with the italicised and underlined questions focused only on the project leaders while the normal fonts were meant for the rest of the team members:

- ***Indicate the software development model your team used.***

  This was the first question that under the category of software development processes. The participants were required to "tick" one or more approach that was employed by their teams as their model for software development.

  Software Development Life Cycle (SDLC) Approach

  Prototype Approach

  Spiral Approach

  Others (allowing participants to specify any other approach that is not mentioned in the above categories)

- ***How much time, percentage wise, did you spend performing the following project management and administrative activities?***

  This question required the participants to state the percentage of time they spent performing the following activities:

  Project Management

  Administration

  Risk Analysis and Management

  Configuration Management

Quality Management and

Training

- ***Have you had any prior industry/work experience before your involvement in this software engineering project? Circle an appropriate number on the scale.***

  This question was the first in the "group dynamics" category that required response from all the participants. The response was required in terms of a measure from a scale with the numbers 0 for never, 5 for part time and 10 for full time. The purpose of the question was to establish whether the participants had prior industry work experience before their involvement in the software engineering project.

- ***Indicate who was responsible for setting the team goals and objectives. Please also rate their degree of participation by circling a number on the scale.***

  The purpose of the question was to establish whether the goal setting task is sorely left to the PL or if it is a task that involves all the group members. The participants were required to specify who were involved in setting up the group goals and objectives. The scale was 0 for never and 10 for always with the following choices:

  Project leader

  Team member

  Project team

  Others (allowing participants to specify any other person or group of people responsible for setting goals and objectives)

- **How easy was it for you to communicate with your PL? Please circle the appropriate number on the scale.**

  The question was meant for the rest of the team members, excluding the PLs. Participants were required to weigh on a scale of 0 for never and 10 for always to establish how easy it was for the individuals to communicate with their project leaders.

- ***How often did you communicate with your team members? Please circle the appropriate number on the scale.***

  This question was similar to the above question with the only difference being its focus on the PLs. The PLs were required to state on their frequency of communication with their team members.

- ***How well did you understand the role you were supposed to play in your team? Please circle the appropriate number on the scale.***

  The purpose of this question was to establish whether the participants were aware and understood the roles they were supposed to play within their teams. The response was through a scale of numbers, with 0 for never and 10 for always.

- ***How often did you give feedback regarding the performance of your team members?***

  The question required the PLs to suggest on how often they provided performance feedback to their team members.

- **Please indicate the type of feedback and circle the number of times you received feedback from your PL regarding your performance.**

  The question was meant for the rest of the team members, excluding the PLs with the purpose of establishing whether or not the PLs provided performance feedback to their team members. The participants were required to provide a response in terms of a scale of numbers between 0 and 10. The choices for the question were:

  Positive feedback

  Negative feedback

  Others (allowing participants to specify any other form of feedback they received from their PLs regarding their performance)

- ***Please indicate the type of feedback and circle the number of times you gave feedback from your team members regarding their performance.***

  This question was similar to the above question with the only difference being its focus on the PLs. The PLs were required to state on the type of feedback they provided to their team members with the number of times that feedback was offered. The scale is also similar to the above scale and had the same choices, namely, positive feedback, negative feedback and others.

- **What scale do you rate your project leader as far as his/her performance goes?**

  Unlike the previous questions, this question requires a response on the measure of 0 for poor, 5 for average and 10 for always. The participants were required to rate the performance of their PLs.

- ***How often did you encounter conflicts in your team?***

  This was the first question in the category of "conflict-related issues" questions. The purpose of the question was to establish from the participants how often they encountered conflicts within their groups with the measure scale similar to the previous defined scale.

- ***Please indicate who was involved in the conflict(s) and circle the number of times they occurred.***

  To manage any form of conflict, it is important to first determine who were involved in the conflict. This question was required to establish who involved in the conflicts and the frequency on which these conflicts occurred. The participants were provided with a list of choices including:

  PL v member

  PL v team

  Member v member

  Member v team

  Other (allowing participants to specify any other person or a group of people involved in the conflict(s) and were not represented in the previous choices)

- ***Please indicate the source of the above (question 3b) conflicts and circle the rate of occurrence.***

  This question required the participants to indicate what was the source that brought about the conflicts. A list of possible sources was provided, however, the participants were provided with the "others" for choices that were not provided. The list is as follows:

  Cultural differences

  Personality clashes

  Age/gender related

  Different ideas

  None performing member

  Stress related

  Outside commitments (work, other units, etc.,)

  Other (allowing participants to specify any other source of conflict that has not been represented on the list provided)

- ***Please indicate what types of conflict(s) they were and circle the appropriate number regarding their rate of occurrence.***

  The purpose of this question was to establish how much of the conflicts that had occurred were either constructive or destructive. Participants were required to indicate the type of conflict and the rate they occurred. A scale of 0 measures the rate for never, 5 for sometimes and 10 for always. The list of options provided to the participants was as follows:

  Constructive (useful)

  Destructive (harmful)

  Other (allowing participants to specify any other type of conflict that has not been represented on the list provided)

- ***Please indicate who was involved in handling the conflict(s) and circle a number to measure their rate of involvement.***

  The purpose of this question was to establish what steps groups or individuals took in order to handle conflicts. Participants were required to select from a list provided below and rate the frequency by which the particular person or groups of people were involved in conflict resolution. The list provided to participants is as follows:

  Project leader

  Members involved

  Project team

  Other (allowing participants to specify any other person or group of people who were involved in handling conflicts)

- **How much was your project leader involved in conflict resolution?**

  This question was posed to the rest of the team members excluding the PLs. The purpose was to establish, from the individual members, how much their PLs were involved in handling and resolving conflicts.

- ***As a project leader, how often were you involved in conflict resolution?***

  This question was only posed to the PLs with the purpose of establish from the PLs themselves on how often they were involved in the resolution of group or individual conflicts.

- ***What effect did the resolution of the constructive conflict(s) have towards the productivity of your team?***

  This question and the one following had a unique scale with numbers 0 for negative, 5 for no effect and 10 for positive. The negative side of the scale represented a decrease in productivity while the positive side represented the opposite, increased productivity. The purpose of the question was to establish what type of effect was generated from the resolution of constructive conflicts within the groups.

- ***What effect did the resolution of the destructive conflict(s) have towards the productivity of your team?***

  This question was similar to the previous questions and it tried to establish the effects generated from the resolution of destructive conflicts within the groups.

- ***Did customer interaction contribute to the productivity of your team?***

  In this study, interaction with the customer was part of the software development processes at issue. This question required the participants to provide their opinion on how valuable the customer was to the development of the product. The measurement scale was between 0 for never, 5 for sometimes and 10 for always.

- ***Did you enjoy doing the project?***

  This question required the participants to reply in their own person how much they enjoyed doing the project. The purpose was to establish how tense or at ease the work environment and work relations were within the groups.

- ***Do you think it was a successful project?***

  Participants were required to rate the success of their projects from 0 for never, meaning unsuccessful to 10 for always, meaning the project was successful. This question tried to establish how confident and happy participants were in their work products and performance.

4.4.4 Feedback questionnaire

The feedback questionnaire, appendix D, was designed and initially used by Mullin & Hope (1996) in their study to measure the different variables, discussed below, they deemed as the most likely to contribute to a successful project. This questionnaire was employed by the software engineering unit co-ordinator to gather project information at the end of the first and second academic semesters. This debriefing questionnaire was divided into 9 different categories of questions with most questions requiring a response ranging from 0-10 were 0 stands for low/poor and 10 for high/excellent. These categories of questions were as discussed below.

The first category, "Individual", contained questions requiring the participants to provide their personal information on age, gender, study mode and the team they belonged while the second was the Oracle development environment. This category of questions required the participants to comment on the Oracle suite of products in terms of the satisfaction with the access to terminals, Oracle performance and satisfaction with the Oracle support.

Individual commitment to the project was essential for its success. The third set of questions related to the individual's time commitment to the project. The individuals were required to rate their time commitment whether they were larger or smaller than expected or whether the project was too large or to small for a third year undergraduate project.

Team processes and operation were the fourth and fifth categories of questions respectively. Team processes required the participants to rate on their software development processes that included project planning, work product reviews, risk management, configuration management and the usefulness of the methodology used in developing the software. The set of team operation questions required participants to provide a debriefing on how well their teams operated, how well individual contribution was valued by others and how well the project was managed. (Mullin & Hope, 1996, p. 122).

Other categories of questions were the "software engineering principles" and the "products". The software engineering principles set of questions required participants to outline the software engineering techniques they found useful in the project while the products questions established how satisfied participants were with the requirements definition and the functionality & quality of the finished products.

The last two sets of questions fell under the categories "Productivity" and "The Project". In the productivity questions, participants were supposed to outline the factors that helped and the factors that hindered productivity while the last category required the participants to comment on their experience gained from the project. This questionnaire gathered data concerning different aspects of the Software Engineering project that provided useful input to this study.

4.5 DATA ANALYSIS

The academic examiners used the CMM and SPICE models to evaluate the software development processes practised by the students involved in the software project. The practices that were emphasised by the examiners were the project file, testing, maintenance & user documentation and the final product presentation.

The expected and examined contents of the above listed practices were as follows:

- *project file*

  project plans, time sheets, meetings, project reports, roles and responsibilities matrices, process management, configuration management, the use of standards and risk management.

- *testing*

  test plan, scope of testing, test environment including test bed & test forms, test results (actuals vs expected), completeness of other aspects such as security, installation & auditing.

- *maintenance documentation*

  design updates, data dictionary, code & maintainability

- *user documentation*

  users guide including how to get started statement, installation procedures, help and error manuals, application of standards, document readability such as contents, index and glossary and document format and style .

- *presentation*

  statement of the problem, explanation of the approach taken, system functionality, system quality and overall presentation delivery.

On the other hand, the analysis of the other data gathered from the questionnaires and interview was done using the Spearman's rank correlation coefficient that was introduced in the previous section 2.4, theoretical framework. Spearman's correlation was used because of its robust measures of non-parametric statistical data by providing a less restrictive set of assumptions about the data. (Fenton, 1991, p. 102).

CHAPTER 5

RESULTS

The research data was analysed using the Spearman's Rank Correlation. Initially, individual responses to questions from each questionnaire were correlated to obtain a mean of the groups' responses. This mean was then adjusted against each project team's mark to obtain the correlation between the two variables. These results are discussed in this chapter.

5.1 SEMESTER ONE RESULTS

5.1.1 Questionnaire One

Spearman's analysis of the responses from all participants through questionnaire one was summarised in a spreadsheet format which is presented in Appendix E.

Table 2 - Q1: Statistics

TEAM STATISTICS	A	B	C	D	E	F
Team Size	8	10	9	10	9	12
No members participated in questionnaire	8	9	8	5	5	6
% participated in questionnaire	100%	90%	89%	50%	56%	50%
Female members	1	4	1	1	0	0
% female members	13%	40%	11%	10%	0%	0%
Part-time members	4	5	1	1	1	2
% part-time members	50%	50%	11%	10%	11%	17%

The table above outlines statistical information extracted from questionnaire one. The participation rate was promising with 71% from a total of 58 subjects responding. Only two groups, D and F, recorded 50% team participation while the rest were above that mark. Other statistics which can be extracted from the same table indicate that:

- *the number of female members in team C was the highest with the representation of 40% of all the group members. Teams E and F had no female members as part of their groups at that point in time;*
- *team A members fully participated in the exercise;*
- *teams A and B both recorded the highest percentage of part-time members with 50%, being part-time students. Team D recorded the lowest percentage of part-time members, being 10%.*

5.1.1.1 Likhert Scale Questions

This section provides the responses from participants covering questions that required a Likhert scale score response. The measurement scale had values between 1 and 7 where 1 stood for very important (vi), 4 being neutral and 7 being very unimportant (vu) or as presented on the questionnaire. Below are the sections containing questions which required the Likhert scale and the responses to those questions.

- ***Project Management***

Table 3 - Q1: Project Management Response

KEY		QUESTIONS	A	B	C	D	E	F	Spearman's Rank
		Project Management							
	1	How important do you think PM is for							
1 vi,4 neutral,7 vu		the success of your project?	1.8	1.7	1.3	2.2	2.8	1.7	-0.37

The above table shows Respondents' perception of the importance of project management. The table also shows the Spearman's Rank Correlation of the response against the project mark, suggesting that the project mark would decrease where project management was deemed unimportant to the project success and vice versa.

- ***Project Team***

Table 4 - Q1: Sub-Team, Group Mix & SDPs Response

KEY		QUESTIONS	A	B	C	D	E	F	Spearman's Rank
		Project Team							
	2a	How many sub-teams are there in your project team? *(0 None, 1, 2, 3, 4 Others)*	3	3	3	3	3	3	Constant Var
1 vc,4 neutral,7 vu	2f	Are you comfortable with your team mix?	4.30	1.70	1.90	3.00	3.00	4.00	-0.15
	2i	How well does your project team practice the							
1 vw,4 not well,7 not at all		software development processes?	4.10	3.80	1.80	2.50	1.80	3.20	-0.83

Participants from the six different teams suggested that each of their groups be divided into three sub-teams as depicted in above the table. Each sub-team had the responsibility of maintaining one of the three modules developed by previous teams in previous three years. These modules were project management, configuration management and the estimation modules.

Also the table above provides other information including participants' comfort with their team mix, question 2f. The responses ranged from "very comfortable" to a "neutral" response. The Spearman's Correlation for this particular question showed a number approximately equal to zero, which indicates that there was no correlation between the response and the project teams marks.

Question 21 showed a near negative correlation with the Spearman's outcome of –0.83. This suggested that if the teams were not applying software development processes well, or at all, then their project results would be below the project pass mark. Team A had a response of 4.1 which meant "not well" and subsequently their project mark was way below the average mark. Other teams' marks reflected the way they practised the software development processes, see appendix E for more detail on the results.

- ***Conflict Related Issues***

Table 5 - Q1: Conflict Related Issues Response

KEY	QUESTIONS	A	B	C	D	E	F	Spearman's Rank
	Conflict Related Issues							
1 Yes, 0 No	3a Have there been any conflicts in your team so far?	1	1	0.5	0.2	0.2	0	-0.75
	If YES, What kind of conflict?							
	3b-1 Between two team members	0	0.4	0	1	0.2	0	-0.23
	3b-2 Team member against the team	1	0	1	0	0	0	-0.22
	3b-3 Team member against the project leader	1	0.3	0	0	0.2	0	-0.74
	3b-4 Others	0	0.1	0	0	0	0	-0.42
	Who was involved in handling the conflict(s)?							
	3d-1 Project leader	0.4	0.5	0.5	0.5	0.2	0	-0.36
	3d-2 Team members involved	1	0.7	0.3	1	0.2	0	-0.83
	3d-3 Project team	0.3	0.2	0.3	0	0	0	-0.43
	3d-4 Not yet resolved	0.3	0	1	0	0	0	-0.07
1 Yes, 0 No	3e Has your PL been playing a major role in resolving conflicts?	1	0.3	0.8	1	0.2	0	-0.85

All the teams bar team F had encountered one form of conflict or another as depicted in the table above. Different methods and conflict management techniques were used to resolve and manage conflicts between the parties. Respondents suggested that their project leaders were the major players in the mediation of conflicts. A detailed discussion about team conflicts and how they were managed and/or mismanaged is provided in the Interview One Results section.

5.1.1.2 Open-Ended Questions

Apart from the Likhert scale questions, the remaining were open-ended and therefore required participants to provide detailed information about different aspects of their software project. The questions and summary responses from participants were as follows:

- ***2b What are your roles/responsibilities in the team/sub-team?***

  In previous questions, all participants claimed they had three sub-teams in their project teams. The range of responses provided for this particular question on role/responsibilities were:

  - *Project leader*
  - *Configuration management team manager*
  - *Estimation team manager*
  - *Project management team manager and*

  other multiple roles for other members including analyst, programmer, database administrator (DBA), tester, librarian, risk manager and document controller. Individuals in each sub-team performed one or more of these roles.

  Basically, the roles & responsibilities of individuals within the project teams were established as the project teams prepared their work breakdown structure outlining all tasks required for the successful execution of their projects.

- ***2g How did you go about selecting your project leader?***

  Most project leaders were elected through a democratic voting process that included all the team members. However, other leaders appointed themselves on the grounds that they were fully committed, ready to spend more time than the rest of the members on the project and confident they could perform a better job by promising functionality and quality in the product.

- ***2j What were the reasons of selecting another project leader?***

  Only one group that had more than one project leader from the beginning of the project in late February, to the time this questionnaire was administered in late April. While some team E members stated that their first project leader withdrew from the unit because of other commitments and personal matters, the questionnaires reflect that many team E participants believed that their leader withdrew because he had problems with organisation and lacked confidence among other things. Another team member appointed himself the project leader.

- ***2n Do you think that your project leader is performing his/her duties well?***

  Most participants from teams B and E answered "yes" to the question and provided comments on how well and unbiased they thought their project leaders were in performing their duties. However, team D members commented on the management weaknesses of their project leader such as personal management and communications skills, and recommended improvement in those areas.

  Most team F members selected the "not sure" choice for the question with no comments provided except for one who said, "he is not using software development process at all". These comments suggested that most team F members were not satisfied with the way that their project leader managed the project.

  Team A members had mixed responses to the way their project leader performed his duties. Most participants selected "not sure" and offered no comments. However those who offered comments, either selected a "yes" or "no" choice for the question. The ones who selected "yes" believed that the project leader was working hard on the project while the "no" choices commented that the project leader:

  - *did not trust other team members;*
  - *ignored other members suggestions, and*
  - *was disorganised.*

These mixed feelings within a single group threatened the group's performance because they had the ability to induce destructive conflicts unless they were promptly and efficiently dealt with.

- ***3c What caused the above conflict(s)?***

This question was preceded by two other questions. The first required participants to state whether they faced any form of conflict in their teams, while the second invited members to select those who they believed were involved in the conflicts from a list of choices. Participants provided the following comments for the second question.

In the case of team A, conflicts were either between the team member and the whole team, or the team member and project leader. Conflicts resulted from:

- *disagreements about decisions made;*
- *misunderstandings between team members;*
- *long project meetings, and*
- *individualism and ownership, that is the "mine instead of ours" philosophy.*

Members found these conflicts difficult to deal with especially when left unresolved for some time. Attempts to resolve conflicts were made by applying different conflict resolution methods such as:

- *JAD sessions;*
- *one-on-one discussions, and*
- *the involvement of the supervisor.*

Unfortunately, these efforts were in vain and the conflicts remained unresolved costing the project team dearly. Eventually the project failed (Appendix E). This was the first total project failure since the inception of this project in 1994 (Terry & Hope, 1998).

The responses from team B suggested that most conflicts occurred between two team members and between a team member and the project leader. Members believed that the cause of these conflicts was the lack of frank communication between group members and misunderstandings within the team.

Team member against the team was the major conflicts experienced by project team C. Members indicated that these were brought about by:

- *the lack of performance by one or more of its members;*
- *the lack of faith;*
- *lack quality in work presented, and*
- *the enormous ego of some members.*

Conflicts that involved the non- performing team member(s) went unresolved, at least until the time this questionnaire was administered. The PL and other team members tried different ways to resolve the conflict but still the performance of the member(s) failed to improve.

According to the responses from members of team D, there were no major conflicts in their group. However, one member mentioned an incident that occurred involving two team members. The reason for this conflict was misunderstanding about standards and other aspects of configuration management.

The type of conflict that was experience by team D can be characterised as a C-type conflict in that it was task-oriented and involved a discussion on standards that lead to a mutual understanding between the parties involved.

The responses gathered from team E were similar to the previous group, D, in that only one member mentioned a conflict incident that occurred in the team. He/she noted that there was a personal conflict between two team members and a conflict concerning a

decision made by the PL which involved a team member and the PL. All these conflicts were resolved by the parties involved without the interference from any outsider.

A rather interesting and unique, but possible, response was from team F. By the time this questionnaire was administered they had encountered no conflicts at all.

- ***3f If the answer (question 3e) is NO, please specify:***

  The previous question was whether or not the PL was involved in conflict resolution and in the case of a "NO" response, participants were required to provide reasons behind their answers for this question.

  Most of team A members suggested that their project leader was involved in conflict resolution except for one member who stated that the PL was himself involved in the conflict and therefore was not involved in conflict resolution.

  Team B members reported mixed feelings. While some members suggested that the PL was involved in conflict resolution others believed that the group members themselves resolved conflicts rather than the PL.

  Teams C, D and E all agreed that the project leader was involved in resolving conflicts. As Team F encountered no conflicts, this question was not applicable to their group.

5.1.2 Interview One

A one-to-one interview, Interview One, was conducted in August 1997, during the second semester. Although it was arranged during the second semester, the objectives were to gather information regarding semester one's project activities. The questions in interview one were similar to those in Questionnaire One except for a few changes in questions and questioning style (Appendix B). Despite these similarities, the interview built on questions that were unclear in the first questionnaire, and gave interviewees the opportunity to present any other issues which had manifested themselves since Questionnaire One.

Table 6 - Interview 1: Statistics

TEAM STATISTICS	A	B	C	D	E	F
Team Size	8	10	9	10	9	12
No of members participated in questionnaire	3	2	4	2	3	5
% participated in questionnaire	38%	20%	44%	20%	44%	42%
Female members	1	4	1	1	0	0
% female members	13%	40%	11%	10%	0%	0%
Part-time members	4	5	1	1	1	2
% part-time members	50%	50%	11%	10%	11%	17%

From a total of 58 subjects, only 34% participated in the interview conducted as is depicted in the table above, less than half the subjects involved in this study. Teams C and E had the highest percentage of participation at 44%, not even half the group size. The lowest participation was from teams B and D with 20% attendance. Participants were not willing to attend the interview for many reasons, some of which were the lack of interest, being busy with the project,

personal commitments etc. However, all project leaders participated in the interview and provided the overall project information.

5.1.2.1 Project Team A

Three members from team A managed to attend although by this time this team was defunct, as the software project had failed in the first semester. This team had experienced leadership by two individuals in its entirety, one semester. The first leader was democratically elected but withdrew midway due to the problems that faced the team, while the second leader took over the reins by self-nomination.

Members suggested the difference in culture was one of the major factors that contributed to team conflicts and lead to team failure. Others were:

- *poor planning;*
- *failure to understand the requirements, objectives and goals;*
- *failure to apply appropriate software engineering methodologies;*
- *lack of motivation;*
- *poor communication between the team members;*
- *lack of team spirit: rather than the "ours" philosophy, they were led by the "mine" philosophy which brought about a lack of team cohesion;*
- *lack of team structure;*
- *lack of responsibility;*
- *personality clashes;*
- *some members lacked technical experience; and*
- *poor and unstable leadership.*

These were the factors which smoldered in the team and later erupted into unresolved conflicts which hindered performance and eventually resulted in a disastrous outcome, project failure.

5.1.2.2 Project Team B

The project leader volunteered for the job and he suggested that the structure of the team should depend upon members' experience. Individuals within the team were grouped into three different sub-teams according to their expertise and experiences in different areas i.e. risk management, quality assurance etc. Most members in the team had basic skills in Oracle which they gained from previous computer science units at the university. While this was an advantage, the team still lacked other skills including industrial experience, time management and communications skills. Age, gender and culture had no effect on the functioning of the team.

The types of conflicts encountered by the members of this team were:

- *non performing team members;*
- *communication problems, and*
- *failure to meet deadlines.*

The number of part-time students in the team was also mentioned as a factor that lowered the team's productivity. On the other hand, factors that contributed to the increase in performance of this team were:

- *the use of proper software development processes including: project management, risk management and quality assurance and management;*
- *lack of gender bias;*
- *lack of cultural problems;*
- *individuals' commitment to the project;*
- *relaxed atmosphere: sharing jokes and humour;*
- *progress tracking and monitoring, and*
- *shared leadership: each sub-team was managed democratically and independently.*

Responses from individuals to the question of whether practising good SDPs helps in reducing team conflicts or at least channels A-type conflicts to become constructive conflicts, were positive. Supporting statements indicated that members believed that if software engineering processes were followed from the beginning, the group would develop direction in meeting the project objectives and scope. Also, they indicated that these methodologies assisted in establishing project standards which were later followed by the team. Members believed that this avenue minimised the amount of destructive conflict within the team.

5.1.2.3 Project Team C

The project leader volunteered for the job after everyone else rejected it. Interviews were conducted within the team to establish the skills of the members in the process of building an effective project team. Sub-team leaders were elected and other members were allocated to teams depending on their experience and skills.

The team comprised members with differing skills ranging from basic Oracle skills obtained from previous university units to networking experience. However, the project leader believed that more people who had Oracle skills, preferably industrial skills, were required. Age, gender and culture were not a concern to the team, the only minor problem which involved culture was language.

The team developed spirit by organising activities that involved members meeting outside working hours. This aided the team by building cohesion and coordination among team members and its fruit was shared at the end of the first semester by the group scoring one of the top marks during the first semester (Appendix E).

The major conflict that affected this group was the non performance of a particular team member. Different ways were adopted to resolve the conflict including mediation from the supervisor, but were unsuccessful. Through peer review forms that were used by individual team members to assess each other's performance, colleagues gave this individual a low score and eventually he failed the project. This resulted in one less group member in the second semester of the project.

The responsibilities of the project team members, including the project leaders, were:

- *project management*
- *scheduling*
- *setting the team structure*
- *risk management*
- *design of estimation module*
- *documentation reviewer*
- *configuration management: in charge of methods, standards and configuration management plan*

The software development processes practised by the team included:

- *project management*
- *configuration management*
- *risk management*
- *quality assurance and management*

Scheduling and Verification & Validation (V&V) were considered important processes in software development by the team although by the time this interview was conducted the team had not yet established proper scheduling procedures.

Participants suggested that:

- *team building*
- *peer assessment*
- *motivation*
- *supervision*
- *group cohesion & co-ordination, and*
- *communication*

were the factors that increased their productivity. Factors that were considered a hindrance to the team's performance were:

- *the work environment in terms of space and computer resources*
- *non performing team members*
- *a lack of plan and direction*
- *project scheduling, and*
- *a lack of commitment.*

5.1.2.4 Project Team D

The task of being a project leader requires commitment and sacrifice from the individual involved. Team D members were reluctant to choose the project leader. Eventually, a group member volunteered for the job on a week's trial, after which he continued to be project leader for the duration of the project.

The structure of the team was similar to previous teams in that the group was divided into three sub-teams, which were managed by the sub-team leaders. Each sub-team had the responsibility of maintaining one of the three modules developed by different project teams from previous years. The modules were project management, configuration management and estimation.

Team members offered varying skills from leadership, third generation language (3GL) programming to analysis and documentation. Participants regarded industrial experience in Oracle programming as an important skill which their team lacked.

Social activities, such as drinking together or seeing movies as a group, were part of the team's agenda. These team-building strategies strengthened the group's cohesion and co-operation by creating a comfortable and relaxed work and social environment. However, strong cohesion between the team members does not mean a lack of conflict. As discussed in the literature review, according to some research, conflicts are important if they are task-oriented and are encouraged to develop into constructive conflicts. Some researchers believe that this type of conflict will improve the group's decision making, performance and the eventual outcome of the project. Team D members experienced two major conflicts, namely, communication problems between the project leader and a team member, and conflict between the project team and non performing team members. These conflicts were well managed through combined efforts from the project leader and the team members. Some of the strategies employed by the team to resolve and manage conflicts were:

- *letting an issue go for sometime while the parties involved thought it over and resumed discussion a day or so later, and with a mediator if possible*
- *shared leadership*
- *frank communication between team members*
- *project leader's involvement*

Configuration management, project management, estimation and quality assurance were labeled as the important SDPs practised by the team. The participants also suggested risk management as an important SDP, however this was not yet put into practise by the time this interview was conducted.

Factors associated with the decrease of the team's performance were:

- *lack of individual commitment*
- *harbouring of conflicts*
- *lack of understanding of the goals & objectives, and*
- *other personal commitments (family, work, other units etc)*

Factors suggested by participants that increased the team's productivity were:

- *frank and open communication*
- *project leader's commitment*
- *staff supervision*
- *the use of other tools such as Visual Source Safe (VSS) for configuration management*

5.1.2.5 Project Team E

Initially the project team had an individual who volunteered for the job, however he reneged in the first two weeks for personal reasons. Other team members suggested that it was due to his lack of competence and organisational skills. The second project leader was democratically elected by group members immediately after the departure of their initial project leader.

The project team was divided into three sub-teams, each with the task of maintaining a single module namely, project management, configuration management and estimation. Members in each sub-team had different skills such as database (Access) skills and Oracle experience that was gained from the previous units in university. The team lacked organisational skills, since most of the members were full-time students with no prior industry experience.

This group, like many others, faced the problem of non performing members. Initially, this was a small problem but later it was exacerbated into a major conflict between the project team and the member in question. No mediation could resolve the conflict and the non performing member showed no signs of improving. Through peer review assessment, this member was awarded a low score by colleagues and as a result failed the unit.

The most important SDPs the team practised were:

- *configuration management: change management and control, document management etc*
- *project management: project plan, including walkthroughs, review, peer reviews etc.*
- *requirements*
- *design*
- *testing*

Additional SDPs that were planned for practise during the second phase of the project were:

- *revision of requirements and design*
- *thorough testing*
- *product implementation*

Other SDPs such as work breakdown structure (WBS), project planning and risk management were deemed as important processes but were not fully practised by the group due to restrictions on time.

The factors mentioned by participants as deterrents to the group's performance were:

- *outside influences and commitments (such as work, family, other units etc)*
- *poor work environment and scarce resources, and*
- *sometimes the lack of frank communication.*

Participants isolated the following as factors contributing to successful performance:

- *team building*
- *less commitments from other members*
- *open communication*
- *project leader's commitment and co-operation, and*
- *brainstorming sessions*

5.1.2.6 Project Team F

During the first semester, particularly when questionnaire one was administered, team F members suggested that they had encountered no conflicts in their team. However, at the time this interview was conducted, their first project leader was no longer with the group because he had failed the unit. At the interview, participants stated that their former project leader lacked commitment, had poor management skills, was not organised, and that he himself was a non performing team member. These factors led to his failure as a leader and in addition, the low assessment score awarded to him by his peers contributed to lack of success in the unit.

Despite the early problems associated with the former project leader, team F scored one of the highest marks during the first semester, and in the second semester, scored the only high mark at the end of the project. Its success was attributed to shared leadership, where each team member carried full responsibility for all project tasks in her or his charge.

At the commencement of the second phase of the project, during the second semester, two team members who previously shared leadership responsibilities with the former project leader became the new team's project leaders. More discussion on this unique approach adopted by team F is provided in the next section.

During the first phase of the project, participants outlined the SDPs which they practised in their software development project. They were:

- *software development life cycle(SDLC) approach: the waterfall model*
- *some prototyping techniques*
- *risk management*
- *project management*
- *configuration management*

- *quality assurance*
- *scheduling*

Participants identified the following as factors that hindered their team's performance:

- *poor communication*
- *time constraints*
- *lack of technical and managerial skills*
- *scarce resources*
- *none performing team member(s)*
- *lack of strong leadership*

The following were identified as factors that contributed to the success of the team:

- *adoption of shared leadership*
- *use of both the waterfall and prototyping approach to develop software*
- *technical experience acquired by some team members*
- *open communication between the members*
- *peer assessment and reviews*
- *walkthroughs*
- *staff supervision*
- *management and resolution of conflicts.*

5.1.3 Feedback Semester One

The debriefing questionnaire was designed by the unit co-ordinator to obtain feedback from individuals involved in the software development projects about the project and the work environment at the end of semesters one and two.

Appendix G, section G-1, provides a detailed response summarised from the feedback sheets that were administered during the end of semester one. As other researchers for other studies collated this information, only certain sections of the responses are discussed below.

The table below provides a summary of participants in the debriefing exercise.

Table 7 - FQ1: Statistics

STATISTICS	A	B	C	D	E	F
Average team age	34.20	23.25	22.44	25.22	22.67	23.33
Number of members	8	10	9	10	9	12
Number of members participated	5	9	9	9	9	12
% members participated	62.5%	90.0%	100.0%	90.0%	100.0%	100.0%
Female members	1	4	1	1	0	0
% female members	12.50%	40.00%	11.11%	10.00%	0.00%	0.00%
PT members	4	5	1	1	1	2
% PT members	50.00%	50.00%	11.11%	10.00%	11.11%	16.67%

The information indicates that:

- *the average age of teams B, C, E and F did not vary significantly. However, team A's average age was the highest. According to the Spearman's rank results, it can be suggested the higher the average age of a team, the lower the project mark. This is evident by the near perfect negative correlation of –0.70 from the*

Spearman's analysis and is reinforced by the fact that team A had the lowest project mark.

- *other statistics, which can be extracted from the table above, are the team sizes, number and percentage of female members, and the number and percentage of part-timers.*

The following are selected results from different sections of the feedback questionnaire that related to this study.

- ***Team Process***

  There was a strong positive correlation in question 16 against the groups' project marks. This suggested that teams considered change control (CC) an important part of software development, hence the process was well managed with the exception of team A, see the table below. As a general observation on the results, most teams believed team process activities such as:

  - *the value of reviews*
  - *satisfaction in change control, and*
  - *satisfaction in risk management*

  to be valuable and contributed to favourable outcomes.

Table 8 - FQ1: Team Process

KEY	QUESTIONS	A	B	C	D	E	F
	Team Process						
0 poor - 10 excellent	14 How valuable did you find the reviews?	3.60	7.39	6.22	5.00	8.11	5.73
0 poor - 10 excellent	15 How satisfied were you with the way you team managed risks?	2.00	7.33	7.22	7.11	7.17	8.00
0 poor - 10 excellent	16 How satisfied were you with the way you team managed CC?	1.60	5.89	8.22	8.56	8.78	7.25
0 poor - 10 excellent	17 How valuable was your staff adviser?	7.20	7.81	7.44	8.14	8.25	7.08
0 poor - 10 excellent	18 How useful did you find Fast-APT methodology?	5.20	4.89	4.11	6.44	3.56	2.75

However, the above table shows that team A members provided poor responses to all questions on team process. This indicates dissatisfaction with the manner in which these processes were practised, and reflects the reasons that this team's project failed.

- ***Team Operation***

  The table below provides the responses to the questions that fell under the category of "team operation". Once again, only team A members were not satisfied with the way their team operated and was managed. In retrospect, these responses indicate that the team was suffering from unresolved conflicts, which led to project failure.

Table 9 - FQ1: Team Operation

KEY	QUESTIONS	A	B	C	D	E	F
	Team Operation						
0 poor - 10 excellent	19 How satisfied were you with the way your team operated?	1.00	5.94	6.11	6.56	8.44	7.42
0 poor - 10 excellent	20 How satisfied were you with about the way your contribution was valued by the team?	3.60	6.33	6.22	7.56	7.39	6.83
0 poor - 10 excellent	21 Overall - how well was you project managed?	2.40	6.33	6.89	6.78	8.50	6.33

In appendix G, section G-1, the Spearman's Rank suggests a strong positive correlation on questions 19 and 21 indicating that the higher the satisfaction of team members with the way the team operated and the project managed, the higher the project marks and vice versa. A comparison of each project team's response and their respective project marks can be extracted from appendix G.

- ***Software Engineering Principles***

  This section required the participants to list the Software Engineering techniques they found useful and they believed contributed to the success of their projects. The table below is a summary of responses from all teams, listing the techniques they considered useful.

Table 10 – FQ1: SE Techniques

Team A	Team B	Team C	Team D	Team E	Team F
PM,QA,RM	PM,QA,CM	CM,QA,RM	Estimation	PM,CM,WBS	PM,QA,RM
Design Spec	IEEE stds	IEEE stds	Design	Design	IEEE stds
	MS Project	Diagrams	JAD	Case tools	Schedule
	Reengineering		Testing	Peer reviews	Reviews, RAD
	Sub-teams		Case Tools	Testing	Models, Reports
				Reviews	Testing
					Prototype
				Walkthroughs	Walkthroughs

Most teams isolated different software engineering techniques as beneficial to their projects. The following (in no particular order) were the common responses;

- *project management (PM)*
- *configuration management (CM)*
- *quality assurance (QA)*
- *risk management (RM)*
- *standards*
- *design*
- *reviews and walkthroughs*
- *peer reviews, and*
- *the use of case tools*

- ***Productivity***

Participants were required to isolate the factors that they found most helped their productivity. These factors are outlined in the table below.

Table 11 - FQ1: Factors Helped Productivity

Team A	Team B	Team C	Team D	Team E	Team F
Personal Commitment	Other Members	Other Members	Clear Tasks	Project Room	Team Work
Determination	MS Word	Case Tools	Real Deadlines	E-mail, Phone	Personal Commitment
Communication	Oracle, e-mail	Co-operation	Fast Computers	Shared Area	PM
SE Knowledge	Tech skills	FastApt Stds	Case Tools	Reviews	Good Leadership
	Knowledge	Relaxed Environment	Team Management	Disk Space	Resources
	Staff adviser	Group interaction	Team Help	Good Group	
		Time	Motivation		

Common responses to the question were as follows:

- *personal commitment*
- *case tools*
- *communication*
- *motivation*
- *SE knowledge, and*
- *resources*

The majority of teams considered these factors to be important and believed that they guided the teams to improved productivity and favourable outcomes.

There were also factors that hampered the teams' productivity during their software development activities. These factors are listed in the table below.

Table 12 - FQ1: Factors Hindered Productivity

Team A	Team B	Team C	Team D	Team E	Team F
Attitude	Full Time Work	Other Commitments	Lack of Motivation	Other Commitments	Oracle
Personality Clashes	Limited Time	Poor Leadership	Limited Time	Small Project Room	Poor System Support
Slack Members	Slack Members	Slack Members	PL no trust	Broken PCs	Limited Time
Poor tasks definition	Team Size	Poor Co-operation	Limited Access	Poor Co-operation	Team Size
No Plan	Conflict(s)	Conflict(s)		Limited Access	Personality Clashes
				Network Failure	Poor Maintenance Doco
				Schedule	No Mentor

Most of these factors were considered the main contributors of conflict within the teams although conflict itself was listed as a factor that hindered team productivity. The common factors suggested by different groups as the major hindrance of productivity were as follows:

- *personality clashes*
- *none performing team members*
- *availability of resources*
- *time constraints*
- *lack of commitment*
- *other commitments*
- *poor system support*
- *team size, and*
- *conflict*

5.2 SEMESTER TWO RESULTS

5.2.1 Questionnaire Two

Questionnaire two was administered at the end of the project and experienced full participation from all the subjects. Questionnaire Two was divided into two areas, one that targeted the project leaders only, the other was administered to the remaining team members. This separation was designed to produce two different perspectives, the leaders and other team members. The full results for questionnaire two are provided in Appendix F.

The table below indicates that forty-two subjects were involved in the study during the second phase of the project, second semester. This figure shows 16 less members at this stage of the project compared to the beginning. The 25% decrease was a result of:

- *one group, team A, failing the project*
- *group members of different teams being allocated to individual projects*
- *failure of individual members to meet the average mark required to pass the software engineering unit*
- *withdrawal of some members from the software engineering unit for personal reasons*

Table 13 - Q2: Statistics

TEAM STATISTICS	B	C	D	E	F
Team Size	7	8	9	8	10
No members participated in questionnaire	7	8	9	8	10
% participated in questionnaire	100%	100%	100%	100%	100%
Female members	4	0	0	1	0
% female members	57.14%	0%	0%	12.50%	0%
Part-time members	3	2	2	3	2
% part-time members	42.86%	25.00%	22.22%	37.50%	20.00%

The table above provides a summary of statistics of respondents for Questionnaire Two. The following information can be extracted from the table:

- *team B had the highest female and part-time percentage representation*
- *teams C, D and F had no female members*
- *team F had the lowest percent of part-time members with a representation of 20%*

Further analysis of the results obtained from Questionnaire Two appears in the next sections. The discussion is divided into two sub-sections namely, the project leaders questionnaire and the questionnaire involving the rest of team members.

5.2.1.1 Questionnaire Two - Project Leaders' Results

During the second semester, project team F, in a unique approach, was managed by two project leaders after their first project leader withdrew. In Appendix F section F-1, as well as the table below, F_1 and F_2 indicate the joint project leaders of project team F. Other teams had a single individual as a project leader.

- ***Software development methodology***

Table 14 - Q2 - PLs: Software Development Methodology

QUESTIONS	B	C	D	E	F_1	F_2
1a-1 Software Development Life Cycle Approach	0	1	1	0	1	0
1a-2 Prototype Approach	0	0	0	1	0	1
1a-3 Spiral Approach	1	0	0	0	0	0
1a-4 Other	0	0	0	0	0	0

The common response to this question from the different project leaders was that software development life cycle (SDLC) was the methodology the project teams adopted in developing their software products. However, two other project leaders preferred the prototyping approach while one indicated that his team used the Spiral approach.

- ***Analysis of time in performing different software development activities***

Project management was deemed important by several project leaders, hence they spent most of their time performing activities that fell under that category.

Table 15 - Q2 - PLs: Percent time spent in different activities

KEY	QUESTIONS	B	C	D	E	F_1	F_2
% of time	1b-1 Project Management	10	40	50	20	0	45
% of time	1b-2 Administration	40	44	30	10	2	10
% of time	1b-3 Risk Analysis & Management	10	2	0	10	68	0
% of time	1b-4 Configuration Management	20	2	10	25	10	10
% of time	1b-5 Quality Management	19	10	0	25	10	20
% of time	1b-6 Training	1	2	10	10	10	15

The table above shows the individual project leaders' responses. Project leaders of teams B and C dedicated a higher percentage of their time to administration activities while project leaders for teams D and F spent more time on project management. Team E's project leader evenly distributed his time among all the activities including configuration management, quality management & project management.

It is interesting to note from the table above the shared responsibility between team's F two project leaders. Project leader F_2 was involved in project management while F_1 dedicated most of his time to risk management and they shared almost equal times in performing the remaining activities. This approach ensured that the two project leaders tackled the leadership jointly and without encroaching on each other's field of responsibility. This management strategy was one of the factors that contributed to the success of project team F and their product.

Table 16 - Q2 - PLs: Average time spent in different activities

KEY	QUESTIONS	AVERAGE RESPONSE
% of time	1b-1 Project Management	27.50
% of time	1b-2 Administration	22.67
% of time	1b-3 Risk Analysis & Management	15.00
% of time	1b-4 Configuration Management	12.83
% of time	1b-5 Quality Management	14.00
% of time	1b-6 Training	8.00

The table above represents the average response from all the project leaders regarding the percentage time spent in different software development activities. It is interesting to note that PM ranked first with 27.5% of the time spent, while training ranked last with 8%.

- ***Who was responsible in setting goals and objectives?***

  The response from all project leaders showed that they were involved in setting goals and objectives most of the time, however on some occasions the project team itself se goals.

Table 17 - Q2 - PLs: Objectives & Goals

KEY	QUESTIONS	B	C	D	E	F_1	F_2
0 never - 10 always	2b-1 Project leader	8	9	10	9	6.5	9
0 never - 10 always	2b-2 Team member	0	7	0	5	4.5	0
0 never - 10 always	2b-3 Project team	7	3	0	8	4.5	0
0 never - 10 always	2b-4 Other	0	0	0	0	1.5	0

- ***How often did you give feedback and what type of feedback was it?***

Table 18 - Q2 - PLs: Communications & Feedback

KEY	QUESTIONS	B	C	D	E	F_1	F_2
0 never - 10 always	2e How often did you give performance feedback?	7.00	2.00	10.00	8.00	9.50	5.00
	Indicate the type of feedback						
0 never - 10 always	2f-1 Positive feedback	7.00	4.00	5.00	6.00	4.50	5.00
0 never - 10 always	2f-2 Negative feedback	3.00	4.00	8.00	7.00	4.50	3.00
0 never - 10 always	2f-3 Other	0.00	0.00	0.00	0.00	4.50	5.00

The type of feedback communicated by the project leaders to their team members can be extracted from the table above. Most project leaders provided mostly positive feedback, however project leaders of teams D and E provided negative feedback to their members.

Negative feedback was communicated in the form of constructive criticism to avoid demotivation of team members. Constructive criticism was also utilised by teams as a method to channel any form of conflict to C-type conflicts. In return, this approach improved the efficiency of team members, and this flowed on to an overall improvement in project performance. This is evident from the project mark scored by teams E and D, that is the second (34) and third (29) highest in the software engineering projects, respectively.

- ***How often did you encounter team conflict(s) and who were involved in the conflict(s)?***

Table 19 - Q2 - PLs: Conflicts and People Involved

KEY	QUESTIONS	B	C	D	E	F_1	F_2
0 never - 10 always	3a How often did you encounter team conflicts?	5.00	2.00	7.00	8.00	3.00	2.00
	Indicate who was involved in the conflict(s)						
0 never - 10 always	3b-1 PL v member	4.00	6.00	7.00	8.00	4.00	0.00
0 never - 10 always	3b-2 PL v team	1.00	2.00	3.00	1.00	5.00	0.00
0 never - 10 always	3b-3 Member v member	4.00	1.00	7.00	8.00	6.00	2.00
0 never - 10 always	3b-4 Member v team	3.00	2.00	6.00	1.00	8.00	0.00
0 never - 10 always	3b-5 Other	0.00	0.00	0.00	0.00	0.00	0.00

The above table indicates that team E's project leader encountered the highest amount of conflicts. Leaders of teams C and F responded with low occurrences of conflict within their teams.

Conflicts that occurred frequently were between the project leader and a single team member, followed by conflicts between two team members, and single member against the team. Some of these conflicts were primarily caused by the approach adopted by most of the teams, that is allowing the project leader to be solely responsible for setting the team's goals and objectives.

- ***Indicate the source of conflict(s)***

Table 20 - Q2 - PLs: Sources of Conflicts

KEY	QUESTIONS	B	C	D	E	F_1	F_2
	Indicate the source of the conflict(s)						
0 never - 10 always	3c-1 Cultural differences	0.00	0.00	5.00	3.00	0.00	0.00
0 never - 10 always	3c-2 Personality clashes	2.00	8.00	8.00	6.00	4.00	0.00
0 never - 10 always	3c-3 Age/gender related	1.00	0.00	2.00	0.00	0.00	0.00
0 never - 10 always	3c-4 Different ideas	4.00	3.00	3.00	6.00	4.00	2.00
0 never - 10 always	3c-5 None performing member	4.00	2.00	4.00	3.00	3.00	6.00
0 never - 10 always	3c-6 Stress related	2.00	8.00	7.00	8.00	6.00	2.00
0 never - 10 always	3c-7 Outside commitment (work, other units, etc)	5.00	1.00	10.00	9.00	3.00	0.00
0 never - 10 always	3c-8 Other	0.00	0.00	0.00	0.00	0.00	0.00

The following (in priority order with the number of occurrences considered as the priority criteria):

- *personality clashes*
- *non performing team members*
- *different ideas*
- *stress, and*
- *outside commitments.*

While these were identified by project leaders as the major source of conflict, age and gender were considered the factors contributing least to conflicts.

- ***What types of conflict(s) were they?***

Table 21 - Q2 - PLs: Types of Conflicts

KEY	QUESTIONS	B	C	D	E	F_1	F_2
	What types of conflicts were they?						
0 never - 10 always	3d-1 Constructive (useful)	7.00	5.00	5.00	6.00	3.00	0.00
0 never - 10 always	3d-2 Destructive (harmful)	3.00	5.00	4.00	7.00	4.00	0.00
0 never - 10 always	3d-3 Other	0.00	0.00	0.00	0.00	5.00	3.00

The overall response from project leaders suggested there were more constructive conflicts than destructive. Conflicts generated from the following factors:

- *cultural differences*
- *personality clashes*
- *age/gender*
- *different ideas*
- *none performing team member*
- *stress related, and*
- *outside commitment*

If they were successfully managed, the outcome would be a constructive conflict, unsuccessful management would lead to destructive conflict. However, although destructive conflicts are damaging, teams that experienced these kinds of conflicts tended to learn from their mistakes and avoided them in the future by channeling them towards constructive outcomes.

- ***Who was involved in handling the conflict?***

Table 22 - Q2 - PLs: Conflict Handling

KEY	QUESTIONS	B	C	D	E	F_1	F_2
	Who was involved in handling the conflicts?						
0 never - 10 always	3e-1 PL	6.00	6.00	9.00	7.00	4.00	0.00
0 never - 10 always	3e-2 Members involved	3.00	7.00	0.00	6.00	4.00	5.00
0 never - 10 always	3e-3 Project team	5.00	0.00	0.00	2.00	4.00	0.00
0 never - 10 always	3e-4 Other	0.00	0.00	0.00	0.00	4.00	0.00

The majority of responses suggested project leaders were the major mediators, however some members resolved their own conflicts.

- ***3f How often were you involved in resolving conflict?***

  The previous responses for question 3e-1 suggested the project leaders were the sole mediators of conflicts within their teams. This is reinforced by the response to question 3f, that is that project leaders were mostly involved in conflict resolution.

  However, the response from team F leaders indicated that they were not always involved in conflict resolution because:

  - *they did not encounter a lot of conflicts (response to question 3a)*
  - *most of the conflicts were solved by members involved and/or the project team (responses to questions 3e-2 and 3e-3)*

- ***What effects did the conflicts have towards your productivity and performance?***

Table 23 - Q2 - PLs: Effects of Conflicts

KEY	QUESTIONS	B	C	D	E	F_1	F_2
0 neg - 10 pos	3g What effect did the constructive conflicts have?	6.00	7.00	7.00	8.00	3.00	5.00
0 neg - 10 pos	3h What effect did the destructive conflicts have?	6.00	4.00	6.00	4.00	3.00	5.00

Project leaders suggested a near positive effect of constructive conflicts to the overall productivity and performance of the project teams, and an almost neutral effect by destructive conflicts. Even well managed A-type conflicts had either a neutral or favourable effect on the project.

- ***General Questions***

Table 24 - Q2 - PLs: General Questions Response

KEY	QUESTIONS	B	C	D	E	JOSE 1	JOSE 2
0 never - 10 always	4a Was customer interaction useful?	6.00	1.00	2.00	0.00	0.00	2.00
0 never - 10 always	4b Did you enjoy doing the project?	9.00	10.00	10.00	10.00	8.00	8.00
0 never - 10 always	4c Do you think it was a successful project?	7.50	8.00	10.00	9.00	10.00	9.00

A low score was awarded by most project leaders for question 4a on customer interaction suggesting that the interaction never contributed to the success of their projects. It is interesting to note that with the initial struggle and continuous stress involved in the software engineering projects, all the project leaders responded that they always enjoyed doing the project.

Project leaders were confident about the success of their project teams and their response reflected positively to the end-project score for each of their teams, as depicted from the table above.

5.2.1.2 Questionnaire Two - Other Team Members' Results

The team members' questionnaire two responses provided a different angle on how the members viewed the projects as opposed to the project leaders' views. Appendix F, section F-2 provides questionnaire two team members results.

- ***Software Development Methodology***

Table 25 - Q2 - Members: Software Development Methodology

QUESTIONS	B	C	D	E	F
1a-1 Software Development Life Cycle Approach	1	2	4	4	0
1a-2 Prototype Approach	0	4	0	4	5
1a-3 Spiral Approach	4	1	1	0	2
1a-4 Other	0	0	3	0	1

The table above indicates different methodologies adopted by the project teams in their software development processes as suggested by the team members. Team F practised the prototype approach, team D followed the SDLC approach and team B the spiral approach while the remaining teams used a combination two methodologies, namely, the prototype and the SDLC approaches.

However, the use of either a prototype approach or a combination of the prototype and SDLC approaches led to favourable project outcomes. This was evident from the project scores of teams E & F which applied the combination of both prototype and SDLC methodologies and the prototype approach respectively with each team scoring an end of project score of 34 and 35 respectively.

In appendix F, section F-2, it is observed that the Spearman's rank shows a near perfect positive correlation between the prototype approach and the project results which means a strong correlation between the two variables and hence the importance of the prototype approach to favourable outcomes.

- ***Analysis of time in performing different software development activities***

  The responses for this question reflects on the amount of time the team members spent in performing different software development activities. As opposed to the project leaders' responses that project management took more of their time, most team members suggested the following hierarchy of activities:

  - *configuration management*
  - *quality management*
  - *administration*
  - *training*
  - *risk analysis and management*

  in a priority such that the top most activity was one team members spent more time performing. The table below provides the average response from all the group members on the percent of time spent in different activities.

Table 26 - Q2 - Members: Average Time Spent in Different Activities

KEY	QUESTIONS	AVERAGE RESPONSE
% of time	1b-1 Project Management	16.64
% of time	1b-2 Administration	15.00
% of time	1b-3 Risk Analysis & Management	8.22
% of time	1b-4 Configuration Management	23.26
% of time	1b-5 Quality Management	19.83
% of time	1b-6 Training	8.98
	Others - Estimation/Help/Testing	9.09

From the team members perspective, project management activities were deemed as those activities performed by the project leaders hence ranked top on the project leaders responses and third on team members response. The table above showed that CM and QM as the activities that the team members spent more time.

- ***Who was responsible in setting goals and objectives?***

  Similar to the responses from the project leaders, most team members responded in favour of the project leaders suggesting them as always responsible in setting the projects' goals and objectives. Further more, the responses indicated that the project teams were sometimes responsible in setting the teams' goals and objectives as can be depicted in the figure below.

Table 27 - Q2 - Members: Objectives & Goals

KEY	QUESTIONS	B	C	D	E	F
	Who was responsible in setting goals & objectives?					
0 never - 10 always	2b-1 Project leader	7.67	6.57	7.38	9.14	6.38
0 never - 10 always	2b-2 Team member	3.83	5.57	5.44	4.43	5.50
0 never - 10 always	2b-3 Project team	4.67	7.86	5.25	4.00	4.75
0 never - 10 always	2b-4 Other	0	0	0.63	0	1

- ***How well did you communicate with your PL and what type of feedback did you get from your PL?***

  Most team members responded that they always communicated with their project leaders. The figure below indicates the highest response to question 2c has coming from the members of team F.

Table 28 - Q2 - Members: Communication & Feedback

KEY	QUESTIONS	B	C	D	E	F
0 never - 10 always	2c How well did you communicate with your PL?	7.33	8.00	7.75	7.43	8.88
	Indicate the type of feedback					
0 never - 10 always	2e-1 Positive feedback	6.17	5.00	6.25	7.86	7.50
0 never - 10 always	2e-2 Negative feedback	4.17	2.00	4.50	4.43	3.38
0 never - 10 always	2e-3 Other	0.50	2.00	1.25	0	0

In the case of feedback, team members indicated that they always received positive feedback except in some cases were they were provided with negative feedback which was narrated in the form of constructive criticisms to create a professional and productive work environment by hampering A-type conflicts.

- ***How do you rate your PL's performance?***

  Teams E and F offered excellent scores with regards to the performance of their project leaders as can be depicted from the figure below.

Table 29 - Q2 - Members: Project Leaders Ratings

KEY	QUESTIONS	B	C	D	E	F
0 poor - 10 Excellent	2f What scale do you rate your PL?	5.92	6.79	7.00	8.50	8.44

Appendix F, section F-2, shows a strong correlation of 0.9 between the performance rate of the project leaders with their respective project team marks. Teams E & F had the two highest project scores of 34 and 35 respectively. Other project leaders' performance ratings were also directly related to their project mark, such as team D 29, team C 28 and team B 27. This fact shows that the performance of the project leaders can affect the outcome of the project.

- ***How often did you encounter team conflict(s) and who were involved in the conflict(s)?***

  Members from team D indicated that they encountered conflicts more often than other teams. According to the responses, as depicted from the table below, B, E, C and lastly F succeeded team D with respect to the occurrences of conflicts.

Table 30 - Q2 - Members: Conflicts and People Involved

KEY	QUESTIONS	B	C	D	E	F
0 never - 10 always	3a How often did you encounter team conflicts?	4.50	3.93	6.25	4.43	2.81
	Indicate who was involved in the conflict(s)					
0 never - 10 always	3b-1 PL v member	4.87	2.71	4.75	4.57	2.81
0 never - 10 always	3b-2 PL v team	1.17	2.29	2.88	2.86	1.81
0 never - 10 always	3b-3 Member v member	2.50	2.86	6.50	4.43	2.56
0 never - 10 always	3b-4 Member v team	0	2.29	4.88	4.14	1.69
0 never - 10 always	3b-5 Other	0	0.86	0	0	1

The team members' responses as to who were involved in conflicts were similar to the responses offered by the project leaders. This was attributed by the fact that there were also similarities in the responses between the team members and the project leaders as to who were responsible in setting goals and objectives.

The responses from the team members indicated that conflicts which occurred frequently involved the project leader and a team member followed by occurrences of conflicts between two team members and conflicts between a single team member against the rest of the team.

- ***Indicate the source of conflict(s)***

  Unlike the project leaders responses, differing ideas was top of the list as one of the major sources that brought about conflicts. This was indicated by the responses gathered from the team members and can be depicted in the table below.

Table 31 - Q2 - Members: Sources of Conflicts

KEY	QUESTIONS	B	C	D	E	F
	Indicate the source of the conflict(s)					
0 never - 10 always	3c-1 Cultural differences	0.83	0.71	2.00	0	0.13
0 never - 10 always	3c-2 Personality clashes	5.83	3.00	5.50	3.43	1.88
0 never - 10 always	3c-3 Age/gender related	0.83	1.00	1.13	0.29	0.13
0 never - 10 always	3c-4 Different ideas	6.33	4.14	7.38	4.29	3.75
0 never - 10 always	3c-5 None performing member	3.50	3.57	4.75	4.14	2.63
0 never - 10 always	3c-6 Stress related	6.00	3.43	4.88	6.71	4.13
0 never - 10 always	3c-7 Outside commitment (work, other units, etc)	3.00	3.00	5.00	4.86	3.38
0 never - 10 always	3c-8 Other	0	0.29	0	0	0

The other sources of conflicts in order of the occurrence frequency were as follows:

- *stress related*
- *personality clashes*
- *outside commitment*
- *none performing team member*
- *cultural differences, and*
- *age/gender related*

- ***What types of conflict(s) were they?***

  The majority of conflicts were constructive conflicts. However, there was room for destructive conflicts because they could not be fully avoided, instead they were well managed and were channelled to favourable outcomes. The table below provides the team members' responses on the types of conflicts that occurred.

Table 32 - Q2 - Members: Types of Conflicts

KEY	QUESTIONS	B	C	D	E	F
	What types of conflicts were they?					
0 never - 10 always	3d-1 Constructive (useful)	4.00	4.00	5.63	5.57	4.63
0 never - 10 always	3d-2 Destructive (harmful)	4.17	1.57	6.00	3.14	2.13
0 never - 10 always	3d-3 Other	0	0	0.88	0	0

- ***Who were involved in handling the conflict(s)?***

  Team members indicated, from their responses, that most of the time people involved in the conflicts resolved their own conflicts without any interference from other members. In some occasions the project leaders and sometimes even the supervisor were involved in conflict resolutions.

Table 33 - Q2 - Members: Conflict Handling

KEY	QUESTIONS	B	C	D	E	F
	Who was involved in handling the conflicts?					
0 never - 10 always	3e-1 PL	3.20	5.71	4.38	4.71	3.75
0 never - 10 always	3e-2 Members involved	5.40	4.43	7.63	4.43	4.25
0 never - 10 always	3e-3 Project team	1.60	2.86	3.38	5.86	3.50
0 never - 10 always	3e-4 Other	0	0	0	0	0
0 never - 10 always	3f How often was your PL involved in resolving conflicts?	5.20	5.14	4.75	5.14	4.38

From appendix F, section F-2, on the same question on who was involved in handling conflicts it shows that there is a strong correlation between the project teams, as the conflict handlers, and the project marks. This suggests that at any time, it is best to let the project team handle conflicts to get favourable outcomes.

- ***What effects did the conflict(s) have towards the productivity and performance of your team?***

  Constructive conflicts had a positive effect towards the productivity and performance of most of the project teams. In the case of destructive conflicts, the responses (table below) indicated that they were heading to favourable outcome with most members' responses measured at a scale greater than 4, where 4 stands for neutral (no effect). However, team B indicated that sometimes destructive conflicts had a negative effect towards their productivity and performance and is evident from the project mark of 27 the team scored at the end which was a low mark.

Table 34 - Q2 - Members: Effects of Conflicts

KEY	QUESTIONS	B	C	D	E	F
0 neg - 10 pos	3g What effect did the constructive conflicts have?	4.80	5.79	5.56	6.71	5.57
0 neg - 10 pos	3h What effect did the destructive conflicts have?	3.80	5.14	5.00	4.71	4.88

The positive effect brought about from the destructive conflicts suggests the practice of good conflict management and resolution strategies employed by most teams to channel these destructive conflicts to obtain a favourable project outcome.

- ***General Questions***

  Similar to the project leaders' responses regarding customer interaction, the rest of the team members also indicated (table below) the unimportance of this process as it related to the success of their projects.

  Most team members indicated that they enjoyed doing their projects except for Team B. They also indicated their confidence in the success of their projects. Teams E and F always believed their projects were successful which in fact proved to be true when their projects scored the second and first highest project marks respectively.

Table 35 - Q2 - Members: General Questions Response

KEY	QUESTIONS	B	C	D	E	F
0 never - 10 always	4a Was customer interaction useful?	3.80	1.71	3.50	1.57	2.38
0 never - 10 always	4b Did you enjoy doing the project?	2.80	7.00	7.13	6.57	5.13
0 never - 10 always	4c Do you think it was a successful project?	3.80	7.71	7.13	8.29	8.81

Team B members were not satisfied on the success of their project as indicated from their response in the table above and this reflected on their project mark. See appendix F for full details on the results from questionnaire two.

5.2.2 Feedback Semester Two

This section provides the results from the feedback questionnaire administered at the end of semester two. This questionnaire was similar to the one used in semester one, however the responses might differ. The sections are structured in the same way as the previous sections on semester one feedback results.

Table 36 - FQ2: Statistics

STATISTICS	B	C	D	E	F
Average team age	23.83	25	23.22	23	22.80
Number of members	7	8	9	8	10
Number of members participated	7	8	9	8	10
% members participated	100.00%	100.00%	100.00%	100.00%	100.00%
Female members	4	0	0	1	0
% female members	57.14%	0.00%	0.00%	12.50%	0.00%
PT members	3	2	2	3	2
% PT members	42.86%	25.00%	22.22%	37.50%	20.00%

The table above provides the statistical information on the participation for the debriefing exercise. Unlike the feedback from semester one, this exercise received full participation from all the teams.

Other information that can be depicted from the table above are:

- *the average ages of students was almost equally distributed across the teams. Unlike the average ages recorded in the responses from feedback one where the ages varied greatly across the teams.*
- *information about the number and percentage of female and part-time members*

- ***Team Process***

  In comparison to the previous responses from feedback one it was interesting to note that there was an increase in responses supporting the value of reviews. However, the responses regarding the following:

  - *the way the teams managed risks*
  - *the way the teams managed CC*
  - *the value of the staff advisors, and*
  - *the usefulness of the FAST-Apt methodology*

  decreased in feedback two compared to feedback one. This suggested that from the experience the team members gained throughout the project, the rate of risks decreased and change control was well managed and monitored. In the case of FAST-Apt methodology, groups utilised different standards such as the IEEE standards as they gained more knowledge in the software engineering principles. The latter covers more project scope in the students' software engineering project than the former.

Table 37 - FQ2: Team Process

KEY	QUESTIONS	B	C	D	E	F
	Team Process					
0 poor - 10 excellent	14 How valuable did you find the reviews?	7.86	7.00	6.89	7.00	6.80
0 poor - 10 excellent	15 How satisfied were you with the way you team managed risks?	6.43	8.00	6.78	7.00	6.80
0 poor - 10 excellent	16 How satisfied were you with the way you team managed CC?	3.86	7.00	7.00	7.63	7.00
0 poor - 10 excellent	17 Ho valuable was your staff advisor?	7.00	7.13	7.44	7.88	6.56
0 poor - 10 excellent	18 How useful did you find Fast-APT methodology?	4.29	2.76	4.56	2.19	1.50

- ***Team Operation***

  In question 19, teams B, C and D indicated a decrease in their responses from feedback two compared to feedback one, which reflected on the decrease in their project marks for the respective semesters.

In questions 20 and 21 the general responses indicated an increase in the satisfaction about the way the teams valued other members input and how well their projects were managed. This was also reflected by the strong positive correlation in the responses for both questions.

Table 38 - FQ2: Team Operation

KEY	QUESTIONS	B	C	D	E	F
	Team Operation					
0 poor - 10 excellent	19 How satisfied were you with the way your team operated?	6.00	7.88	6.67	8.66	7.80
0 poor - 10 excellent	20 How satisfied were you with about the way your contribution was valued by the team?	6.86	6.88	6.56	7.75	7.90
0 poor - 10 excellent	21 Overall - how well was you project managed?	6.71	7.50	7.11	8.22	7.80

- ***Software Engineering Principles***

  The software engineering principles deemed important by all teams during the second phase of the project extracted from feedback sheet two were almost identical to the responses from feedback sheet one. These were:

  - *project management*
  - *configuration management*
  - *quality assurance*
  - *risk management, and*
  - *reviews and walkthroughs*

  See the table below for an extensive list.

Table 39 – FQ2: SE Techniques

Team B	Team C	Team D	Team E	Team F
RM, QA, PM	RM, QA, PM, CM	RM, PM, CM	RM, QA, PM, CM	QA, PM, CM
	Scheduling	Conflict resolution	SCR, CC	Task Tracking
	Process		Testing	Time Management
			Estimation	Testing
			Walkthroughs	Estimation
			Prototype	Methodology
			Team dynamics	Leadership

- ***Productivity***

  Common factors deemed by the teams as the contributing factors to productivity were as follows:

  - *personal commitment*
  - *communication*
  - *team work*
  - *time management*
  - *availability of resources including project room access, use of access cards, fast machines, etc., and*
  - *team building*

  Other factors were as displayed in the table below.

Table 40 - FQ2: Factors Helped Productivity

Team B	Team C	Team D	Team E	Team F
CD-ROM	Resources	Resources	Team Work	Team Work
Piece	Team unity	TM	Resources	Other Commitments
Quite	Room access	Team Feedback	Tools avail	Team mates
Plan	Less units	IEEE stds	Team Feedback	Project Manegement
Communication	Discussion	Hard Work	Reviews	Leadership
Discuss			Communication	Resources
			Environment	

Factors that hindered productivity are summarised in the table format below.

Table 41 – FQ2: Factors Hindered Productivity

Team B	Team C	Team D	Team E	Team F
Resources	Other commitments	Slack Members	Limited Time	Oracle
Small Project Room	Communication	Communication	Personality Clashes	Limited Time
Limited Time	Member Dependency	Other commitments	FT/PT Students	
Slack Members	Poor Documents	Conflict(s)	Small Project Room	
Conflict(s)			Lack of Skills	
			Other commitments	
			System Support	

However, the common responses were:

- *scant resources*
- *group sizes*
- *lack of software engineering skills*
- *non performing team members*
- *communication*
- *conflict(s), and*
- *personality clashes*

An interesting response could be observed from team F which showed a decrease in factors that hindered productivity in feedback two as compared to feedback one and this is suggested as one of the factors which led to the success of the team in the project.

DISCUSSION

A detailed discussion of the findings of the previous section is provided in this chapter. The findings are addressed by discussing the answers collected from the research questions.

6.1 DISCUSSION ON FINDINGS

This study suggested a link between SDPs and team harmony which had an impact on the resulting software project outcome. The findings suggest that for project teams to improve performance and enjoy favourable project outcomes, the link between SDPs and team harmony needs to be well established. Failure to establish this link might lead to poor performance and even project failure.

This section describes the findings of the questionnaires and interview responses. These responses showed how the link between SDPs and harmony could be established and maintained, and how this link could fail, resulting in a poor outcome.

The section is divided into three sub-sections namely, software development processes, harmony and project performance. These sections were derived from the hypothesis of this research, "Good Software Development Processes Lead to Harmonious Project Teams Which in Turn Lead to Effective Project Performance". The underlined words were used as key words for the formation of the sub-sections. Each research question is addressed in related sub-sections.

6.1.1 Software Development Processes

Software development processes are defined in the glossary. However, the research questions and findings relating to SDPs are discussed in this section.

6.1.1.1 What are good SDPs?

Good software development processes are regarded, in this study, as the software practices which guide a team to harmonious work behaviour and environment, both considered necessary conditions for improving team performance.

In their study Deephouse, Mukhopadhyay, Goldneson & Kellner (1996, p. 189) suggested that project planning and cross-functional teams were practices associated with favourable outcomes. However, Deephouse et al. (1996) did not take into account the harmony factor as an outcome of these processes. This study included team harmony as an outcome of practising good software development processes.

The software project teams involved in this study, particularly E and F, provided a baseline standard for good SDPs which accounted for team harmony. These practices are:

- ***Software development methodology***

  The results favour the use of the prototype or both the prototype and SDLC approaches.

- ***Project management***

  This includes different activities such as project planning, scheduling, tasks allocation and tracking, progress tracking, etc.

- ***Configuration management***

  This includes the change control procedures, document history, versioning and tracking etc.

- ***Risk management***

  This includes the processes of risk identification and prioritisation, assessment, avoidance and monitoring strategies

- ***Quality assurance***

  This entailed the use of standards such as the IEEE and FAST Apt.

- ***Administration***

  These were project activities which included meetings, minutes, agendas, timesheets, etc.

- ***Training***

  Most teams offered task training to their current and new members. New team members received team, process and task induction to familiarise them with their new work environment.

Strong correlations between these differing variables and the project marks suggest the importance of practising these processes to lead to a harmonious project environment and eventually, effective project performance.

6.1.1.2 In what priority order should SDPs be practised?

The priority order for practising these SDPs was determined from the overall average percentage of time spent by all teams in performing those activities.

The project was organised in a way that enabled students to produce the major project deliverables twice in its entirety, at the end of semester one and at the end of semester two. Because of these expectations, during semester one all project teams spent more time in the design phase of the project, while in semester two they spent most of the time in coding.

However, the findings suggested the following hierarchy of software development activities with the top most activity the one teams spent more time performing, and the bottom activity the least:

- *coding*
- *administration*
- *design*
- *management*
- *testing*
- *requirements*

Coding was the most practised activity because of the following:

- *Lack of experience*

  Most students involved in the project had no software industrial experience and therefore took a longer time to perform some of the activities. Coding claimed most time because team members had to learn the Oracle suite of products at the same time as using the package to build their products.

- *Maintenance*

  In 1997, the main requirements were to maintain and enhance the software products developed by project teams in previous years. This meant a revision in the design of the product and major maintenance which involved exhaustive coding.

The table below presents the responses from project participants to the percentage time they spent performing different software development activities. (Note that the percentage time spent in different activities by the winning project team F was not available, hence it was not included in these statistics.)

Table 42 - Percent time spent in activities

Activity	Total
Requirements	690.55
% time in requirements	6%
Design	1917.55
% time in design	18%
Coding	3695.55
% time in coding	34%
Testing	697.69
% time in tests	7%
Management (project planning, schedule, reviews, walkthroughs etc)	1834.4
% time in management	17%
Administration (meetings, timesheets, agendas, etc)	1955.26
% time in administration	18%
Total Time	10691

Other activities, in priority order were:

- *configuration management*
- *quality management*
- *risk analysis and management, and*
- *training*

6.1.2 Harmonious Project Teams

The outcome of practising good SDPs is harmonious project teams. Following are the research findings as to factors which constitute a harmonious project team and other related aspects of project team harmony.

6.1.2.1 What is Harmony?

Harmony as described in this study, is not the lack of conflict but the management, control, monitoring and if possible, avoidance of A-type conflicts. Efforts should be made to channel A-type conflicts to become C-type conflicts, which result in favourable outcomes.

Harmonious teams, according to this study, will have most of the following characteristics:

- *c-type conflicts*
- *open and frank communication*
- *creativity*
- *integration*
- *cohesion*
- *co-ordination*
- *co-operation*
- *commitment, and*
- *motivation*

6.1.2.2 What factors contribute to team harmony?

The following are factors that contribute to team harmony:

- *good software development practice*
- *creation of c-type or constructive conflicts*
- *good leadership*
- *team building*
- *software engineering knowledge*
- *open communication*
- *commitment*
- *favourable work environment, and*
- *sufficient resources*

6.1.2.3 How can the link between good SDPs and team harmony be measured?

The link between good SDPs and team harmony can be measured through the project outcome. According to this study, team harmony does determine the project outcome and therefore, if a link exists between good SDPs and team harmony the determinant of that link would be effective project performance.

Another possible way of measuring this link is to, at any time before the end of the project, compare the SDPs that are being utilised with the list mentioned in section 6.1.1.1 to check whether the projected outcome would result in team harmony. Team harmony can be measured by using the checklist listed in the previous section 6.1.2.2. If the check listed factors do not match the initial outcome from the SDPs then it will suggest that the link does not exist.

6.1.3 Improved Project Performance

Improved project performance is the result of practising good SDPs which leads to harmonious project teams. Working in harmony, as described in this study, results in increased productivity and eventually effective performance. Whether harmony makes a difference to the project outcome is discussed below.

6.1.3.1 Does harmony make a difference to the project outcome?

This research question tried to establish whether harmony had any effect on the project outcome. The answer was positive, harmony did make a difference to the project outcome. The observations made in this study were:

- *the teams which did not practise the SDPs well missed the link to team harmony and eventually performed poorly. Project team A was a typical example.*
- *teams which practised good SDPs made a link to team harmony and ultimately performed well in their projects. Examples were teams E and F, which scored 34 and 35 as the project mark respectively.*

CHAPTER 7

CONCLUSION

In this final chapter, recommendations are made which may improve the computer science undergraduate students' software engineering projects, future enhancements to the study are suggested and finally the thesis conclusion.

7.1 RECOMMENDATIONS

The following are the recommendations suggested to improve the performance of future Edith Cowan University's computer science projects:

7.1.1 Software Development Environment & Resources

The software development environment includes the Oracle suite of products and other resources such as the project room, computers etc. Oracle should be taught in the first software engineering workshops during the first semester. This will assist students to gain the requisite knowledge of the environment they will use to develop their products.

Since the team sizes have changed in 1997, the inanimate resources should be re-assessed and changed accordingly. The project room, computers, etc should be improved to reflect the new environment.

7.1.2 Standards

The unit co-ordinator, in conjunction with examiners, should derive a set of standards from IEEE standards and FAST Apt methodology, which are the current standards, to be followed by students when developing software. This approach will provide an easier guide to students and might improve project performance because students will have improved access to the university set standards. Currently there is restricted access to the FAST Apt methodology as

there are only a few available site licences and a single copy of the IEEE standards as a reference in the university library. These restrictions hinder learning and create difficulty in following the standards.

7.2 ENHANCEMENTS TO THE STUDY

This study suggests future enhancements in the area of team composition. Several factors relating to the composition of teams contributed to the poor performance exhibited by some of the project teams. The factors were:

- *average age of students in a team*
- *the number of female members*
- *the number of part-time members*

The results from the feedback questionnaires (see Appendix G) show a strong negative correlation between the average age of the team and the project results suggesting that an increase in the average age will result in a decrease in the project mark and vice versa. This was also evidence in relation to the number of female and part-time members in the groups. (See Appendix G, section G-1)

Different researchers might be prepared to consider these factors in their studies to ascertain whether there are reasons to believe that the above listed factors can contribute to poor performance.

7.3 THESIS CONCLUSION

The hypothesis "Good Software Development Processes Leads to Harmonious Project Teams Which in turn Leads to Effective Project Performance" has been confirmed in this study. In semester one, this study focused on a total of 58 subjects divided into 6 different teams, however the numbers decreased to 42 subjects divided into 5 different teams in the second semester. The subjects were undergraduate computer science students at Edith Cowan University.

These students were required to develop and maintain software products as part of their third year software engineering project. The software development environment was the identical for all the project teams and was prescribed by the unit co-ordinator.

The purpose of the study focused the interaction between the activities, behaviour and outcomes of these project teams. Questionnaires and an interview were the main instruments used for data collection. The data was correlated using the Spearman's rank method against the project team scores to come up with meaningful analysis.

The results suggested that all the teams which practised good SDPs, developed a harmonious team work environment which eventually led to the success of their projects. This study reinforced the thesis that good SDPs lead to harmonious project teams, which in turn lead to effective project performance.

Amason, A., Hochwarter, W., Thompson, K., & Harrison, A. (1995, Fall). Conflict: An important dimension in successful management teams. Organizational Dynamics, 24 (2), 20-35.

Bantel, K., & Jackson, S. (1989). Top management and innovations in banking: Does the composition of the top team make a difference? Strategic Management Journal, 10, 107-124.

Bolman, L., & Deal, T. (1992). What makes a team work? Organizational Dynamics, 21 (2), 34-44.

Bowen, J. (1996). Ariane 5: Flight 501 failure [on-line]. Available WWW: http://www.cs.rdg.ac.uk/cs/people/jpb/teaching/ethics/ariane5anot.html [1998, January 20].

Brown, K., Klastorin, T., & Valluzzi, J. (1990). Project performance and the liability of group harmony. IEEE Transactions on Engineering Management, 37 (2), 187-205.

Deephouse, C., Mukhopadhyay, T., Goldenson, D., & Kellner, M. (1996). Software processes and project performance. Journal of Management Information Systems, 12 (3), 117-125.

Eldridge, J. (1997). Does good project management ensure successful software development? Honours Dissertation, Edith Cowan University, Perth, Western Australia.

Fenton, N. (1991). Software Metrics: A Rigorous Approach. Melbourne: International Thomson Computer Press.

Firth, J. (1991). A proactive approach to conflict resolution. Supervisory Management, 36 (11), 3-4.

Isaacson, W. (1997, December 29 – 1998, January 5). Man of the year: The passion of Andrew Grove. Time Magazine, 22-27.

ISO/IEC JTC1/SC7 (1995). Software Process Assessment Part 1: A model for process management. Working Draft 1.0.

ISO/IEC JTC1/SC7 (1995). Software Process Assessment Part 2: A model for process management. Working Draft 1.0.

ISO/IEC JTC1/SC7 (1995). Software Process Assessment Part 9: Vocabulary. Working Draft 1.0.

Kendall, M., & Gibbons, J. (1990). Rank Correlation Methods. New York: Oxford University Press.

Krug, J. (1995). Growing pains. Journal of Management in Engineering, 11 (6), 18-22.

Matsubara, T. (1991, June). Project management in Japan. American Programmer, 4 (6), 41-50.

Mullin, K., & Hope, S. (1996). An application of quantitative techniques to the question of what contributes to a successful software development project. 1996 Australian Software Engineering Conference Proceedings, 118-130, USA: IEEE Computer Press.

Oxford Advanced Learner's Dictionary of Current English (5th ed.). (1995). New York: Oxford University Press.

Paulk, M., Curtis, B., Chrissis, M., & Weber, C. (1993). Capability Maturity Model for Software. Version 1.1. Report CMU/SEI-93-TR-24, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania.

Pressman, R. (1997). Software Engineering: A Practitioner's Approach (4th ed.). New York: McGraw-Hill, Inc.

Pressman, R. (1992). Software Engineering: A Practitioner's Approach. Sydney: McGraw-Hill, Inc.

Rakos, J. (1990). Software Project Management for Small to Medium Sized Projects. Englewood Cliffs, New Jersey: Prentice-Hall.

Ratcliff, B. (1987). Software Engineering: Principles and Methods. Melbourne: Blackwell Scientific Publications.

Rout, T. (1995). SPICE: A Framework for Software Process Assessment. Software Process-Improvement and Practice, Pilot Issue, 57-66.

Saiedian, H., & Kuzara, R. (1995, January). SEI Capability Maturity Model's Impact on Contractors. IEEE Computer, 16-26.

Sallis, P., Tate, G., & MacDonell, S. (1995). Software Engineering: Practice, Management, Improvement. Sydney: Addison-Wesley.

STDAS Help System (1997). Spearman [on-line]. Available WWW: http://ra.stsci.edu/HelpSys/spearman.html [1997, 20 August]

SPICE. (1997). What is SPICE? [on-line]. Available WWW: http://www-sqi.cit.gu.edu.au/spice/what.shtml [1997, 25 November].

SPICE – Document Suite. (1997). An Introduction to the Documents [on-line]. Available WWW: http://www-sqi.cit.gu.edu.au/spice/suite_intro.shtml? [1997, 26 November].

Terry, J., & Hope, S. (1998). The simulation of formal management reviews to increase quality in undergraduate software engineering projects. Proceedings of the 1998 International Conference Software Engineering: Education & Practice (SE-EP '98). IEEE Press.

The ISO 9000 Group. (1997). What Is ISO 9000? [on-line]. Available WWW: http://www.commerce-associates.com/iso/WhatsISO.html [1997, 25 November].

Trillium. (1997). The Trillium Model [on-line]. Available WWW: http://seweb.cit.gu.edu.au/trillium/trillium.html [1997, 10 June].

Trillium Capability Areas, Roadmaps and Practices, [on-line]. Available WWW: http://seweb.cit.gu.edu.au/trillium/t3modc41.html [1997, 10 June].

Whitten, N. (1990). Managing Software Development Projects: Formula for Success. Brisbane: John Wiley & Sons, Inc.

B

Base Practice:

A software engineering or management activity that directly addresses the purpose of a particular process and contributes to the creation of its output. A base practice is an essential activity of a particular process *(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 17)*.

C

Capability Level:

A set of common features (i.e. generic practices) that works together to provide a major enhancement in the capability to perform a process *(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 18)*.

H

Harmony:

In this study, team harmony is not the lack of conflict but its presence, especially the constructive type, and how the destructive type conflict is managed within the group to get different alternatives of creative and constructive ideas regarding a problem and this approach improving a group's productivity. More details on the types of conflict are provided in chapter 3- review of relevant literature.

The characteristics of group harmony gleaned from differing sources appear to be:

- *open communication*
- *creativity*
- *integration*

- *respect*
- *co-ordination*
- *co-operation*
- *cohesion*
- *commitment and*
- *motivation*

(Amason, Hochwarter, Thompson & Harrison (1995), Brown, Klastorin & Valluzzi (1990) and Firth (1991))

ISO 9001: 1994

International Standard Organisation's model for quality assurance in design, development, production, installation and servicing.

Source: [WWW: http://www.commerce-associates.com/iso/WhatsISO.html]

ISO 9000-3: 1991

International Standard Organisation's quality management and quality assurance standards - Part 3: Guidelines for the application of ISO 9001 to the development, supply and maintenance of software.

Source: [WWW: http://www-sqi.cit.gu.edu.au/spice/suite_intro.shtml?]

ISO 9004-4: 1993

International Standards Organisation's quality management and quality systems elements - Part 4: Guidelines for quality improvement.

Source: [WWW: http://www-sqi.cit.gu.edu.au/spice/suite_intro.shtml?]

ISO/IEC DTR 15504:

See SPICE.

Practice:

A software engineering or management activity that contributes to the creation of the output (work product) of a process or enhance the capability of a process

(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 9).

Process (in this International Standard):

A statement of purpose and an essential set of practices (activities) that address that purpose

(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 9).

Process Improvement:

Action taken to change an organisation's processes so that they meet the organization's business needs and achieve its business goals more effectively.

(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 9).

Provisional Assessor:

An assessor who has not yet demonstrated competence or obtained validation of the skills, education and training appropriate to conducting assessments in accordance with the provisions in part 6 of this International Standard.

(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 14).

Qualified Assessor:

An individual who has attained the qualifications for carrying out process assessments, as defined in part 6 of this International Standard.

(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 14).

R

Roadmaps:

A roadmap is a set of related practices that focus on an organisational area or need, or a specific element within the product development process. Each roadmap represents a significant capability for a software development organisation.

Source: [WWW: http://seweb.cit.gu.edu.au/trillium/t3modc41.html]

S

Software Development Process:

Refers to the entire process of software production and evolution from the initial concept through definition of requirements, design of software products, programming, implementation, operation, maintenance and enhancement, to eventual retirement of the software (Sallis et al., p.15).

Software Process:

The process or set of processes used by an organisation or project to plan, manage, execute, monitor, control and improve its software related activities

(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 9).

SPICE (Software Process Improvement Capability dEtermination):

It is a major international initiative to support the development of an International Standard for Software Process Assessment. For more details on SPICE see section 3.4.3.

Source: [WWW: http://www-sqi.cit.gu.edu.au/spice/what.shtml]

W

Well-Defined Process:

A process with inputs, entry criteria, tasks, validation, outputs, and exit criteria that are documented, consistent, and complete.

(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 21).

Work Product:

An artefact associated with the execution of a practice (e.g., a test case, a requirement specification, code, or a work breakdown structure). The existence of the work product indicates that the practice is performed

(ISO/IEC JTC1/SC7 Part 9: Vocabulary, 1995, p. 21).

QUESTIONNAIRE ONE

QUESTIONNAIRE ONE
April 1997

Date: _____
Name: _____ Sex: *(M/F)* _____
Study mode: Full time / Part time *(Circle the appropriate answer)*
Team *(eg MLX)* : _____ Number of members: _____
Number of female members: _____ Number of male members: _____

Project Management

(Please circle the appropriate answers)

1. How important do you think project management is for the success of your project?

Very Important			Neither			Very Unimportant	Don't Know
1	2	3	4	5	6	7	9

Project Team

2a. How many sub-teams are there in your project team?

none	1	2	3	others

If Others, please specify: _____

2b. What are your roles/responsibilities in the team/sub-team: _____

_____

2c. How long did it take to structure your team?

1	2	3	4	5	6	7	others	in days

If Others, please specify: _____

2d. How well do you know other team members in your team?

Very Well			Not Well			Not at All	Don't Know
1	2	3	4	5	6	7	9

2e. Do you feel uncomfortable working with any members in your team?

Not at All			Neutral			Very Uncomfortable	Don't Know
1	2	3	4	5	6	7	9

2f. Are you comfortable with your team mix? (Age/Sex/Nationality)

Very Comfortable			Neutral			Very Uncomfortable	Don't Know
1	2	3	4	5	6	7	9

2g. How did you go about selecting you project leader? Please explain: _____

_____

2h. How many deputy project leaders do you have in your team? | none | 1 | 2 | 3 | | others |

If Others, please specify: _____

2i. Have you had more than one project leader since the beginning of the project? YES / NO

2j. If YES (question 2i), what were the reasons of selecting another project leader? _____

_____

2k. How often does your project team meet?

Very Often | 1 | 2 | 3 | 4 | 5 | 6 | 7 | **Occasionally** | **Don't Know** | 9 |

2l. How well does your team practice the software development processes?

Very Well | 1 | 2 | 3 | **Not Well** | 4 | 5 | 6 | 7 | **Not at All** | **Don't Know** | 9 |

2m. How many hours per week do you work on the project? | 4 < | 8 | 12 | > 16 |

2n. Do you think that your project leader is performing his/her duties well? | yes | not sure | no |

Please specify: _____

_____

_____

Conflict Related Issues

3a. Have there been any conflicts in your team so far? YES / NO

3b. If YES, what kind of conflicts were they? *(Tick appropriate answer. You can tick more than one if it applies)*

3b-1. Between two team members _____
3b-2. Team member against the team _____
3b-3. Team member against the project leader _____
3b-4. Others _____

If Others, please specify: _____

3c. What caused the above conflict(s)? _____

_____

_____

_____

3d. Who was involved in handling the conflict(s)? *(Tick appropriate answer. You can tick more than one if it applies)*

3d-1. Project leader _____
3d-2. Team members involved _____
3d-3. Project team _____
3d-4. Not yet solved _____ (Please specify: _____

_____)

3e. Has your project leader been playing a major role in resolving conflicts? YES / NO

3f. If the answer (question 3e) is NO, please specify: _____

_____

_____

3g. Does the conflict affect your team productivity? YES / NO

3h. If the answer (question 3g) is NO, please specify: _____

_____

_____

INTERVIEW ONE

B-1. PROJECT LEADERS

INTERVIEW ONE
August 1997

THIS INTERVIEW IS CONFIDENTIAL, NONE OF THIS DISCUSSION WILL BE DISCLOSED TO ANY OF THE OTHER TEAM LEADERS AND/OR MEMBERS.

(PROJECT LEADER)

Date: _____/ August / 1997

SEMESTER ONE

PL/PM name: _____
Team: _____
Number of members: _____
Number of female members: _____
Number of part timers: _____

Team Building

1a. How did you become the team leader?_____
_____

1b. How is your team built, structure wise? _____
_____
_____
_____
_____

1c. Is your team made up of members from mixed cultures? _____

1d. How many hours per week, in average, do you work? _____
1e. your team work? _____

1f. What skills do members of your team, including yourself, have? _____
_____
_____
_____

1g. Are there any other skills which you think are important but your team doesn't have? Name them:
_____
_____
_____

1h. What kind of team composition (considering sex/age/culture, etc.,) would you suggest to increase the performance and reduce conflicts to your team? _____

1i. Does your team meet socially? Explain: _____

Team Conflicts

2a. Have you come across any leadership difficulties and/or team conflicts? _____

2b. What types? _____

2c. How have you managed the difficulties and/or team conflicts within your group? _____

Team Management

3a. Which duties do you perform as the project leader? _____

3b. Do you have shared leadership within your team? Explain what you do: _____

3c. What scope of the project is your team concentrating on? _____

3d. Do you think you will deliver what you have mentioned in 3c? Give reasons: _____

Software Development

4a. Can you name, in priority order, which are the most important software development processes your team has been practising?_____

4b. Do you think you need to practise any other processes? Name them: _____

4c. Do you think all the processes you mentioned above are important as far as software development is concerned? Explain: _____

4d. In your own opinion/experience, do you think practising good software development processes helps in reducing team conflicts? Explain: _____

Others

5a. Name the factors which you think decrease the performance of your team? _____

5b. Name the factors which you think increase the performance of your team? _____

5c. Is there anything else you think is important and would like to add to this interview? Namely: _

Thank you very much for your time and the contribution you have given me towards my research. I wish you all the best in your project.

B-2. OTHER TEAM MEMBERS

INTERVIEW ONE
August 1997

THIS INTERVIEW IS CONFIDENTIAL, NONE OF THIS DISCUSSION WILL BE DISCLOSED TO ANY OF THE OTHER TEAM LEADERS AND/OR MEMBERS.

(TEAM MEMBER)

Date: _____/ August / 1997

SEMESTER ONE

Name: _____
Team: _____
Responsibility: _____

Team Building

1a. Are you happy with the structure and composition (considering sex/age/culture, etc.,) of your team?
Explain: _____

1b. How many hours per week, on average, do you work? _____

1c. What kind of team composition (considering sex/age/culture, etc.,) would you suggest to increase the performance and reduce conflicts to your team? _____

Team Conflicts

2a. Have you come across any major conflicts within your team? _____

2b. What types? _____

2c. How were the conflicts managed within your group? Explain: _____

Team Management

3a. Which duties do you perform in your team? Explain: _____

3b. How well do you think your project leader manages the project and its resources? Explain: ____

3c. Is your input, as a member of your team, valued by others? Explain: _____

3d. Does your project leader value other members input? Explain: _____

Software Development

4a. Can you name, in priority order, which are the most important software development processes your team has been practising?_____

4b. Do you think you need to practise any other processes? Name them: _____

4c. Do you think all the processes you mentioned above are important as far as software development is concerned? Explain: _____

4d. In your own opinion/experience, do you think practising good software development processes helps in reducing team conflicts? Explain: _____

Others

5a. Name the factors which you think decrease the performance of your team? _____

5b. Name the factors which you think increase the performance of your team? _____

5c. Is there anything else you think is important and would like to add to this interview? Namely: _

Thank you very much for your time and the contribution you have given me towards my research.
I wish you all the best in your project.

QUESTIONNAIRE TWO

C-1. PROJECT LEADERS

PROJECT LEADER

QUESTIONNAIRE TWO
November 1997

Date: _____
Name: _____ Sex: *(M/F)* _____
Study mode: Full time / Part time *(Circle the appropriate answer)*
Team *(eg MLX)* : _____

What were your roles/responsibilities as the project leader? _____
_____
_____

1. SOFTWARE DEVELOPMENT PROCESS

1a. Indicate the software development model your team used.

1a-1. Software Development Life Cycle (SDLC) Approach ☐
1a-2. Prototype Approach ☐
1a-3. Spiral Approach ☐
1a-4. Other ☐
(please specify): _____

1b. How much time, percentage wise, did you spend performing the following project management and administrative activities?

1b-1. Project Management	_____ %
1b-2. Administration	_____ %
1b-3. Risk Analysis and Management	_____ %
1b-4. Configuration Management	_____ %
1b-5. Quality Management	_____ %
1b-6. Training	_____ %
Total *(should be exactly 100%)*	**100** %

2. GROUP DYNAMICS

2a. Have you had any prior industry/work experience before your involvement in this software engineering project? number on the scale.

Never | 0 | 1 | 2 | 3 | 4 | **Part Time** | 5 | 6 | 7 | 8 | 9 | 10 | **Full Time**

2b. Indicate who was responsible for setting the team goals and objectives. Please also rate their degree of participation by circling a number on the scale.

	Never					Sometimes					Always
2b-1. Project leader	0	1	2	3	4	5	6	7	8	9	10
2b-2. Team member	0	1	2	3	4	5	6	7	8	9	10
2b-3. Project team	0	1	2	3	4	5	6	7	8	9	10
2b-4. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

2c. How often did you communicate with your team members? Please circle the appropriate number on the scale.

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

2d. How well did you understand the role you were supposed to play in your team? Please circle the appropriate number on the scale.

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

2e. How often did you give feedback regarding the performance of your team members?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

2f. Please indicate the type of feedback and circle the number of times you gave that feedback to your team members regarding their performance.

	Never					*Sometimes*					*Always*
2f-1. Positive feedback	0	1	2	3	4	5	6	7	8	9	10
2f-2. Negative feedback	0	1	2	3	4	5	6	7	8	9	10
2f-3. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

3. CONFLICT RELATED ISSUES

3a. How often did you encounter conflicts in your team?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

3b. Please indicate who was involved in the conflict(s) and circle the number of times they occurred.

	Never					*Sometimes*					*Always*
3b-1. PL v member	0	1	2	3	4	5	6	7	8	9	10
3b-2. PL v team	0	1	2	3	4	5	6	7	8	9	10
3b-3. Member v member	0	1	2	3	4	5	6	7	8	9	10
3b-4. Member v team	0	1	2	3	4	5	6	7	8	9	10
3b-5. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

3c. Please indicate the source of the above (question 3b) conflicts and circle the rate of occurrence.

	Never					Sometimes					Always
3c-1. Cultural differences	0	1	2	3	4	5	6	7	8	9	10
3c-2. Personality clashes	0	1	2	3	4	5	6	7	8	9	10
3c-3. Age/gender related	0	1	2	3	4	5	6	7	8	9	10
3c-4. Different ideas	0	1	2	3	4	5	6	7	8	9	10
3c-5. None performing member	0	1	2	3	4	5	6	7	8	9	10
3c-6. Stress related	0	1	2	3	4	5	6	7	8	9	10
3c-7. Outside commitments (work, other units etc)	0	1	2	3	4	5	6	7	8	9	10
3c-8. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

3d. Please indicate what types of conflict(s) they were and circle the appropriate number regarding their rate of occurrence.

	Never					Sometimes					Always
3d-1. Constructive (useful)	0	1	2	3	4	5	6	7	8	9	10
3d-2. Destructive (harmful)	0	1	2	3	4	5	6	7	8	9	10
3d-3. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

3e. Please indicate who was involved in handling the conflict(s) and circle a number to measure their rate of involvement.

	Never					Sometimes					Always
3e-1. Project leader	0	1	2	3	4	5	6	7	8	9	10
3e-2. Members involved	0	1	2	3	4	5	6	7	8	9	10
3e-3. Project team	0	1	2	3	4	5	6	7	8	9	10
3e-4. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

3f. As a project leader, how often were you involved in conflict resolution?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

3g. What effect did the resolution of the constructive conflict(s) have towards the productivity of your team?

Negative *(decreased productivity)*					No Effect					Positive *(increased productivity)*
0	1	2	3	4	5	6	7	8	9	10

3h. What effect did the resolution of the destructive conflict(s) have towards the productivity of your team?

Negative *(decreased productivity)*					No Effect					Positive *(increased productivity)*
0	1	2	3	4	5	6	7	8	9	10

4. GENERAL

4a. Did customer interaction contribute to the productivity of your team?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

4b. Did you enjoy doing the project?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

4c. Do you think it was a successful project?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

Thanks for your co-operation and I wish you all the best in your coming exams.

☺

C-2. OTHER TEAM MEMBERS

TEAM MEMBER

QUESTIONNAIRE TWO
November 1997

Date: _____
Name: _____ Sex: *(M/F)* _____
Study mode: Full time / Part time *(Circle the appropriate answer)*
Team *(eg MLX)*: _____

What were your roles/responsibilities in the team/sub-team? _____
_____

1. SOFTWARE DEVELOPMENT PROCESS

1a. Indicate the software development model your team used.

1a-1. Software Development Life Cycle (SDLC) Approach ☐
1a-2. Prototype Approach ☐
1a-3. Spiral Approach ☐
1a-4. Other ☐
(please specify): _____

1b. How much time, percentage wise, did you spend performing the following project management and administrative activities?

1b-1. Project Management	_____ %
1b-2. Administration	_____ %
1b-3. Risk Analysis and Management	_____ %
1b-4. Configuration Management	_____ %
1b-5. Quality Management	_____ %
1b-6. Training	_____ %
Total *(should be exactly 100%)*	**100** %

2. GROUP DYNAMICS

2a. Have you had any prior industry/work experience before your involvement in this software engineering project? number on the scale.

Never | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | **Full Time**

Part Time

2b. Indicate who was responsible for setting the team goals and objectives. Please also rate their degree of participation by circling a number on the scale.

	Never					**Sometimes**					**Always**
2b-1. Project leader	0	1	2	3	4	5	6	7	8	9	10
2b-2. Team member	0	1	2	3	4	5	6	7	8	9	10
2b-3. Project team	0	1	2	3	4	5	6	7	8	9	10
2b-4. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

2c. How easy was it for you to communicate with your PL? Please circle the appropriate number on the scale.

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

2d. How well did you understand the role you were supposed to play in your team? Please circle the appropriate number on the scale.

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

2e. Please indicate the type of feedback and circle the number of times you received feedback from your PL regarding your performance.

	Never					Sometimes					Always
2e-1. Positive feedback	0	1	2	3	4	5	6	7	8	9	10
2e-2. Negative feedback	0	1	2	3	4	5	6	7	8	9	10
2e-3. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

2f. What scale do you rate your project leader as far as his/her performance goes?

Poor					Average					Excellent
0	1	2	3	4	5	6	7	8	9	10

3. CONFLICT RELATED ISSUES

3a. How often did you encounter conflicts in your team?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

3b. Please indicate who was involved in the conflict(s) and circle the number of times they occurred.

	Never					Sometimes					Always
3b-1. PL v member	0	1	2	3	4	5	6	7	8	9	10
3b-2. PL v team	0	1	2	3	4	5	6	7	8	9	10
3b-3. Member v member	0	1	2	3	4	5	6	7	8	9	10
3b-4. Member v team	0	1	2	3	4	5	6	7	8	9	10
3b-5. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

3c. Please indicate the source of the above (question 3b) conflicts and circle the rate of occurrence.

	Never					Sometimes					Always
3c-1. Cultural differences	0	1	2	3	4	5	6	7	8	9	10
3c-2. Personality clashes	0	1	2	3	4	5	6	7	8	9	10
3c-3. Age/gender related	0	1	2	3	4	5	6	7	8	9	10
3c-4. Different ideas	0	1	2	3	4	5	6	7	8	9	10
3c-5. None performing member	0	1	2	3	4	5	6	7	8	9	10
3c-6. Stress related	0	1	2	3	4	5	6	7	8	9	10
3c-7. Outside commitments (work, other units etc)	0	1	2	3	4	5	6	7	8	9	10
3c-8. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

3d. Please indicate what types of conflict(s) they were and circle the appropriate number regarding their rate of occurrence.

	Never					Sometimes					Always
3d-1. Constructive (useful)	0	1	2	3	4	5	6	7	8	9	10
3d-2. Destructive (harmful)	0	1	2	3	4	5	6	7	8	9	10
3d-3. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

3e. Please indicate who was involved in handling the conflict(s) and circle a number to measure their rate of involvement.

	Never					Sometimes					Always
3e-1. Project leader	0	1	2	3	4	5	6	7	8	9	10
3e-2. Members involved	0	1	2	3	4	5	6	7	8	9	10
3e-3. Project team	0	1	2	3	4	5	6	7	8	9	10
3e-4. Other	0	1	2	3	4	5	6	7	8	9	10

(please specify): _____

3f. How much was your project leader involved in conflict resolution?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

3g. What effect did the resolution of the constructive conflict(s) have towards the productivity of your team?

Negative *(decreased productivity)*					No Effect					Positive *(increased productivity)*
0	1	2	3	4	5	6	7	8	9	10

3h. What effect did the resolution of the destructive conflict(s) have towards the productivity of your team?

Negative *(decreased productivity)*					No Effect					Positive *(increased productivity)*
0	1	2	3	4	5	6	7	8	9	10

4. GENERAL

4a. Did customer interaction contribute to the productivity of your team?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

4b. Did you enjoy doing the project?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

4c. Do you think it was a successful project?

Never					Sometimes					Always
0	1	2	3	4	5	6	7	8	9	10

Thanks for your co-operation and I wish you all the best in your coming exams.

FEEDBACK QUESTIONNAIRE

Software Engineering Project – First and Second Semester Feedback Sheet 1997

Where the question indicates a response in the range 0-10, assume 0 is low/poor and 10 is high/excellent

Individual		**Comments**
Campus/Team (e.g. ML4):		
Age		
Gender		
Study Mode (F/P)		

Oracle

How satisfied were you with access to terminals? (0-10):		
How satisfied were you with the Oracle environment (performance, reliability, security)? (0-10)		
How satisfied were you with the Oracle tools (Forms, Reports, Graphics)? (0-10)		
How satisfied were you with the Oracle support (assistance, manuals)?		

Your time commitment to the project

Was your commitment larger or smaller than you would have liked? (please circle one):	Smaller	About Right	Larger	
Was it larger or smaller than you expected at the beginning of the year? (please circle one):	Smaller	About Right	Larger	
Was it too large or too small for a 3rd year undergraduate project? (please circle one):	Too Small	About Right	Too Large	

Team Processes

How well did your project follow the plan? (please circle):	Usually on plan	Sometimes on plan	Rarely on plan		
How frequently did you have reviews of the work produced by the team? (please circle one):	Weekly	Monthly	On Occasions	Never	
How valuable did you find the reviews? (0-10):					
How satisfied were you with the way your team managed the risks? (0-10):					

How satisfied were you with the way your team managed configuration change? (0-10):		
How valuable was your staff advisor? (0-10):		
How useful did you find the Fast-APT methodology? (0-10):		

Team Operation

How satisfied were you with the way your team operated? (0-10)		
How satisfied were you that your contribution was valued by the rest of the team? (0-10)		
Overall - how well was your project managed? (0-10)		

Software Engineering Principles

Did the project lead to better understanding of concepts taught in the lectures? (please circle one)	Most Concepts	Some Concepts	No Concepts	
List the Software Engineering techniques you found most useful in the project:				

Your products

How satisfied were you with your statement of requirements? (0-10)		
How satisfied were you with your design? (0-10)		
How satisfied were you with the usefulness of your work products? (0-10)		
How satisfied were you with the quality of your work products? (0-10)		

Productivity

List the factors you found most helped your productivity:	
List the factors you found most hindered your productivity:	

The Project:

How valuable was the project experience? (0-10)		
What would you change about the project, to improve it?		

QUESTIONNAIRE ONE - RESULTS

TEAM STATISTICS	A	B	C	D	E	F	Spearman's Rank
Team Size	8	10	9	10	9	12	0.31
No members participated in questionnaire	8	9	8	5	5	6	
% participated in questionnaire	100%	90%	89%	50%	56%	50%	
Female members	1	4	1	1	0	0	-0.69
% female members	13%	40%	11%	10%	0%	0%	
Part-time members	4	5	1	1	1	2	-0.68
% part-time members	50%	50%	11%	10%	11%	17%	

APPENDIX E: QUESTIONNAIRE ONE - RESULTS

KEY		QUESTIONS	A	B	C	D	E	F	Spearman's Rank
		Project Management							
	1	How important do you think PM is for							
1 vi,4 neutral,7 vu		the success of your project?	1.6	1.7	1.3	2.2	2.8	1.7	-0.37
		Project Team							
	2a	How many sub-teams are there in your project team?	3	3	3	3	3	3	**Constant Var**
		(0 None, 1, 2, 3, 4 Others)							
	2b	What are your roles//responsibilities in the team/sub-team?							
In days	2c	How long did it take to structure your team?	4.80	3.00	5.80	2.40	12.00	8.20	**0.70**
1 vw,4 not well,7 not at all	2d	How well do you know other members in your team?	4.40	3.10	2.60	3.00	2.60	3.20	-0.65
	2e	Do you feel uncomfortable working with							
1 not at all,4 neutral,7 vu		any members in your team?	6.10	3.30	2.60	3.20	3.20	3.50	-0.59
1 vc,4 neutral,7 vu	2f	Are you comfortable with your team mix?	4.30	1.70	1.90	3.00	3.00	4.00	-0.15
	2g	How did you go about selecting your PL?							
	2h	How many deputy project leaders do you have in your team?	1	3	2	1	1	3	0.20
1 Yes, 0 No	2i	Have you had more than one PL since the beginning?	0	0	0	0	1	0	0.42
	2j	If YES...							
1 vo - 7 occasionally	2k	How often does your project team meet?	3.6	2.5	2.9	2.7	2.0	4.2	-0.03
	2l	How well does your project team practice the							
1 vw,4 not well,7 not at all		software development processes?	4.10	3.80	1.80	2.50	1.80	3.20	**-0.83**
| 4< | 8 | 12 | >16 |	2m	How many hours per week do you work on the project?	14.30	17.00	11.80	14.00	13.00	12.30	**-0.88**
1 Yes, 0 No	2n	Do you think that your PL is performing his/her duties well?	0.50	1	1	0.90	0.90	0.60	0.25

APPENDIX E: QUESTIONNAIRE ONE - RESULTS

KEY	QUESTIONS	A	B	C	D	E	F	Spearman's Rank
	Conflict Related Issues							
1 Yes, 0 No	3a Have there been any conflicts in your team so far?	1	1	0.5	0.2	0.2	0	**-0.75**
	If YES, What kind of conflict?							
	3b-1 Between two team members	0	0.4	0	1	0.2	0	-0.23
	3b-2 Team member against the team	1	0	1	0	0	0	-0.22
	3b-3 Team member against the project leader	1	0.3	0	0	0.2	0	**-0.74**
	3b-4 Others	0	0.1	0	0	0	0	-0.42
	3c What caused the conflict?							
	Who was involved in handling the conflict(s)?							
	3d-1 Project leader	0.4	0.5	0.5	0.5	0.2	0	-0.36
	3d-2 Team members involved	1	0.7	0.3	1	0.2	0	**-0.83**
	3d-3 Project team	0.3	0.2	0.3	0	0	0	-0.43
	3d-4 Not yet resolved	0.3	0	1	0	0	0	-0.07
1 Yes, 0 No	3e Has your PL been playing a major role in resolving conflicts?	1	0.3	0.8	1	0.2	0	-0.65
	3f Please specify							
1 Yes, 0 No	3g Does the conflict affect your team productivity?	1	1	1	1	0.2	0	-0.65
	3h If YES							
	Project Mark out of 40	**9**	**29**	**33**	**31**	**33**	**33**	

QUESTIONNAIRE TWO - RESULTS

F-1. PROJECT LEADERS - RESULTS

TEAM STATISTICS	B	C	D	E	F	Spearman's Rank
Team Size	7	8	9	8	10	**0.82**
No members participated in questionnaire	7	8	9	8	10	
% participated in questionnaire	**100%**	**100%**	**100%**	**100%**	**100%**	
Female members	4	0	0	1	0	-0.45
% female members	**57.14%**	**0%**	**0%**	**12.50%**	**0%**	
Part-time members	3	2	2	3	2	-0.29
% part-time members	**42.86%**	**25.00%**	**22.22%**	**37.50%**	**20.00%**	

KEY	QUESTIONS	B	C	D	E	F_1	F_2	Spearman's Rank
	1a-1 Software Development Life Cycle Approach	0	1	1	0	1	0	**0.00**
	1a-2 Prototype Approach	0	0	0	1	0	1	**0.53**
	1a-3 Spiral Approach	1	0	0	0	0	0	**-0.66**
	1a-4 Other	0	0	0	0	0	0	**Constant Var**
% of time	1b-1 Project Management	10.00	40.00	50.00	20.00	0.00	45.00	**-0.29**
% of time	1b-2 Administration	40.00	44.00	30.00	10.00	2.00	10.00	**-0.90**
% of time	1b-3 Risk Analysis & Management	10.00	2.00	0.00	10.00	68.00	0.00	**0.45**
% of time	1b-4 Configuration Management	20.00	2.00	10.00	25.00	10.00	10.00	**0.18**
% of time	1b-5 Quality Management	19.00	10.00	0.00	25.00	10.00	20.00	**0.22**
% of time	1b-6 Training	1.00	2.00	10.00	10.00	10.00	15.00	**0.89**
0 never - 10 full-time	2a Any prior industry experience?	0.00	7.00	4.00	0.00	9.50	4.00	**0.40**
	Who was responsible in setting goals & objectives?							
0 never - 10 always	2b-1 Project leader	8.00	9.00	10.00	9.00	6.50	9.00	**-0.12**
0 never - 10 always	2b-2 Team member	0.00	7.00	0.00	5.00	4.50	0.00	**-0.03**
0 never - 10 always	2b-3 Project team	7.00	3.00	0.00	8.00	4.50	0.00	**-0.22**
0 never - 10 always	2b-4 Other	0.00	0.00	0.00	0.00	1.50	0.00	**0.53**
0 never - 10 always	2c How often did you communicate with team members?	7.00	8.00	10.00	10.00	9.50	7.00	**0.16**
0 never - 10 always	2d How well did you understand your role?	6.00	9.00	6.00	8.00	9.50	7.00	**0.47**
0 never - 10 always	2e How often did you give performance feedback?	7.00	2.00	10.00	8.00	9.50	5.00	**0.23**
	Indicate the type of feedback							
0 never - 10 always	2f-1 Positive feedback	7.00	4.00	5.00	6.00	4.50	5.00	**-0.28**
0 never - 10 always	2f-2 Negative feedback	3.00	4.00	8.00	7.00	4.50	3.00	**0.13**
0 never - 10 always	2f-3 Other	0.00	0.00	0.00	0.00	4.50	5.00	**0.83**

KEY	QUESTIONS	B	C	D	E	F_1	F_2	Spearman's Rank
0 never - 10 always	3a How often did you encounter team conflicts?	5.00	2.00	7.00	8.00	3.00	2.00	**-0.16**
	Indicate who was involved in the conflict(s)							
0 never - 10 always	3b-1 PL v member	4.00	6.00	7.00	8.00	4.00	0.00	**-0.28**
0 never - 10 always	3b-2 PL v team	1.00	2.00	3.00	1.00	5.00	0.00	**0.03**
0 never - 10 always	3b-3 Member v member	4.00	1.00	7.00	8.00	6.00	2.00	**0.20**
0 never - 10 always	3b-4 Member v team	3.00	2.00	8.00	1.00	8.00	0.00	**-0.19**
0 never - 10 always	3b-5 Other	0.00	0.00	0.00	0.00	0.00	0.00	**Constant Var**
	Indicate the source of the conflict(s)							
0 never - 10 always	3c-1 Cultural differences	0.00	0.00	5.00	3.00	0.00	0.00	**-0.03**
0 never - 10 always	3c-2 Personality clashes	2.00	8.00	8.00	6.00	4.00	0.00	**-0.35**
0 never - 10 always	3c-3 Age/gender related	1.00	0.00	2.00	0.00	0.00	0.00	**-0.55**
0 never - 10 always	3c-4 Different ideas	4.00	3.00	3.00	6.00	4.00	2.00	**-0.13**
0 never - 10 always	3c-5 None performing member	4.00	2.00	4.00	3.00	3.00	6.00	**0.19**
0 never - 10 always	3c-6 Stress related	2.00	8.00	7.00	8.00	6.00	2.00	**-0.13**
0 never - 10 always	3c-7 Outside commitment (work, other units, etc)	5.00	1.00	10.00	9.00	3.00	0.00	**-0.32**
0 never - 10 always	3c-8 Other	0.00	0.00	0.00	0.00	0.00	0.00	**Constant Var**
	What types of conflicts were they?							
0 never - 10 always	3d-1 Constructive (useful)	7.00	5.00	5.00	6.00	3.00	0.00	**-0.79**
0 never - 10 always	3d-2 Destructive (harmful)	3.00	5.00	4.00	7.00	4.00	0.00	**-0.13**
0 never - 10 always	3d-3 Other	0.00	0.00	0.00	0.00	5.00	3.00	**0.83**

APPENDIX F: QUESTIONNAIRE TWO - RESULTS

KEY		QUESTIONS	B	C	D	E	F_1	F_2	Spearman's Rank
		Who was involved in handling the conflicts?							
0 never - 10 always	3e-1	PL	6.00	6.00	9.00	7.00	4.00	0.00	**-0.50**
0 never - 10 always	3e-2	Members involved	3.00	7.00	0.00	6.00	4.00	5.00	**0.12**
0 never - 10 always	3e-3	Project team	5.00	0.00	0.00	2.00	4.00	0.00	**-0.19**
0 never - 10 always	3e-4	Other	0.00	0.00	0.00	0.00	4.00	0.00	**0.53**
0 never - 10 always	3f	How often were you involved in resolving conflicts?	6.00	6.00	10.00	7.00	4.00	3.00	**-0.54**
0 neg - 10 pos	3g	What effect did the constructive conflicts have?	6.00	7.00	7.00	8.00	3.00	5.00	**-0.56**
0 neg - 10 pos	3h	What effect did the destructive conflicts have?	6.00	4.00	6.00	4.00	3.00	5.00	**0.69**
0 never - 10 always	4a	Was customer interaction useful?	6.00	1.00	2.00	0.00	0.00	2.00	**-0.50**
0 never - 10 always	4b	Did you enjoy doing the project?	9.00	10.00	10.00	10.00	8.00	8.00	**-0.44**
0 never - 10 always	4c	Do you think it was a successful project?	7.50	8.00	10.00	9.00	10.00	9.00	**-0.54**
		Project Mark out of 40	**27**	**28**	**29**	**34**	**35**	**35**	

F-2. OTHER TEAM MEMBERS - RESULTS

KEY	QUESTIONS	B	C	D	E	F	Spearman's Rank
	1a-1 Software Development Life Cycle Approach	1	2	4	4	0	-0.05
	1a-2 Prototype Approach	0	4	0	4	5	**0.74**
	1a-3 Spiral Approach	4	1	1	0	2	-0.36
	1a-4 Other	0	0	3	0	1	0.45
% of time	1b-1 Project Management	22.00	17.86	21.25	4.57	17.50	**-0.80**
% of time	1b-2 Administration	12.00	19.29	12.63	13.57	17.50	0.40
% of time	1b-3 Risk Analysis & Management	6.00	8.43	12.13	1.43	13.13	0.40
% of time	1b-4 Configuration Management	28.00	22.86	24.38	23.57	17.50	**-0.70**
% of time	1b-5 Quality Management	27.00	22.57	20.00	11.43	18.13	**-0.90**
% of time	1b-6 Training	5.00	9.00	9.63	5.00	16.25	0.56
	Others - Estimation/Help/Testing	*0*	*0*	*0*	*40.43*	*0*	
0 never - 10 full-time	2a Any prior industry experience?	4.17	4.71	1.63	2.57	1.63	**-0.72**
	Who was responsible in setting goals & objectives?						
0 never - 10 always	2b-1 Project leader	7.67	6.57	7.38	9.14	6.38	-0.30
0 never - 10 always	2b-2 Team member	3.83	5.57	5.44	4.43	5.50	0.30
0 never - 10 always	2b-3 Project team	4.67	7.86	5.25	4.00	4.75	-0.20
0 never - 10 always	2b-4 Other	0	0	0.63	0	1	0.67
0 never - 10 always	2c How well did you communicate with your PL?	7.33	8.00	7.75	7.43	8.88	0.60

APPENDIX F: QUESTIONNAIRE TWO - RESULTS

KEY		QUESTIONS	B	C	D	E	F	Spearman's Rank
0 never - 10 always	2d	How well did you understand your role?	7.67	7.43	7.50	7.71	8.75	**0.70**
		Indicate the type of feedback						
0 never - 10 always	2e-1	Positive feedback	6.17	5.00	6.25	7.86	7.50	**0.80**
0 never - 10 always	2e-2	Negative feedback	4.17	2.00	4.50	4.43	3.38	0.10
0 never - 10 always	2e-3	Other	0.50	2.00	1.25	0	0	-0.67
0 poor - 10 Excellent	2f	What scale do you rate your PL?	5.92	6.79	7.00	8.50	8.44	**0.90**
0 never - 10 always	3a	How often did you encounter team conflicts?	4.50	3.93	6.25	4.43	2.81	-0.50
		Indicate who was involved in the conflict(s)						
0 never - 10 always	3b-1	PL v member	4.67	2.71	4.75	4.57	2.81	-0.20
0 never - 10 always	3b-2	PL v team	1.17	2.29	2.88	2.86	1.81	0.30
0 never - 10 always	3b-3	Member v member	2.50	2.86	6.50	4.43	2.56	0.30
0 never - 10 always	3b-4	Member v team	0.00	2.29	4.88	4.14	1.69	0.30
0 never - 10 always	3b-5	Other	0.00	0.86	0.38	0.00	1.19	0.45
		Indicate the source of the conflict(s)						
0 never - 10 always	3c-1	Cultural differences	0.83	0.71	2.00	0	0.13	-0.60
0 never - 10 always	3c-2	Personality clashes	5.83	3.00	5.50	3.43	1.88	**-0.70**
0 never - 10 always	3c-3	Age/gender related	0.83	1.00	1.13	0.29	0.13	-0.60
0 never - 10 always	3c-4	Different ideas	6.33	4.14	7.38	4.29	3.75	-0.50
0 never - 10 always	3c-5	None performing member	3.50	3.57	4.75	4.14	2.63	-0.10
0 never - 10 always	3c-6	Stress related	6.00	3.43	4.88	6.71	4.13	0.00
0 never - 10 always	3c-7	Outside commitment (work, other units, etc)	3.00	3.00	5.00	4.86	3.38	0.56
0 never - 10 always	3c-8	Other	0.00	0.29	0.00	0.00	0.00	-0.35

APPENDIX F: QUESTIONNAIRE TWO - RESULTS

KEY		QUESTIONS	B	C	D	E	F	Spearman's Rank
		What types of conflicts were they?						
0 never - 10 always	3d-1	Constructive (useful)	4.00	4.00	5.63	5.57	4.63	0.56
0 never - 10 always	3d-2	Destructive (harmful)	4.17	1.57	6.00	3.14	2.13	-0.20
0 never - 10 always	3d-3	Other	0.00	0.14	0.88	0.00	0.00	0.00
		Who was involved in handling the conflicts?						
0 never - 10 always	3e-1	PL	3.20	5.71	4.38	4.71	3.75	0.10
0 never - 10 always	3e-2	Members involved	5.40	4.43	7.63	4.43	4.25	-0.62
0 never - 10 always	3e-3	Project team	1.60	2.86	3.38	5.86	3.50	**0.90**
0 never - 10 always	3e-4	Other	0.00	0.00	0.00	0.00	0.00	Constant Var
0 never - 10 always	3f	How often was your PL involved in resolving conflicts?	5.20	5.14	4.75	5.14	4.38	-0.50
0 neg - 10 pos	3g	What effect did the constructive conflicts have?	4.80	5.79	5.56	6.71	5.57	0.10
0 neg - 10 pos	3h	What effect did the destructive conflicts have?	3.80	5.14	5.00	4.71	4.88	**0.90**
0 never - 10 always	4a	Was customer interaction useful?	3.80	1.71	3.50	1.57	2.38	**-0.82**
0 never - 10 always	4b	Did you enjoy doing the project?	2.80	7.00	7.13	6.57	5.13	0.50
0 never - 10 always	4c	Do you think it was a successful project?	3.80	7.71	7.13	8.29	8.81	0.10
		Project Mark out of 40	**27**	**28**	**29**	**34**	**35**	

FEEDBACK QUESTIONNAIRE - RESULTS

G-1. FEEDBACK QUESTIONNAIRE - SEMESTER ONE RESULTS

TEAM STATISTICS	A	B	C	D	E	F	Spearman's Rank
Average team age	**34.20**	**23.25**	**22.44**	**25.22**	**22.67**	**23.33**	**-0.70**
Number of members	8	10	9	10	9	12	0.31
Number of members participated	8	10	8	10	8	10	
% members participated	**100%**	**100%**	**89%**	**100%**	**89%**	**83%**	
Female members	1	4	1	1	0	0	-0.69
% female members	**13%**	**40%**	**11%**	**10%**	**0%**	**0%**	
PT members	4	5	1	1	1	2	-0.68
% PT members	**50%**	**50%**	**11%**	**10%**	**11%**	**17%**	

KEY		QUESTIONS	A	B	C	D	E	F	Spearman's Rank
		Oracle							
0 poor - 10 exc	5	How satisfied were you with access to terminals?	6.80	5.44	6.22	5.78	6.56	7.58	0.27
0 poor - 10 exc	6	How satisfied were you with the Oracle environment?	6.00	6.11	5.78	6.89	6.56	5.42	-0.27
0 poor - 10 exc	7	How satisfied were you with the Oracle tools?	6.00	6.22	7.11	7.56	8.22	5.83	0.27
0 poor - 10 exc	8	How satisfied were you with the Oracle support?	4.33	5.56	5.89	4.88	4.00	4.55	0.03
		Your time commitment to the project							
	9	Was your commitment larger or smaller than you would have liked? *(1 - Smaller, 2 - About Right, 3 - Larger)*	2.00	2.67	2.78	2.33	2.00	2.42	0.28
	10	Was it larger or smaller than you expected at the beginning of the year? *(1 - Smaller, 2 - About Right, 3 - Larger)*	2.40	2.89	2.33	2.44	2.22	2.46	-0.40
	11	Was it too large or small for a 3rd year undergraduate project? *(1 - Too Small, 2 - About Right, 3 - Too Large)*	2.80	2.89	2.39	2.63	2.28	2.58	**-0.88**
		Team Process							
	12	How well did you follow the plan? *(1 - Usually on plan, 2 - Sometimes, 3 - Rarely on plan)*	2.20	1.56	1.44	1.67	1.33	1.64	**-0.70**
	13	How frequently did you have reviews of your work product by the team? *(1 - Weekly, 2 - Monthly, 3 - On Occasions, 4 - Never)*	2.20	1.44	1.78	2.00	1.22	1.42	**-0.70**
0 poor - 10 exc	14	How valuable did you find the reviews?	3.60	7.39	6.22	6.00	8.11	6.73	0.52
0 poor - 10 exc	15	How satisfied were you with the way your team managed risks?	2.00	7.33	7.22	7.11	7.17	8.00	0.52
0 poor - 10 exc	16	How satisfied were you with the way your team managed CC?	1.60	5.89	8.22	8.56	8.78	7.25	**0.70**
0 poor - 10 exc	17	Ho valuable was your staff advisor?	7.20	7.81	7.44	8.14	8.25	7.08	0.09
0 poor - 10 exc	18	How useful did you find Fast-APT methodology?	5.20	4.89	4.11	6.44	3.56	2.75	**-0.76**

APPENDIX G: FEEDBACK QUESTIONNAIRE - RESULTS

KEY	QUESTIONS	A	B	C	D	E	F	Spearman's Rank
	Team Operation							
0 poor - 10 exc	19 How satisfied were you with the way your team operated?	1.00	5.94	6.11	6.56	8.44	7.42	**0.82**
0 poor - 10 exc	20 How satisfied were you with about the way your contribution was valued by the team?	3.60	6.33	6.22	7.56	7.39	6.83	0.58
0 poor - 10 exc	21 Overall - how well was you project managed?	2.40	6.33	6.89	6.78	8.50	6.33	**0.74**
	Software Engineering Principles							
	22 Did the project lead to better understanding of concepts taught in the lectures? *(1 - Most Concepts, 2 - Some Concepts, 3 - No Concepts)*	1.80	1.72	1.11	1.25	1.33	1.75	-0.52
	23 List the SE techniques you found useful in the project:							
	Your Products							
0 poor - 10 exc	24 How satisfied were you with your statement of requirements?	4.00	7.00	6.89	6.63	6.78	6.92	0.33
0 poor - 10 exc	25 How satisfied were you with your design?	1.80	6.44	6.50	7.63	7.67	7.67	**0.83**
0 poor - 10 exc	26 How satisfied were you with the usefulness of your work products?	4.00	6.33	6.25	7.38	7.89	7.25	0.52
0 poor - 10 exc	27 How satisfied were you with the quality of your work products?	5.00	6.11	7.44	7.75	7.78	7.29	**0.70**
	Productivity							
	28 List the factors you found most helped your productivity:							
	29 List the factors you found most hindering your productivity:							

APPENDIX G: FEEDBACK QUESTIONNAIRE - RESULTS

KEY	QUESTIONS	A	B	C	D	E	F	Spearman's Rank
	The Project							
0 poor - 10 exc	30 How valuable was the project experience?	6.60	7.44	7.89	8.25	9.13	8.33	**0.82**
	31 What would you change about the project, to improve it?							
	Project Mark out of 40	**9**	**29**	**33**	**31**	**33**	**33**	

G-2. FEEDBACK QUESTIONNAIRE - SEMESTER TWO RESULTS

TEAM STATISTICS	B	C	D	E	F	Spearman's Rank
Average team age	23.83	25	23.22	23	22.60	**-0.90**
Number of members	7	8	9	8	10	**0.82**
Number of members participated	7	8	9	8	10	
% members participated	**100%**	**100%**	**100%**	**100%**	**100%**	
Female members	4	0	0	1	0	-0.45
% female members	**57.14%**	**0.00%**	**0.00%**	**12.50%**	**0.00%**	
PT members	3	2	2	3	2	-0.29
% PT members	**42.86%**	**25.00%**	**22.22%**	**37.50%**	**20.00%**	

KEY		QUESTIONS	B	C	D	E	F	Spearman's Rank
		Oracle						
0 poor - 10 exc	5	How satisfied were you with access to terminals?	6.57	6.50	6.33	6.75	6.50	-0.05
0 poor - 10 exc	6	How satisfied were you with the Oracle environment?	5.71	5.00	7.00	7.25	3.80	-0.10
0 poor - 10 exc	7	How satisfied were you with the Oracle tools?	7.43	6.25	6.89	8.38	4.00	-0.30
0 poor - 10 exc	8	How satisfied were you with the Oracle support?	5.00	3.63	6.00	5.63	3.40	-0.20
		Your time commitment to the project						
	9	Was your commitment larger or smaller than you would have liked? *(1 - Smaller, 2 - About Right, 3 - Larger)*	2.57	2.25	2.22	2.00	2.80	0.00
	10	Was it larger or smaller than you expected at the beginning of the year? *(1 - Smaller, 2 - About Right, 3 - Larger)*	3.00	2.75	2.67	2.38	2.80	-0.40
	11	Was it too large or small for a 3rd year undergraduate project? *(1 - Too Small, 2 - About Right, 3 - Too Large)*	2.86	2.63	2.89	2.50	2.80	-0.30
		Team Process						
	12	How well did you follow the plan? *(1 - Usually on plan, 2 - Sometimes, 3 - Rarely on plan)*	2.43	1.50	2.00	1.50	1.90	-0.41
	13	How frequently did you have reviews of your work product by the team? *(1 - Weekly, 2 - Monthly, 3 - On Occasions, 4 - Never)*	1.57	1.63	1.78	1.00	2.00	0.40
0 poor - 10 exc	14	How valuable did you find the reviews?	7.86	7.00	6.89	7.00	6.80	**-0.82**
0 poor - 10 exc	15	How satisfied were you with the way your team managed risks?	6.43	8.00	5.78	7.00	6.80	0.10
0 poor - 10 exc	16	How satisfied were you with the way your team managed CC?	3.86	7.00	7.00	7.63	7.00	0.67
0 poor - 10 exc	17	Ho valuable was your staff advisor?	7.00	7.13	7.44	7.88	6.56	0.00
0 poor - 10 exc	18	How useful did you find Fast-APT methodology?	4.29	2.75	4.56	2.19	1.50	**-0.70**

APPENDIX G: FEEDBACK QUESTIONNAIRE - RESULTS

KEY	QUESTIONS	B	C	D	E	F	Spearman's Rank
	Team Operation						
0 poor - 10 exc	19 How satisfied were you with the way your team operated?	5.00	7.88	5.67	8.56	7.80	0.30
0 poor - 10 exc	20 How satisfied were you with about the way your contribution was valued by the team?	5.86	6.88	5.56	7.75	7.90	**0.70**
0 poor - 10 exc	21 Overall - how well was you project managed?	5.71	7.50	7.11	8.22	7.80	**0.80**
	Software Engineering Principles						
	22 Did the project lead to better understanding of concepts taught in the lectures? *(1 - Most Concepts, 2 - Some Concepts, 3 - No Concepts)*	1.57	1.54	1.11	1.44	1.56	-0.30
	23 List the SE techniques you found useful in the project:						
	Your Products						
0 poor - 10 exc	24 How satisfied were you with your statement of requirements?	5.67	6.29	5.56	6.50	6.70	**0.70**
0 poor - 10 exc	25 How satisfied were you with your design?	6.33	6.57	6.78	6.75	7.33	**0.90**
0 poor - 10 exc	26 How satisfied were you with the usefulness of your work products?	5.67	7.00	6.22	7.31	8.11	**0.90**
0 poor - 10 exc	27 How satisfied were you with the quality of your work products?	6.00	6.57	6.89	8.06	8.56	1.00
	Productivity						
	28 List the factors you found most helped your productivity:						
	29 List the factors you found most hindering your productivity:						

KEY	QUESTIONS	B	C	D	E	F	Spearman's Rank
	The Project						
0 poor - 10 exc	30 How valuable was the project experience?	7.67	9.29	8.67	9.13	8.50	0.10
	31 What would you change about the project, to improve it?						
	Project Mark out of 40	**27**	**28**	**29**	**34**	**35**	