

CHAPTER 2 SOFTWARE PROJECT PLANNING

2.1 Introduction

This chapter describes the domain of software project planning in order to understand its characteristics and assess what considerations are necessary when developing an intelligent assistant system for this domain. It also describes the current states of art and practice in the software industry with regard to the usage of software project support tools, thus highlighting the potential benefits of incorporating intelligent assistance into software project planning tools.

2.2 Software Project Planning

Whatever the size of the project, good planning is essential if it is to succeed. The software project planning process [Fairclough, 96] contains five major activities (figure 2.1), which can be applied to a whole project or to a phase of a project. Each activity may be repeated several times to make a feasible plan. In principle, every activity can be linked to the other activities by feedback loops, in which information gained at a later stage in planning is used to revise earlier planning decisions.

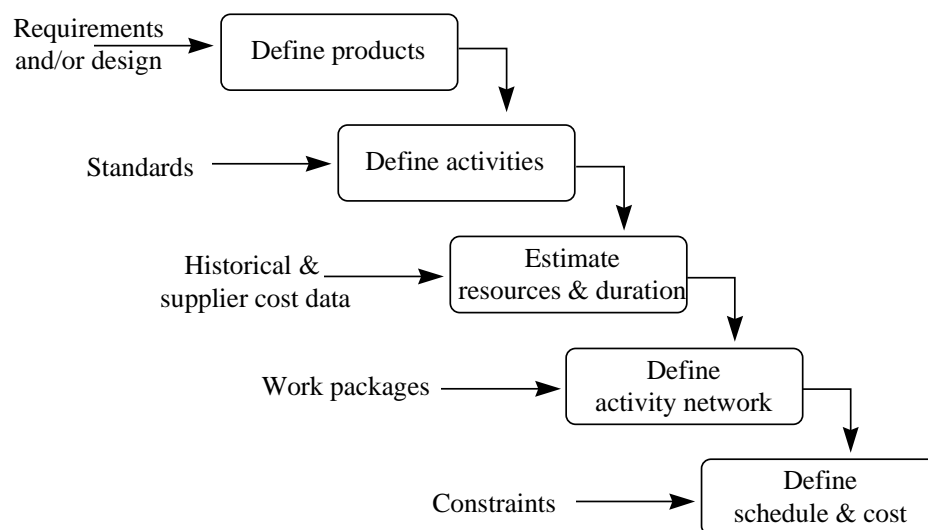


Figure 2.1 - Planning Process

During the life of a project, the management emphasis will shift from initiation planning to implementation planning according to different time zones, each with its own time horizon. Usually these time zones cover the immediate, intermediate and future periods [Procter and Bouchier, 94]. At the initiation stage (immediate time zone), the plan (and its alternatives) will be expressed at a high level, because the detail is not available and uncertainty will be high. The plan is a 'theoretical' model of the potential project. The system does not issue instructions nor record and respond to feedback. It does not need to communicate with the 'real' world it attempts to represent and control.

The work scheduling and monitoring in the 'intermediate' zone may create the most serious practical problems. At this stage the planner is concerned with the current position of the project and its immediate future. Tools are better at reporting on the current status (based on the inputted data). They can report on what has been done, what the plans say should be done next and what can be done with resources available. The danger is that reports may be incomplete, out of date or inappropriate for the recipient. In this intermediate time zone, of potentially significant benefit to the project manager is the ability to reason about project plans, analyse alternative strategies in the approach to problems, seek advice from lessons learned during previous projects (the knowledge base) and consult organisational and international standards.

Beyond the intermediate horizon, the future has both 'micro' and 'macro' planning modes [Procter and Bouchier, 94], neither of which are well supported by tools. In the 'micro' environment of the project, there is little to assist the predictive function necessary for detailed forward planning, nor is there much support for 'macro' strategic planning, which sees the project in relation to the wider environment it seeks to serve.

2.3 Software Project Support Systems

To support project managers, organisations have sought to develop tools to assist with various aspects of the management of their software processes. As well as general purpose software project planning tools that support activity definition, PERT and scheduling, specialised project planning tools are available for constructing process models and estimating software project costs. Project planning tools normally support [Fairclough, 96]:

- The definition of work packages and their duration
- The definition of resources and resource availability
- the allocation of resources to work packages
- The highlighting of resource conflicts, or over utilisation
- The construction of activity networks
- The definition of the critical path
- The definition of the schedule

Most projects will benefit from initiation planning with even the simplest tool. However, constructing, maintaining and extending large complex software systems pose the problems of managing all the people, systems and agencies involved. Although many project management systems are readily available, the enormous scope and complexity of software systems means moving beyond the current state of the art, as such systems do little to support the ‘average’ project manager. For example [O’Connell, 96] suggests;

“...if you are a poor project manager, then using Microsoft Project™ will probably make you worse”.

Most project planning tools are successful at showing the outline plan - phases, stages, etc. - identifying critical path and overall duration. Given appropriate basic cost and time data, they may be able to do basic ‘what-if’ analysis.

It is the proposition of this research that what would be of greater benefit to the project manager is advice on basic strategic alternatives such as selection of a lifecycle

process, and reuse of knowledge gained from previous projects undertaken in the organisation.

We have isolated two main areas in which tool support is weakest: First is the creation of plans. While support in some areas has significantly improved, few tools yet offer automatic creation of technical and management plans; the user has still to directly input the plan data with little support for the accuracy, completeness and quality of the plan. Of use to the project manager would be the automatic creation of an outline plan from specified (pre-defined) types of projects, which could be further refined to the particular project under consideration.

Second is decision support. Most of these systems fall short of supporting the project manager in the decision making process and do not offer assistance in representing knowledge about plans and designs, or provide mechanisms for reasoning about plans and designs in flexible ways. Although most tools offer 'what if' analysis in response to changing parameters, few offer direct 'recommendations' for action given a certain situation. Less still allow for the simulation of a possible future plan, given a key parameter change, yet such information and decision support would be of great benefit to the project manager in the immediate and intermediate time zones.

A further aspect to supporting the software project manager which is not addressed by today's support systems is the distributed and cross-platform nature of systems development. The massive reduction in the cost of Personal Computers coupled with enhanced communications technology, has lead to an increased trend towards the development of heterogeneous client-server systems. At the system level we have witnessed the widespread acceptance of distributed middleware technology such as CORBA (Common Object Request Broker Architecture) [OMG, 96] and at the programming level, the Java programming language is poised to bring platform-independent languages to a new level. However, for the software developer there is nothing by way of support systems which are orientated towards these new trends in systems development.

One of the main reasons for this pattern of strengths and weaknesses is that 'standard' software is being offered for the management of 'unique' projects. It follows that the

software will concentrate on the common functions, such as calculating the overall schedule from the set of activities. This is concerned with the logical relationship between tasks, which can be represented by standard symbols, rather than the technical content of those tasks. In contrast, short term control and decision support (where tools are not strong) are more dependent on the specific technical detail of the way things are actually done. This tends to be industry, organisation, or project specific.

Users of existing software project planning systems could benefit greatly from the inclusion of intelligent assistance techniques in such tools. In addition, such new support systems should provide for the distributed cross-platform nature of modern client-server development.

2.4 Software Project Management Tools

In the 1980's there was a marked increase in the number of organisations using software engineering methodologies and tools to assist in the planning, control and execution of software development projects. In 1984 70% of organisations said they used no recognised methods or tools. This figure reduced to 30% by 1988 and a survey in 1992 suggested this has fallen to less than 15% [Mair, 92]. It is clear that the number of tools in the market place and the number of organisations using them will continue to increase, thus leading to increased demands from users for more sophisticated tools [Hughes and Cotterall, 99]. Recent studies of project management software trends indicate that the worldwide project management software market has grown to US\$750 million and it will continue to grow, exceeding US\$1.2 billion by the year 2000 [Hodges and Rogers, 97].

Software project management tools are available at different levels of sophistication and can typically be categorised by the types of project managers who use them [Hampton, 97]:

1. The multi-project manager - Some organisations have a need to track multiple projects simultaneously. It requires software that can identify

conflicting demands on the same resources as well as allow the project manager to set priorities among the projects that require the same resource.

2. Mid-range project managers - These users manage large projects - up to 2000 tasks. They may have a couple of projects going at the same time, but the emphasis is not on multiple projects and they are typically interested in planning, scheduling, tracking and the production of reports.
3. Low-end project managers - Are typically used by project managers who want to automate the process of laying out plans, prepare occasional status reports and produce simple Gantt and PERT charts. Such users may be in charge of small development projects and thus require limited functionality from a project management tool.

Table 2.1 shows a classification [Jones, 94] and description of the main types of features found in project management tools.

Feature	Description
Input methods	A key task for users is the entry into the system of a task breakdown, task details and dependencies between tasks. If this is to be done with the minimum of errors it is essential that input can be performed in an intuitive manner.
Applying dependencies	The range of dependency types which a product can support is a key factor in its usefulness in particular situations. Among the key types are; start to finish, finish to start, lags and inter-project logic.
Scheduling	Scheduling is a key activity for project managers and the sophistication of the algorithm affects the usefulness of the product. Aspects which should be taken into account include; task priorities, multiple schedules, fixed date, as soon as possible and as late as possible.
Data import / export	Users may wish to import or export data to other packages.
Resource control	Initial and ongoing control of the resources applied to a project is a key element of project management. Typically

	tools assist with allocating and monitoring resources.
Cost monitoring	Information regarding actual and estimated costs should be captured, such as; timesheets, committed costs, cash flows, borrowing needs, etc.
Progress tracking	There are a wide variety of metrics for the progress of a project against its plans. Products normally support a variety of these types such as; % completion for time, cost or work, estimation of end date or cost and baseline comparison for time or work effort.
Reporting features	A varied reporting mechanism is essential and should include a variety of reports such as; milestone report, variance reports, status per task/team member, etc.
Multiple projects	A project manager may be responsible for many projects and will require support to handle issues such as; prioritisation between projects, staff / resource sharing and viewing consolidated information.
Charts	A variety of charting mechanisms is desirable, such as; Gantt, Pert, work breakdown structure, resource, etc.
What-if capabilities	A common requirement for project managers is to be able to investigate the effects of potential changes in the situation of a project. They may need to see the effects of adding or withdrawing a particular resource.
Help facilities	There are a number of aspects to help including; online tutorials, internet support, on-screen context sensitive help.
Networking	Organisations may require packages to operate in a network environment and allow for multiple simultaneous users.
System parameters	The limitations of the tool may be an important factor. Among the principal limits are; maximum number of projects, tasks, resources and levels of granularity.

Table 2.1 - Classification of project management tool features

The following section will briefly contrast some project management tools which are representative of the current state of the market, from the perspective of the provision

of intelligent assistance. For a definitive review of project management tools the reader is directed to [Budd, 98].

2.4.1 Commercial Examples

A market leader for type 1 (multi-project managers) projects discussed above would be Primavera Project Planner (supplied by Primavera Systems Inc.), which is primarily aimed at the high end of the multi-project market [Heck and Mitchell, 96]. It provides all the standard project management functionality outlined above and in addition provides extra functionality specifically orientated towards the needs of managers of large-scale multi-project organisations. It also provides for developing what-if scenarios but little in terms of intelligent assistance as discussed in section 1.5 and does not assist with analysing the suggested alternatives and selecting the most suitable course of action.

PE/Project Manager (supplied by LBMS Corporation) is primarily orientated towards organisations with a well defined software process [Humphrey, 89], with its typical users being in charge of type 2 (mid-range project managers) projects. PE/Project Manager provides much of the standard project management functionality outlined in table 2.1 and in addition provides extra functionality specifically orientated towards software process management. Unlike Primavera, PE/Project Manager claims to have some intelligent assistance capabilities. These are mainly concerned with the selection of the most appropriate process model (from a supplied set) and providing assistance in guiding the process of converting it into an outline project plan. However, much of the information that is used in the procedure is gained from pre-existing process models which are supplied with the tool. It is therefore rather general and offers nothing by way of assisting the project manager in reasoning about the selection process. Although it does provide a facility to build and reuse process models, it does not provide any features for capturing knowledge gained during the execution of a process, or the rationale behind the choices made during the execution of the project/process.

MS-Project (supplied by Microsoft) is the popular choice of type 3 (Low-end project managers) project managers [Heck and Mitchell, 96]. It provides a number of the project management functionality outlined in table 2.1, and is primarily orientated towards basic project planning and scheduling. Project does advertise an “*intelligent assistant to provide guidance while you work*”. However, this is actually a ‘Microsoft style Wizard’, referred to as a Microsoft Agent [Microsoft, 97]. It appears as a ‘friendly’ face or icon on the screen which provides advice on how to achieve certain tasks using the Project tool. A number of intelligent agent projects including Microsoft Bob [Miller, 97] have explored the concept of giving human-like attributes to agents by visually representing them in the form of cartoon-like animated faces [Maes, 97]. However, in Project, this assistant uses a predefined mechanism to provide the user with tool assistance and does not provide any features for capturing knowledge or assisting the user in reasoning about a project.

IntraPlan (supplied by Intra2000) is an Internet groupware project management application orientated towards organisations involved in Internet/Intranet development [Stone, 97], with a typical client being a type 3 (Low-end project manager) project manager. IntraPlan does advertise some ‘intelligent’ capabilities. However, these are also a ‘Microsoft style’ Wizard [Microsoft, 97] which guides the user through a series of predefined questions in an attempt to identify a set of suggested solutions.

A number of commercial tools claim to have ‘intelligent’ features. However, when these features are further investigated, it can be seen that they primarily refer to efficient algorithms, task automation, or other clever labour and time saving facilities. Some of these tools feature Wizards or graphical assistants which assist the user in interacting with the tool or in following a predetermined recommended series of actions. These however, only react to predetermined situations and do not have any capabilities for analysing the current situation or for providing advice unique to that situation. Most of these tools do provide a ‘What if’ method of generating scenarios to allow the project manager hypothesise about the impact of possible future decisions. These features simply use algorithmic techniques to generate project plans, etc. based on altering the value of given project variables. They do not analyse the impact of a

potential decision on the project or the organisation as a whole, or attempt to give advice to the project manager on best practices in a given situation.

None of these tools provide the intelligent assistance features discussed in chapter 1, such as:

- Assisting the user in assimilating knowledge and best practices, with regard to decision making.
- Providing the capability for project managers to reason about a project's plans, analyse alternatives and select the most suitable course of action.
- Providing a facility to capture knowledge gained during a project, and reuse this knowledge as an aid to future project decision-making.
- Assisting the project manager in adherence to standards, industry best practices and implementation of company policy.

2.5 Tool Users

In this section, the results of a tool user survey are presented. The purpose of the survey was to obtain an appreciation of the type of tools that are being used by project managers and to get a better understanding of the actual state-of-practice regarding these tools, i.e. what do the project managers actually use these tools for and is this consistent with the tool vendors intended usage. In addition, users were asked to consider the aspects of intelligent assistance and comment on the possible benefits of incorporating these into a project management support system.

It was not the purpose of this survey to provide a comprehensive in-depth study of tools users. In order to guarantee a wider range of opinion and thus be further assured of the representative nature of the survey results, a more comprehensive survey of project managers would be required. However, this small scale survey provides enough data to obtain an appreciation of the general trend of user opinion.

A group of six project managers from three European countries took part in this study. These project managers represent a variety of software development organisations,

from small project teams of 2-3 developers, to large multi-national organisations with over one hundred developers. The project managers themselves varied from novice (first time), to experienced (greater than 10 years) senior managers. The projects they manage vary from small projects of 2-3 months duration (2-6 person months of effort), to large scale complex projects in excess of 2 years duration.

Each interview lasted approximately two hours and was tape recorded to assist the interviewer in writing a report after the meeting. Each project manager was asked a series of questions (cf. Appendix B), ranging from the highly specific - aimed at investigating a particular area - to the more generic, to allow the project manager to further consider and develop their own opinions. The questions asked in the survey were divided into the following categories:

- General background questions regarding the person and employer.
- Questions to ascertain the type of projects normally undertaken.
- Questions about methodologies, standards and development tools used.
- Questions about the use of project management tools.
- Questions regarding the potential benefits of an intelligent assistant system.

In relation to project management tools, each project manager was asked a series of questions aimed at finding out what (if any) tools were being used for project management, the manner in which they were being used and the usefulness of certain types of features. Each manager was also asked to consider the proposal of an intelligent assistant in the context of a software project planning tool and offer an opinion on the proposed features.

The following six sections present a synopsis of the interview with each of the six project managers, in order of the size of the organisation. A profile of each of the project managers and their working environment is presented, as well as summary of the interview under the main heading above. In order to respect the privacy the project managers, they will be referred to as subjects 'A' to 'F'.

2.5.1 Project Manager A

Heading	Description
Organisation	Software Competency Centre, Group Schneider Electric (France).
Organisation profile	Specialist software development division (100 software engineers) of a large multi-national specialising in industrial control and automation products. Within the organisation there is a strong emphasis on adherence to agreed processes, standards and quality procedures.
Personal profile	15 years in software business, 8 of them as a project manager.
Tools available	There are a range of high-end and low-end tools, with the choice usually dependent on the individual preferences of the project manager.
Tool usage	There is a strong bias towards the use of the Artemis (high-end enterprise tool). Low-end tools such as Microsoft Project are also used for planning small projects and also as an aid to ‘sketch out’ new projects.
Recurring project management difficulties	The main areas of recurring difficulties in project management for subject are estimation and scheduling of priorities between tasks. She suggested that existing project management tools are not of much help in these areas.
Benefits of intelligent assistant	She considered that an intelligent assistant system could prove useful - in particular the notion of a tool which a manager could ‘bounce’ ideas of, in terms of project plans. She also believed a tool which could assist a project manager in ensuring the implementation of company policy (in respect of quality, organisational processes, etc.) would be advantageous.

Table 2.2 - Profile of project manager A

2.5.2 Project Manager B

Heading	Description
Organisation	Development Programmes Department, Intracom (Greece).
Organisation profile	Research and development division (50 software developers) of long established telecommunications organisation.
Personal profile	15 years in research and development, 5 as a project manager.
Tools available	A number of different tools are available. The choice of tool usually depends on the scale of the project or the individual preference of the project manager.
Tool usage	Microsoft Project is frequently used in pre-project planning stages, to help build possible views of the project and in trying to get a ‘feel for’ it. This information is often used to assist in developing tentative schedules and calculating potential resource requirements for the project. For the actual management of an individual project, a number of mid-range tools such as the LBMS tool set are often used.
Recurring project management difficulties	Scheduling of multiple projects and ensuring that all relevant steps were taken into account in the planning stages. This issue is often compounded by the fact that the developers on some projects are geographically dispersed throughout a number of locations and often with access to different computer platforms.
Benefits of intelligent assistant	He had a number of suggestions for improved tool support: a tool which could be used to centrally manage project plans for a multi-location project (distributed heterogeneous network); the ability to analyse the impact (knock-on effect) on other projects of a decision taken in one project; assistance with ensuring traceability is kept between requirements and product functionality. He also suggested that a tool which could ‘coach along’ a project manager in aspects of improving control and quality would be valuable.

Table 2.3 - Profile of project manager B

2.5.3 Project Manager C

Heading	Description
Organisation	Siemens Business Services (Ireland).
Organisation profile	Software development and consulting division, with approximately 30 software engineers.
Personal profile	17 years in IT business, 6 as a senior project manager.
Tools available	Microsoft Project, some use of LBMS tools for certain clients.
Tool usage	Although subject C is a senior project manager, with 3 project managers reporting to her, the organisation has a very low usage of specialist project management software. Spreadsheets are widely used to create and update schedules. Microsoft Project is used on occasion for scheduling and other reporting to clients.
Recurring project management difficulties	The main areas of recurring difficulties in project management for subject C are that of scheduling and estimation, as well as coping with new technologies. However, in general, C stated her projects usually ran on time and within budget, but that there is scope for a more useful tool (than Microsoft Project) to assist in routine work.
Benefits of intelligent assistant	Among her suggestions were; a tool facility which could prompt her about the various phases of a project - to act as a reminder of what management activities should be carried out when; assistance/advice on how to build concepts such as quality into particular projects; a facility in which to record the lessons learned from a project and provide easy access to it when a similar situation occurred again in another project.

Table 2.4 - Profile of project manager C

2.5.4 Project Manager D

Heading	Description
Organisation	Irish Distillers, member of Pernod Ricard group.
Organisation profile	IT department, with 7 software developers and numerous support staff. IT consultants are regularly used.
Personal profile	21 years in IT, 15 of them as a project manager.
Tools available	Microsoft Project.
Tool usage	Pen and paper charts and occasionally Microsoft Excel are used to sketch out required resources for a particular project. The only time a project management tool is used is on larger new projects, when Microsoft Project is used to schedule high level tasks.
Recurring project management difficulties	Slippages in project deadlines, mostly due to a lack of prior notification of new projects which have to be started in parallel with existing projects.
Benefits of intelligent assistant	D was very articulate about what he would require from a project management tool and responded to the notion of intelligent assistant capabilities in a project management tool with several suggestions: The tool should be 'very easy to use and not require loads of data input'; He felt that tools should be able to capture information regarding people's skills and abilities, and assist with using this information when assigning people to tasks and scheduling those tasks; The ability to insert data about tasks and priorities and to 'bounce schedule ideas' of a tool which could develop possible schedule scenarios.

Table 2.5 - Profile of project manager D

2.5.5 Project Manager E

Heading	Description
Organisation	BTT Systems (Ireland).
Organisation profile	Software house, with 10 software engineers.
Personal profile	Owner-director, 30 years experience in IT, 10 in project management.
Tools available	Microsoft Project.
Tool usage	Microsoft Project, which is used to develop schedule reports which are shown to customers. However, E admits that “ <i>these schedules are not even looked at by developers</i> ”, they are produced “ <i>to keep the customer happy</i> ”. All actual management aspects of projects are done manually using paper based plans and charts.
Recurring project management difficulties	Problems are primarily due to the rapidly changing pace of technology, particularly in the area of network software and the multi-vendor situation they work in. They have constant difficulties in keeping up to date with new technology/products and capturing the associated knowledge gained from using this technology.
Benefits of intelligent assistant	He believed the availability of an intelligent assistant would be of great benefit to him, if it incorporated a knowledge base which would keep track of the “Eureka Factor”, (i.e. specialist knowledge gained during projects), which could then be searched when similar problems occur again. Other additions he suggested would be appropriate for such a system included; an ability to assist the project manager in identifying complexity in a project; help with formulating steps to deal with customers, especially during the requirements phase; and a tool which would assist with, and enforce a procedure for documenting knowledge learned on projects.

Table 2.6 - Profile of project manager E

2.5.6 Project Manager F

Heading	Description
Organisation	Softworks Computing (Ireland).
Organisation profile	Recently established software house, specialising in human resources management software. 5 software developers.
Personal profile	Owner-director, 6 years experience in software development.
Tools available	None.
Tool usage	All plans and schedules are “ <i>scribbled on bits of paper</i> ” and when a “ <i>reasonable looking plan</i> ” emerges, it is translated onto a whiteboard which is altered in an ad-hoc manner over time to reflect the current state of all tasks and people assigned to them in all current projects.
Recurring project management difficulties	They have had requirements management problems due to clients who regularly change their requirements, thus causing a knock-on effect throughout the project. Like project manager E, he would like a tool which could assist in the requirements engineering process.
Benefits of intelligent assistant	F has previously conducted postgraduate research in Expert Systems and thus had a good understanding of the proposal of intelligent assistance in project management tools. He considered the proposed intelligent assistant to be very useful and had potential to be of use in other aspects of management, not just for software development. He warned of potential user problems, which could be overcome with careful user interface design and subtle direction by the tool. He also suggested that a tool for capturing knowledge about projects, and the reasons behind design and other decisions would be most useful. In addition, the notion of being able to automatically create possible alternative project plans and receive advice on which may be the most appropriate ‘text book’ approach, would also be useful.

Table 2.7 - Profile of project manager F

2.5.7 Survey Results

The project managers who participated in the study represented a range of organisations, both in terms of number of software developers and types of project management tools used. However, it is interesting to note that the majority of project managers had similar problems, particularly in respect to estimation and scheduling. Additionally, they identified similar difficulties with existing project management tools. The project managers surveyed provided a number of suggestions for enhancements to such tools, and a number of these suggestions serve to reinforce the proposition previously discussed. The project managers considered an intelligent project assistant to be a useful addition to the existing range of features in project management tools. In particular, they supported the concept of a tool which could intelligently manage project knowledge and capture knowledge and lessons learned about projects into a project knowledge base. Apart from the intelligent assistant aspects of this research, the problems associated with organisations having distributed project teams coupled with multiple hardware platforms was identified by all the project managers surveyed, thus highlighting the need for a distributed platform tool.

The main purpose of the tool user survey was to validate the proposition of an intelligent assistant system and obtain user feedback on the notion of incorporating intelligent assistance in a project planning tool. Having analysed both the software project management tools discussed above and the survey of tool users, it is considered that the initial premise of this thesis has been validated.

To obtain further feedback from potential tool users and from the wider software engineering community, the results of this survey coupled with details of the proposed intelligent assistant system were presented at the 9th European Software Control and Metrics (ESCOM) conference [O'Connor and Jenkins, 98]. A number of positive comments were made about the need for, and potential usefulness of, such a tool. The main concern that was expressed was in relation to aspects of knowledge elicitation and knowledge representation. These issues will be dealt with in chapter 5.

Further validation was obtained by the implementation of a prototype system, which was demonstrated to the tool users previously surveyed, in conjunction with a wider study. This exercise allowed users to more easily appreciate and consider the proposed

system, and in addition, a prototype system provided an easier mechanism to demonstrate the system to a larger audience.

2.6 Summary

This chapter contains a description of software project planning and its characteristics in order to better understand what is required from an intelligent assistant system for software project managers. This has also presented a discussion on the functionality of software project planning tools and a survey of software project planning tool users in an attempt to validate the premise of this research.

Chapter 3 will examine intelligent assistant systems in other domains with an emphasis on their underlying architecture. The issues surrounding the architectural concerns of client-server and distributed systems will also be examined to set the context for a discussion on the architecture for the proposed system.