Technology Opportunities and Potential for The Virtual Construction Site

Project Planning Software Review

David Heesom and Lamine Mahdjoubi

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The Virtual Construction Site
Technology Opportunities and Potential

Executive summary

This document presents Volume 2 of the Technology Opportunities and Potential for the Virtual construction Site (VIRCON) project. The report provides technical reviews of the most prominent project planning software packages currently available. The aim of this review is to identify a shortlist of planning software packages that possess the potential to be utilised by the VIRCON project. The report is divided into 3 sections:

1. Section 2 presents a basic technical specification of 12 leading commercial project planning software systems. The packages reviewed include Realtime Projects, CA-SuperProject, Dekker TRAKKER, X-Pert, Microsoft Project, OPX2, PowerProject, Pertmaster, Planview, Primavera, Project Scheduler and TurboProject.

This section of the report provides background information about the developments of the software since its inception. It also provides basic technical analysis, including its capability to perform critical path analysis of project schedules, as this forms the basis of construction scheduling.

2. Following the overall review of the capabilities of the software packages, the next section presents details of an in depth functionality test that was carried out on each of the software packages reviewed.

12 technical areas were identified in the specification of each of the software packages and these were investigated further. From each of the technical areas identified a scoring system was derived that could be used to quantify the capability of the software to undertake various technical tasks. The scoring was employed to derive a functionality matrix that identified software packages with a higher technical functionality.

From this review, three software packages were short listed for use with the VIRCON system. The short listed software packages were Microsoft Project, PowerProject and Primavera. They were primarily selected for their ranking in the functionality and their usage within the UK construction industry. Preliminary work, undertaken for the Virtual Construction Site project, investigated the use of project planning software within the UK construction industry and concluded that these packages were currently the most widely diffused within the construction sector.

3. The final section of the report investigates possible future developments of each of the three short listed software packages. In order to undertake this section of the investigation, a questionnaire was derived to extract further technical information from delegates of the software companies identified. The responses to the questionnaires can be seen in appendix B of this report.
In addition to obtaining further technical information about the software package, the questionnaire also aimed at obtaining information from the developers pertaining to possible future developments. This information could then be used to assess the impact of these developments on the VIRCON system. Potential future developments included features such as:

- The inclusion of greater data exchange functionality
- Extended database exchange methodology
- The potential to assign work execution space to tasks, in a similar way that resource can be assigned to tasks currently

In summary this report has provided a full technical evaluation of the current commercially available project planning software and appraised its potential for compatibility with the VIRCON system. The report presents a technical review including background developments of 12 of the industry available planning software packages. Following this a quantitative analysis was undertaken on the software packages to determine a shortlist of software that had the highest functionality. In addition to the quantitative analysis, qualitative analysis was used from work previously undertaken at the preliminary stages of the VIRCON research.

Using the methods described above a shortlist of three software packages that could be utilised by VIRCON was compiled. This list included Microsoft Project developed by Microsoft Corporation, PowerProject developed by Asta Developments and Primavera Project Planner (P3) developed by Primavera.

The results of the questionnaire highlighted areas of future developments of the software packages that could affect the development of the VIRCON system. Potential future developments of the CPA software included the addition of data exchange formats for PowerProject that may utilise XML and Data Access Objects (DAO) to assist the exchange of information via databases. Responses from Primavera demonstrated that there was no strategy to investigate space allocation for possible inclusion into the construction scheduling process whilst little information was received from Microsoft about the possible future developments of Microsoft Project.

The report recommends that for the development of the VIRCON system to progress Microsoft Project be utilised as the Critical Path Analysis engine. Microsoft Project ranked highest in the functionality testing carried out in the report. However this was only part of the rationale for its choice. Investigation has shown that the diffusion of Microsoft Project is substantially higher than that of Primavera or PowerProject and so should assist in the rapid diffusion of VIRCON.
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1.0 INTRODUCTION

Scheduling of construction tasks is a key requirement to the success of a construction project. Using a project scheduling software tool, the project planner can bring together information pertaining to resource assignments and relationships between tasks and hence produce a schedule of anticipated events and milestones. Once the tasks are derived and programmed by their dependencies, the critical path can be determined. The Critical Path of a project comprises a set of dependent activities (each dependent on the preceding one), which together take the longest time to complete (Modell, 1996). These tasks must be completed on time for the project completion date to be met, as activities on the critical path have no float.

1.1 Review of available software

There are currently several software packages available, which have the ability to carry out the functions of compiling a project schedule and analysing the critical path of the plan. In order to distinguish the suitability of a particular software package to the VIRCON, various aspects of the software are examined. These range from its current use throughout the industry, to its technical specification in order to assess how the software system would interact with other programs within VIRCON.

1.2 Technical review of software

A technical review is undertaken of a selection of the most prominent project scheduling software packages that are currently available. In order for the VIRCON system to work efficiently, the software used to compile the construction schedule and carry out the critical path analysis, needs to interact with the other VIRCON modules. This is in addition to the usual functions such as defining and sequencing activities, critical path calculation, resource analysis and production of reports. This review includes details such as the export formats available for each of the software packages including the structure of the export map used i.e. fixed or customisable and the data fields available for exporting. Also included will be a review of database support provided by the planning tool including Open Database Connectivity (ODBC).

Open Database Connectivity (ODBC) is a vendor-neutral interface, based on the SQL Access Group specifications, announced by Microsoft in December 1991. A developer can use ODBC to access data in a heterogeneous environment of relational and non-relational databases.

1.3 Future developments of CPA software

Software developers are continually updating Critical Path Analysis software, and future updates may have a significant effect on the VIRCON system. For this reason the developers of the leading software packages were approached regarding possible known future developments that may affect the VIRCON system. Questionnaires were used to obtain information relating to possible future developments such as new connectivity methods and the possibility of providing linkage between the CPA software and 3D graphical interfaces. The inclusion of space as an attribute of a resource or task was also investigated.
1.4 Structure of Report
The following report is divided into 3 sections. Section 2 presents an overall review of
deleven CPA software packages with the ability to carry out critical path analysis on a
construction schedule. Each of these systems is reviewed for specific technical
abilities that could facilitate the VIRCON system. The results of these technical
requirements are presented in tabular format to allow easy reference.

Section 3 of the report performs a detailed functionality test on each of the software
packages reviewed, identifying various technical capabilities and using a grading
system to rank each of the packages. From this review a shortlist of software
packages is defined for use in the VIRCON system with the reasons for their choice
outlined and discussed further.

The fourth section of the report investigates the possible future developments of
each of the short listed software packages using information provided by delegates
from the software companies. A questionnaire was derived to encapsulate
information relating to the software packages including potential future developments
that could affect the functionality of the VIRCON system.

The final section of the report presents the conclusions and the recommendations of
the CPA software for the use with the VIRCON.
2.0 EXISTING PROJECT PLANNING SOFTWARE

2.1 Realtime Projects – Advanced Management Systems

2.1.1 Background
Advanced Management Solutions (AMS) was founded in 1983 and is an independent software company serving a broad range of clients and industries. The headquarters of AMS is based near Los Angeles, California, with offices in Herndon, Virginia and throughout the USA, as well as in Reading. Outside of the UK and USA AMS has a network of software and consulting partners, with offices throughout Europe, Asia and South America.

Realtime Projects is part of the Realtime Suite of products produced by AMS, which includes other software such as AMS REALTIME Costs, AMS REALTIME Resources, AMS REALTIME Solo, and AMS REALTIME Server. The software is available in the following languages; Chinese, Dutch, English, French, German, Japanese, Korean, Polish and Russian.

Website: - http://www.amsusa.com/

2.1.2 Scheduling Capabilities
AMS Realtime Projects has the ability to create a construction schedule in either spreadsheet, PERT or bar chart mode using any units ranging from seconds to years. From the compiled schedule a full critical path analysis can be undertaken. The software also has the capability of creating networked schedules from which the critical path is calculated in real time as activities and constraints are manipulated. Working cycles and calendars, in addition to the normal five-day week can be defined with a maximum of 250 calendars per project.

The software can provide up to a maximum of 100 structures per project (Work Breakdown Structure, Organisational Breakdown Structure and Resource Breakdown Structure). The software also has the capability of scheduling 25000 tasks and 2000 resources per project.

2.1.3 Export Capabilities
AMS Realtime Projects has the ability to export the project data in a number of ways. There is a direct MPX, MPP and MPT gateway, which will allow full usability with Microsoft Project.

‘Projects’ also has the ability to export the schedule data in database format and this can be exported to any Oracle database or any ODBC compliant database package. The package also supports the use of database mapping to external tables and distributed databases.

2.1.4 System requirements
The software is able to run both as a client and a server running on Win 95/NT/3.x, Solaris, HP, RS or Mac (System 7.x) operating systems. The minimum configuration for the client is 486 processor, 8MB RAM and 20MB hard disk. The minimum configuration for the server is Pentium class processor, 32MB RAM and 100MB hard disk. The software is also 100 % Cross-platform compatible.
2.1.5 Summary

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<td>N</td>
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<td>Application programming Interface</td>
<td>Y</td>
</tr>
<tr>
<td>Programming language</td>
<td>Y</td>
</tr>
</tbody>
</table>

2.2 CA SuperProject – Computer Associates

2.2.1 Background

Based in New York, USA, Computer Associates was founded in 1976 by Charles Wang, Judy Cedeno, and Russ Artzt. The initial strategy is to provide IBM hardware customers with performance-enhancing software. CA is engaged in the development of various software packages including CA-SuperProject 5.0. This latest version of their project planning and management software was released in May 2000.

In addition, CA has also developed SuperProject/Net, an Internet/Intranet server designed to work with SuperProject. This package extends the functionality of SuperProject by using the Internet / Intranet to provide dynamic Web portals to each person involved in the project. Using these allows the processing of project information and the return of project information as a series of home pages.

SuperProject is available in various language versions including English, French, Norwegian, Italian, Spanish and German.

Website: - [http://www.cai.com](http://www.cai.com)

2.2.2 Scheduling Capabilities

CA-SuperProject provides the ability to schedule 16000 tasks utilising an unlimited number of stored resources. Tasks can be added to the project schedule using Bar chart, PERT, table or WBS views using varying timescales. Once all tasks are input a critical path of the project schedule can be calculated. Unlimited calendars and resources (obtained from a central resource pool) can be specified for a project and unlimited projects can be combined and analysed together to form a multiproject. In addition, costs, resource availability and material use can be charted over any time phase. The package provides support for thirty breakdown structures and provides support for user defined structures.

Using SuperProject, tasks can be designated to be completed As Soon As Possible (ASAP) or As Late As Possible (ALAP) thus supporting the critical chain concepts of planning.

2.2.3 Export Capabilities

As an OLE 2.0 automation server, other programs can be used to automate SuperProject. As an OLE 2.0 client, SuperProject can imbed OLE objects to tasks, resources, and assignments. Using DDE as a client or server, control or access can
be made of SuperProject functionality and data or to paste links to or from Super
Project's data fields. Flexible import and export facilities allow connectivity with other
applications. Formats include CSV, dBase, Lotus 1-2-3, Excel, and Microsoft Project
MPX format. Project data can be exported with full control of selection and sorting.

Through ODBC and Data Access Objects (DAO), the schedule can be connected to
any supporting database. Multi-project data can be stored into a single relational
database repository for ultimate cross-project updating, analysis, and reporting. In
addition CA-SuperProject provides an extended BASIC development language
allowing the creation of simple macros or full applications.

The software also now provides a MAPI-compliant, 32-bit e-mail system, to allow
communication of project information with other team members. This feature allows
the sending of project files or Task Status Forms to other team members based on
selection criteria or Start dates.

### 2.2.4 System requirements
CA-SuperProject provides the ability to run both as a client and a server on Windows
95, 98 NT or Win OS/2. The minimum client configuration is a 486 processor.

For CA-SuperProject/Net to operate as a Server, the minimum configuration is a 486
processor, 32MB of memory, 20MB of available disk space and Microsoft Windows
NT 3.51 or higher. As a client the minimum configuration is a browser that supports
HTML 3.0 and Java with Netscape or MS Explorer 4.0 or higher recommended.

### 2.2.5 Summary

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<td>Supports OLE</td>
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<td>Application programming Interface</td>
<td>Y</td>
</tr>
<tr>
<td>Has programming language</td>
<td>Y</td>
</tr>
</tbody>
</table>

### 2.3 Dekker TRAKKER – DMTI

#### 2.3.1 Background
In 1984, Dekker, Ltd. Management Technologies Institute (DMTI) was founded to
develop business decision support software products. The company is based in
California, USA and provides expertise in project management solutions providing
the Dekker TRAKKER® product line. The software suite is available in English,
Spanish, Dutch or French language versions.

Website: [http://www.dtrakker.com](http://www.dtrakker.com)

#### 2.3.2 Scheduling Capabilities
Dekker TRAKKER allows the planner to input an unlimited number of tasks into the
project program utilising the storage capability of unlimited resources. Once the tasks are defined, a full critical path analysis can be undertaken. Where required multiple critical paths for schedules can be analysed and reported. Task data can be input through spreadsheet views or via a Gantt chart view, with each amendment to the task details updating all other aspects of the schedule in real time. In addition, unlimited projects can be linked together to form a multiproject providing a multiple user environment.

During schedule evaluation various time cycles can be defined and 10 calendars can be defined for each project. TRAKKER provides unlimited breakdown structures whilst also providing the user with the ability to define specific breakdown structures.

2.3.3 Export Capabilities
Dekker RAKKER has the ability to export and integrate with Microsoft Office products such as MS Project, MS Excel and MS Access. Import and export facilities for the Microsoft Project software is available through the MPX file format.

TRAKKER also provides the ability to export schedule information to database format. Schedule information can be exported directly to an Oracle, Microsoft Access or FoxPro database format. In addition the database export also facilitates distributed database support.

2.3.4 System requirements
Dekker TRAKKER can be operated in either a client or server configuration. For the software to run as a client, the minimum operating system required is Windows 95, however the software is compatible with Windows 98, 2000 and NT. The minimum hardware requirements for client operation is a Pentium class processor with 16MB RAM and a 1 GB hard disk.

For the software to run as a server, the minimum operating system required is Windows NT, Novell or Unix. The minimum hardware requirement for the server configuration is a Pentium class processor with 128MB RAM and 10GB of hard disk space.

2.3.5 Summary

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<tr>
<td>No. of resources</td>
<td>Unlim</td>
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<td>Supported databases</td>
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<td>Supports OLE</td>
<td>Y</td>
</tr>
<tr>
<td>Application programming Interface</td>
<td>Y</td>
</tr>
<tr>
<td>Programming language</td>
<td>Y</td>
</tr>
</tbody>
</table>

2.4 Micro Planner X-Pert – Micro Planning International

2.4.1 Background
Formed in 1978 in the UK, Micro Planning Services began developing project management software with the first package being Micro Planner, the first PC based
project management software for the Apple II. In 1987 Micro Planning Services became Micro Planning International and relocated to San Francisco, USA. Following the release of Micro Planner for both Windows and Macintosh in 1988, development of Micro Planner X-Pert was underway and this was released in 1989. Since the original release, Micro Planner has released various enhanced versions with the most current being Version 2.4.1 for Windows released in 1998.

Website: - [http://www.microplanning.com](http://www.microplanning.com)

### 2.4.2 Scheduling Capabilities
Micro Planner X-Pert has the ability to process up to 15000 tasks per project with up to 50 projects within a multi-project. A maximum of 200 resources per project are allowed and each task can be added to the project in Network Diagram (PERT), Gantt chart, Linked Gantt Chart, Table or Spreadsheet format using varying timescales and 200 calendars per project. From the inputted information a full critical path analysis can be carried out. A maximum of 999 work breakdown structures can be contained in one schedule with the ability for customised breakdown structures to be identified by the planner.

### 2.4.3 Export Capabilities
Micro Planner X-Pert provides the ability to export project information in Text, CSV or DIF formats. No support is given however, for the exporting of information into database format, however limited support is given for the interchange of data from Microsoft Project. Micro Planner provides the ability to import and export to Microsoft MPX file format.

### 2.4.4 System requirements
Micro Planner Xpert can run as a client or server application with either a Windows or a Macintosh operating system required.

### 2.4.5 Summary

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<td>Supports OLE</td>
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<tr>
<td>Application programming Interface</td>
<td>N</td>
</tr>
<tr>
<td>Programming language</td>
<td>N</td>
</tr>
</tbody>
</table>

### 2.5 Microsoft Project 98 – Microsoft Corporation

#### 2.5.1 Background
Microsoft was founded in 1975 by Paul Allen and Bill Gates and has gone on to establish itself as one of the largest companies in the world. The company has had unprecedented success with its Windows and Office products and Microsoft has quickly expanded to cover a multitude of areas. In 1990 Microsoft Corporation first introduced Microsoft Project 1.0 for Windows, one of the first planning software
packages of its time. Since then there has been various releases of the software and the latest release was in 2000, which saw the release of Microsoft Project 2000. Due to the extended use of Microsoft projects, the software is available in most languages.

Website: [http://www.microsoft.com](http://www.microsoft.com)

### 2.5.2 Scheduling Capabilities

Microsoft Project allows the planner to input task information in a variety of ways. Task data can be input into the schedule in either Gantt, PERT, spreadsheet or calendar mode. As tasks are input or varied the critical path is calculated in real time allowing the impact of task variation on the critical path to be viewed.

Tasks can be input and schedules analysed, using various timescales ranging from minutes to years. Multiple projects can be networked and analysed for critical path where a maximum of 1000 projects can be scheduled simultaneously. The maximum number of tasks allowed per project is entirely dependent on the power of the PC used to run the software. The amount of memory available constrains the number of tasks, as is the case with the maximum number of calendars for a project. Unlimited resources can however be applied to a particular task. Microsoft Project 2000 supports user defined WBS and defined tasks can be designated to be completed As Soon As Possible (ASAP) or As Late As Possible (ALAP), supporting the critical chain concepts of planning.

### 2.5.3 Export Capabilities

Microsoft Project 2000 supports numerous file formats that can be used for data import and export. These include Microsoft Project Exchange (MPX), Microsoft Access, ODBC database, Microsoft Excel, HTML, Text-only or ASCII and CSV. Any of these methods can be used for the exporting or reading of schedule data. In addition to these methods of transfer Project also supports distributed databases allowing the remote reading of schedule data. In addition, Project can link with Microsoft Outlook to schedule tasks using this software and also allow the transmission of schedule data via electronic mail.

Project also provides a Visual Basic for Applications (VBA) module that allows the user to define and customise Project using the Basic programming language.

### 2.5.4 System requirements

Microsoft Project can run in either Client or Server configuration. For the software to run as a client, it requires Windows 95, 98 or NT with a minimum hardware configuration of a 486 processor with 16 MB of memory. The amount of memory required does however have an effect on the amount of tasks that can be analysed in the schedule.

For Microsoft Project to be used as a server application it requires Windows 95, 98, NT or 2000, however the hardware configuration is dependent on the number of users for the software and the size of the projects to be compiled and analysed.
2.5.5 Summary

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<td>No. of tasks</td>
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<td>No. of resources</td>
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<td>Supported databases</td>
<td>MS Access, Oracle, dBASE, FoxPro, ODBC</td>
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<td>Supports OLE</td>
<td>Y</td>
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<td>Application programming Interface</td>
<td>Y</td>
</tr>
<tr>
<td>Programming language</td>
<td>Y</td>
</tr>
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</table>

2.6 OPX2 Pro (Planisware)

2.6.1 Background
Based in Redwood City, California, Planisware developed OPX2, a project planning and control software, that was announced in 1996. The software was developed in partnership with European consulting companies that specialize in Project Management.

Website: [http://www.planisware.com](http://www.planisware.com)

2.6.2 Scheduling Capabilities
OPX2 provides the ability for the planner to schedule an unlimited number of tasks using an unlimited number of resources that can be allocated from a generated resource pool. The task information can be input using Gantt, Pert or Tabular methods. Once the task information is input, a full critical path analysis of the schedule can be undertaken. Unlimited calendars can be specified for a project and there are no constraints on the number of projects that can be scheduled simultaneously.

OPX2 supports all forms of breakdown structures and a maximum of 10 structures can be specified per project with the ability for the user to define structures. In addition, the level of detail of the schedule can be manipulated to allow for various reporting of the schedule.

2.6.3 Export Capabilities
OPX2 provides the ability to export and integrate with various applications. Direct bi-directional integration is available between OPX2 and Microsoft Project or Scitor Project Scheduler utilising the Microsoft MPP and MPX gateway.

OPX2 also provides the ability to import and export schedule information in database format to various database formats including ODBC, Microsoft Access and Oracle. Distributed databases are supported, allowing the use of remote information storage. Facilities also exist for the linking of schedule data to other software packages such as Microsoft Outlook. The software also provides the user with the ability to generate Macrocode to automate processes.
2.6.4 System requirements
OPX2 can be run as either a client or a server application. For the software to run as a client, Windows 95/98 or NT is required, with a hardware specification of a Pentium class processor with 32MB RAM.

For the software to run as a server, Windows NT or Unix is required, with a minimum hardware configuration of a Pentium 200 class processor with 128MB RAM.

2.6.5 Summary

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</tr>
<tr>
<td>Programming language</td>
<td>Y</td>
</tr>
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</table>

2.7 PowerProject – Asta Developments

2.7.1 Background
ASTA DEVELOPMENT PLC, part of ASTA GROUP PLC, is a British software and services company, founded in 1986. PowerProject® was launched in October 1988. PowerProject® was one of the first systems to use a graphical user interface and WYSIWIG output, enabling users to draw plans directly on to a computer screen without having to understand the complexities of PERT networks before they could input and present project data.

PowerProject is available in 8 languages throughout the following countries: - Austria, Belgium, Czech Republic, Eire, Germany, Holland, Hong Kong, Norway, Poland, Singapore, Sweden, Switzerland, Russia and the USA.

Website: - [http://www.astadev.com](http://www.astadev.com)

2.7.2 Scheduling Capabilities
Task information can be input into the project schedule using the Gantt chart or spreadsheet method or by using a combination of both, with no limit existing for the amount of resources that can be applied to a particular task. Tasks and the project schedule can be defined using a range of timescales from seconds to years. Once the task data has been input into the schedule a full critical path analysis is undertaken.

Tasks can have notes and ALAP/ASAP settings that support the critical chain concepts. Any task or resource can have any calendar from an unlimited supply. Plans can have a folding calendar to focus on working time. Additionally, tasks can be summarised into hierarchical work breakdown structure (WBS) of any complexity, whilst the ability to customise Work Breakdown Structures is also supported.
2.7.3 Export Capabilities
Schedule information can be saved and exported using the Microsoft Project eXchange (MPX) format. Information can also be exported into database format using open database connectivity ODBC and Data Access Objects (DAO). The exporting of information can be mapped by user-defined fields, allowing specific information to be exported.

Power project also makes use of OLE2 technology, providing the ability to link the package and the schedule information to Microsoft Office and other applications. In addition the software also provides the Industry Standard macro language - Microsoft Visual Basic for Applications. This facilitates the customisable development of the software.

2.7.4 System requirements
The minimum operating system requirements for PowerProject is Microsoft Windows 95, 98, 2000 or NT4. The minimum hardware requirement for the software is a Pentium 133 processor, with 32MB RAM and 50 MB hard disk space.

2.7.5 Summary

<table>
<thead>
<tr>
<th>Feature</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Path Analysis</td>
<td>Y</td>
</tr>
<tr>
<td>No. of tasks</td>
<td>Unlim</td>
</tr>
<tr>
<td>No. of resources</td>
<td>Unlim</td>
</tr>
<tr>
<td>Supported databases</td>
<td>ODBC, MS Access</td>
</tr>
<tr>
<td>Supports OLE</td>
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</tr>
<tr>
<td>Application programming Interface</td>
<td>Y</td>
</tr>
<tr>
<td>Programming language</td>
<td>Y</td>
</tr>
</tbody>
</table>

2.8 Pertmaster Professional - Pertmaster

2.8.1 Background
Pertmaster Professional planning software is produced by Pertmaster software, a UK based software developer based in London. Pertmaster has been a software developer since the early 1980’s producing project planning software with Pertmaster Planner being one of the first comprehensive project management systems to be designed for the PC. The latest version of the software to be released is Pertmaster V.7

Website: [http://www.pertmaster.com](http://www.pertmaster.com)

2.8.2 Scheduling Capabilities
Pertmaster allows task information to be input into the project schedule either via bar chart, precedence network or spreadsheet views. Each project is limited to a maximum of 16,000 tasks, however a benchmark has been developed that states that 5000 tasks and 15,000 links can be processed and analysed for a critical path in less than 1 second using a Pentium class PC.

Unlimited resources can be specified for the project and these can be divided into
resource teams to be allocated to specific tasks. In addition Pertmaster fully supports multi-project analysis allowing numerous project plans to be combined and analysed for critical path activities. Once combined these separate projects can be merged and de-merged to facilitate reporting. All critical path calculations are undertaken in real time so that amendments to the critical path are shown as task data is amended. Pertmaster also provides support for the definition of WBS and OBS.

2.8.3 Export Capabilities
Pertmaster project information can be exported to other software packages using various file formats. Task data can be imported and exported using the Microsoft Project MPX file format. Provision is also made for the importing of data using the Microsoft Project database file type (mpd) and Microsoft Access database files (mdb). In addition to using these formats direct support is provided for Primavera P3 and Suretrak files, allowing direct import and export to these file types.

Schedule information can be imported and exported directly using the dBase III format. Information can also be exported as text based files using either text with comma delimiters or text with tab delimiters. During export using these formats the information is based on a fixed export map predefined in the software.

2.8.4 System requirements
Pertmaster v7 can operate as a client system. The minimum operating system required for the efficient running of the software is Microsoft Windows 95, 98, 2000 or NT 4.0. The minimum hardware requirement for the software is a Pentium class processor with 16MB of RAM and 20MB of hard disk space.

2.8.5 Summary

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<td>Supports OLE</td>
<td>N</td>
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<tr>
<td>Application programming Interface</td>
<td>N</td>
</tr>
<tr>
<td>Programming language</td>
<td>N</td>
</tr>
</tbody>
</table>

2.9 Planview Software – Planview (Inc)

2.9.1 Background
PlanView was founded in 1989 to integrate resource and project management on a multi-tier system. PlanView was the first to offer a commercial client/server software solution for the project management industry in 1990.

The target industries include Finance, Insurance, Utilities, Technology and Consulting. PlanView has 200+ customers and over 100,000 copies of its software in use around the world. PlanView Inc. is based in Austin, Texas with offices in Washington D.C., Dallas, Sacramento, Atlanta, New York, and Portland. International offices are located in Holland, Italy, Germany, and England.
2.9.2 Scheduling Capabilities
Planview planning software can be implemented either as an Intranet or an Extranet. An unlimited number of tasks can be input into a project plan and resources can be applied to each of the tasks from a pool of unlimited resources. This data can be entered into the plan using varying timescales and by either spreadsheet or bar chart view. Once completed, a critical path analysis of the schedule can be undertaken and Planview also provides the capacity for an unlimited number of projects to be scheduled simultaneously.

Planview supports an unlimited number of breakdown structures including WBS, OBS and RBS and also provides the planner with the ability to define custom breakdown structures.

2.9.3 Export Capabilities
Schedule information from Planview can be imported and exported to other software packages using the Microsoft Project MPX file format. Schedule information can also be stored using database format allowing the usage of schedule information by remote users. Various database formats are supported by Planview including Oracle, Sybase and MS Access.

Planview also provides an Application Programming Interface (API) that allows the user to customise access to the schedule information. OLE technology is also used to allow the dynamic exchange of Planview data providing the ability for information to be presented in other applications.

2.9.4 System requirements
Planview can run as either a client or a server application. Running in client mode the software requires a minimum operating system of Windows 95, 98 or NT with Internet Explorer 4.5 or Netscape 4.06. The package also requires a minimum hardware requirement of a Pentium class processor with 24MB RAM and 4MB of hard disk space. TCP/IP connection is also required to a Local Area Network (LAN) or an Intranet.

For the package to run as a server application, a Windows NT, Unix or Novell operating system is required with a minimum hardware requirement of a Pentium 450 processor with 256MB RAM and 1MB of temporary storage space per user.
### 2.9.5 Summary

<table>
<thead>
<tr>
<th>Feature</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Path Analysis</td>
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</tr>
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<tr>
<td>No. of resources</td>
<td>Unlim</td>
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<tr>
<td>Supported databases</td>
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<td>Supports OLE</td>
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</tr>
<tr>
<td>Application programming Interface</td>
<td>Y</td>
</tr>
<tr>
<td>Programming language</td>
<td>Y</td>
</tr>
</tbody>
</table>

#### 2.10 Primavera Project Planner (P3) 2.0 – Primavera

**2.10.1 Background**

Joel Koppelman and Richard Faris founded Primavera in 1983. Primavera’s customer base spans a broad range of industries, including information technology, financial services, telecommunications, chemical processing, energy, engineering, construction, utilities, and aerospace and defence. Primavera is the 32nd largest PC-based software company in the US. Primavera is headquartered in Bala Cynwyd, Pennsylvania, with offices in New York, San Francisco, Chicago, Concord (New Hampshire), London and Hong Kong

Website: [http://www.primavera.com](http://www.primavera.com)

**2.10.2 Scheduling Capabilities**

Primavera provides the project planner with the ability to schedule up to 100,000 activities per project using mixed durations from minutes to month periods. Unlimited resources can be utilised and can be applied in any number to specific tasks. In addition, unlimited calendars are available for each project. Task information can be input into the project schedule using a variety of methods including bar charts, spreadsheets or PERT logic diagrams. Once all task information is entered, a critical path analysis of the schedule can be carried out. As task information is updated the critical path is re-analysed, ensuring that changes occur in real time. Unlimited projects can be linked to form a multiproject from which a critical path can be determined.

Primavera also provides the ability to store ‘fragnets’. These modules contain groups of tasks, relationships and resources that can be used as templates for other projects or sub projects. The software also provides for 20 work breakdown structures with the capability for these to be defined by the user.

**2.10.3 Export Capabilities**

Primavera allows for project information to be imported and exported using a variety of methods. Direct access is provided to many scheduling packages by use of the Microsoft mpx file format. In addition to this method of data exchange, project information can also be stored using database format and Primavera Project Planner provides the capability to utilise ODBC.

Project Planner also provides an Application Programming Interface (API) allowing
the user to customise access to the schedule information through development tools such as Visual Basic and C++. OLE2.0 technology is also used to allow the dynamic incorporation of schedule and project information with other OLE2.0 compliant development tools.

In addition to these aspects, Primavera also provides the facilities for information to be distributed via e-mail. Directly using Microsoft Mail, cc:Mail or any other MAPI-compliant mail service allows for specific task information to be sent electronically.

2.10.4 System requirements
Project Planner can run in either a client or server configuration. The minimum operating system for the client configuration is Windows 3.x or Microsoft Windows 95/98. For operation in this mode a minimum hardware requirement of a 486 processor is required, with 32MB RAM and 40MB hard disk space. For the software to run in server configuration, a minimum operating system of Windows NT 3.5 is required.

2.10.5 Summary

<table>
<thead>
<tr>
<th>Feature</th>
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</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>No. of resources</td>
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<tr>
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<td>Supports OLE</td>
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<tr>
<td>Application programming Interface</td>
<td></td>
</tr>
<tr>
<td>Programming language</td>
<td>Y</td>
</tr>
</tbody>
</table>

2.11 Project Scheduler 8.0 – (Scitor Corporation)

2.11.1 Background
Scitor has been a leader in Project Management Solutions, Systems Engineering, and Information Systems for over 20 years. Since it’s beginning in 1979, Scitor has enjoyed continuous, profitable growth. Today, Scitor employs over 800 people with revenues in excess of $175m dollars. In addition to developing award-winning business software, Scitor provides management-consulting services in project management, strategic planning, cost and risk analysis, program justification and business process improvement. Project Scheduler was released as the industry first PC DOS based project management software in 1982. The latest release of the software, Version 8.0 was released in 2000.

Website: [http://www.scitor.com/](http://www.scitor.com/)

2.11.2 Scheduling Capabilities
Project scheduler has the capability to analyse a schedule that contains up to 99,999 activities. These activities can be input into the schedule using network, outline, task spreadsheet and Gantt chart views. In addition, recurring tasks are remembered enabling rapid scheduling. Work Breakdown Structures are available and these can be broken down into 10 levels, with the ability for the planner to define customised
structures. 99,999 types of resources can be stored in a project and these can be applied in unlimited number to tasks. 3 types of resource can be specified labour, material and other. As task data is amended the critical path is re-evaluated ensuring amendments are made in real time.

When generating tasks in Project Scheduler, they can be scheduled as ASAP or ALAP and feeding/project buffers can be inserted automatically supporting scheduling using the critical chain concepts. Unlimited multiple projects can be analysed by Project Scheduler however, the number is limited by the power of the PC being used.

2.11.3 Export Capabilities
Schedule information stored in the Microsoft MPX file format can be seamlessly imported into Project Scheduler whilst information can also be exported into MPX format. In addition to this method of data transfer, project information can also be exported into database format. Scheduler supports ODBC database formats enabling the exchange of information with all ODBC compliant databases. Information can also be exported as text based files using comma or tab delineators. For each database or text based output, the information can be customised allowing only selected fields to be exported.

Project Scheduler provides an Application Programming Interface (API) allowing the user to customise access to the schedule information. Additionally, the software provides OLE2.0 client / server technology that allows the dynamic incorporation of schedule and project information with other OLE2.0 compliant development tools.

2.11.4 System requirements
Project Scheduler can run only as a client application. The minimum operating system for the software operation is Microsoft Windows 95, however, it can operate under Microsoft Windows M.E., NT4 or 2000. The minimum hardware requirement for the software operation is a Pentium class processor with 32MB RAM and 50MB hard disk space.

2.11.5 Summary

<table>
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<td>Application programming Interface</td>
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<tr>
<td>Programming language</td>
<td>N</td>
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</tbody>
</table>
2.12 TurboProject Pro – (IMSI)

2.12.1 Background
Since its foundation in 1982, International Microcomputer Software, Inc. (IMSI) has evolved from a small direct mail software company, to one of the world's leading developers and publishers of design software for businesses and consumers. Headquartered in Novato, USA, IMSI produces and sells visual content, design, and graphics software over the Internet. TurboProject was originally launched in May 1996 whilst the current version, V4, was released in December 2000.

Website: http://www.imsisoft.com

2.12.2 Scheduling Capabilities
TurboProject v4 provides the capacity to store and analyse up to 32,000 activities per project and over 1000 projects can be analysed simultaneously (depending on the amount of memory available in the PC). Tasks can be stored using various timescales ranging from minutes to months and unlimited tasks can be assigned to an activity. Task information can be input into the schedule using a variety of views including Gantt chart and spreadsheet. Should task data be amended, the critical path is re-calculated and displayed in real time.

TurboProject supports an unlimited number of breakdown structures including WBS, OBS and RBS. These structures can also be user defined to allow for customisation. In addition, tasks can be split and divided so as to simplify any tasks that happen on a recurring basis.

2.12.3 Export Capabilities
Activity and resource information can be imported and exported into TurboProject using the Microsoft Project database (MPD) file format. Schedule information can also be transferred to and from the schedule using database file formats. TurboProject supports all ODBC database formats enabling the exchange and storage of data. There also exists a direct link from TurboProject to Microsoft Excel. Using this, information can be exported into spreadsheet format whilst the exported information can be customised, allowing specific data to be exchanged.

No provision exists within TurboProject for the dynamic exchange of data using OLE technology. The software also does not contain an API, however provision is made for schedule information to be distributed using e-mail via a MAPI compliant e-mail module.

2.12.4 System requirements
TurboProject can run in client or server mode. The operating system required for the software to operate under client mode is Microsoft Windows 95, however it will operate using Windows 98, ME, NT or 2000. The minimum hardware requirement for the software is a Pentium 266 class processor with 64MB RAM and 22MB hard disk space.
2.12.5 Summary

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<tr>
<td>No. of resources</td>
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<tr>
<td>Supported databases</td>
<td>ODBC</td>
</tr>
<tr>
<td>Supports OLE</td>
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</tr>
<tr>
<td>Application programming Interface</td>
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</tr>
<tr>
<td>Programming language</td>
<td>N</td>
</tr>
</tbody>
</table>
2.13 Discussions and summary

This section of the report has presented a review of twelve project planning software packages with the capability to undertake a critical path analysis on a construction schedule. Each of the packages is currently available and provides varying technical capabilities.

The scheduling capability of each of the packages varies, allowing various ranges of tasks and resources to be specified in one project. Some of the packages reviewed provide the planner with the capability to schedule unlimited tasks whilst using an unlimited number of resources from a central resource pool. Additionally some of the packages reviewed allow multiple projects to be linked together forming a ‘multiproject’ where numerous schedules can be combined and analysed for critical path. This concept of using multiple projects could provide a useful capability for the construction industry as it facilitates numerous schedules (that could be provided by various subcontractors) to be included in the main project program.

Most of the software packages provide the ability to update the schedule in real time as the tasks are updated. As task data is varied the critical path or paths are calculated and displayed to the planner.

Interoperation with other software packages is a further area of interest to VIRCON. The basis of the VIRCON system is modular and will require the seamless interoperation of each of the software packages used. For this reason the accurate exchange of data is essential. As highlighted in the review most packages now use the Microsoft Project MPX file format to exchange schedule data whilst some are now using the Microsoft Project MPD file format. These file formats allow for data to be exchanged with relatively small loss of data, however this is reliant on a de-facto method of data exchange that could be viewed as disadvantage as it is reliant on the Microsoft standard.

Another method of data exchange is the capability to export schedule information into database format. This is most significant for the VIRCON as the outline configuration of VIRCON utilises database technology to facilitate the transfer of construction and spatial data and link this to the temporal aspect. Most packages provide the ability to export directly into database format using the ODBC format specification. Other packages allow the exporting of information using standard text files that can then be imported into database software packages. During the exporting process some of the reviewed software allows the provision for the planner to customise the information to be transferred. This allows for only specific information to be transferred and eliminates the transfer of redundant data.
3.0 SOFTWARE SELECTION FOR THE VIRTUAL CONSTRUCTION SITE

3.1 Software Shortlist
Previous research (Kelsey et al., 2001) has demonstrated that at the present time there is no standard CPA software package that is used widely within the construction industry. The planning package used varies between companies.

Using the software technical information a specification grid was compiled that presents the functional capabilities for each of the packages reviewed in the previous section. For each of the packages reviewed twelve functions were compared in order to create a representative comparison of the software capabilities. The functions that were compared were:

1. **Can the software perform critical path calculations?**
   For the planning software to be used in the VCS system, it must provide the capability to perform Critical Path Calculations

2. **How many Work Breakdown Structures (WBS) are possible?**
   Work Breakdown Structures are vital for the successful organisation of a construction schedule, allowing work packages to be assigned to activities.

3. **Can the user customise the WBS?**
   The ability for the user to customise the WBS facilitates more control over the schedule of activities.

4. **The maximum number of tasks that can be analysed**
   Limiting the number of tasks that can be analysed constricts the construction schedule.

5. **The maximum number of resources that can be allocated in a schedule**
   Allowing more resources to be allocated to a project provides more control over the construction schedule. Due to the number of diverse trades operating during the construction phase, numerous resources are used.

6. **The ability to schedule simultaneous projects**
   Providing the ability to link schedules and analyse ‘multiproject’ allows for many schedule to be combined and analysed, for example main and sub contractor’s schedules.

7. **Can Microsoft MPX file format be used to Import/Export?**
   Microsoft has produced the ‘de-facto’ exchange file format (MPX) for schedule information that is becoming widely diffused and adopted.

8. **Can Microsoft MPD file format be used to Import/Export?**
   Following the MPX file format a further ‘de-facto’ standard has been produced known as the Microsoft Project Database. This format is recognised as being more comprehensive than the MPX format by allowing more schedule information to be exchanged.

9. **Is the software ODBC compatible?**
   The exporting of information into database format is a most useful aspect of planning tools. Exporting information to databases allows for schedule information to be used in other applications for example costing. The exporting of schedule data into a database format is critical to the successful operation of the VIRCON system. Open Data Base Connectivity ensures that schedule information can be read by numerous database formats.
10. **If exporting to database format, can the exported data be customised?**

   Exporting information to the database format can produce an assortment of information, some of which may not be relevant to the functions required of the schedule data. The ability to customise the exported data provides the facility to extract only the required information from the project schedule.

11. **Does the software provide the ability to use OLE technology?**

   OLE is a relatively new technology that allows the dynamic exchange of data with other OLE applications. Using OLE allows for information updated in one application to be viewed and used immediately in another application.

12. **Does the software have an Application Programming Interface?**

   The provision of an Application Programming Interface allows for the easy development of additional components to the software. In addition the package can be customised.

For each of the results obtained for the above specification a scoring system was adopted relating to the capabilities of the software. The scoring system is defined in Table 1.
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Specifications</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q. 1 (i)</td>
<td>Can analyse Critical Path</td>
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</tr>
<tr>
<td></td>
<td>(ii) Cannot analyse Critical Path</td>
<td>0</td>
</tr>
<tr>
<td>Q. 2 (i)</td>
<td>0-100 WBS allowed</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>(ii) 100-1000 WBS allowed</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td>(iii) Over 1000 WBS allowed</td>
<td>10</td>
</tr>
<tr>
<td>Q. 3 (i)</td>
<td>WBS can be User-Defined</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>(ii) WBS cannot be User-Defined</td>
<td>0</td>
</tr>
<tr>
<td>Q. 4 (i)</td>
<td>0-20000 Tasks Allowed</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>(ii) 20000-100000 Tasks Allowed</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td>(iii) Over 100000 Tasks Allowed</td>
<td>10</td>
</tr>
<tr>
<td>Q. 5 (i)</td>
<td>0-20000 Resources Allowed</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>(ii) 20000-100000 Resources Allowed</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td>(iii) Over 100000 Resources Allowed</td>
<td>10</td>
</tr>
<tr>
<td>Q. 6 (i)</td>
<td>0-1000 Simultaneous Projects Allowed</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(ii) Over 1000 Simultaneous Projects Allowed</td>
<td>10</td>
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<tr>
<td>Q. 7</td>
<td>Data can be exchanged into MPX format</td>
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<tr>
<td>Q. 8</td>
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<td></td>
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</tr>
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<td>Q. 11</td>
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<tr>
<td>Q. 12</td>
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<tr>
<td></td>
<td>Software has no API</td>
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</table>

Table 1: Benchmark data for software testing

Using the above specifications and scoring system a grid was compiled that presented an overall score for the software package. The grid can be seen in Table 2.
<table>
<thead>
<tr>
<th>Software Package</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
<th>Q9</th>
<th>Q10</th>
<th>Q11</th>
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<td>Realtime Projects</td>
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<td>n</td>
<td>y</td>
<td>y</td>
<td>n</td>
<td>y</td>
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<td>y</td>
<td>n</td>
<td>y</td>
<td>n</td>
<td>y</td>
<td>y</td>
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</tr>
<tr>
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<td>y</td>
<td>unlim</td>
<td>y</td>
<td>unlim</td>
<td>Unlim</td>
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<td>y</td>
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<td>y</td>
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<td>y</td>
<td>15000</td>
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<td>50</td>
<td>y</td>
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<td>unlim</td>
<td>Unlim</td>
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<td>n</td>
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<tr>
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<td>unlim</td>
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<td>16000</td>
<td>Unlim</td>
<td>unlim</td>
<td>y</td>
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<td>y</td>
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<td>unlim</td>
<td>Unlim</td>
<td>unlim</td>
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<td>y</td>
<td>100000</td>
<td>Unlim</td>
<td>unlim</td>
<td>y</td>
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<tr>
<td>Turbo Project</td>
<td>y</td>
<td>unlim</td>
<td>y</td>
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<td>32000</td>
<td>1000</td>
<td>y</td>
<td>y</td>
<td>y</td>
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<td>n</td>
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</table>

Table 2: Software Functionality Grid

The result of undertaking this technical survey demonstrated the variation in functionality of existing CPA project planning software. The resulting graph (seen in Figure 1) shows that Microsoft Project provides the most serviceable software for planning followed by PowerProject and Primavera.

3.2 Software selection method

The results of the survey carried out (shown above), demonstrate that software packages present the ability to undertake a range of tasks with varying degrees of efficiency. From the results it can be seen that Microsoft Project, PowerProject and Primavera present the greatest functionality out of the packages reviewed.

During preliminary review work of the VIRCON project, an investigation was undertaken to ascertain the planning software used by construction planners. This
review involved interviewing construction planners from major UK contractor organisations. The results demonstrated that Microsoft Project, Primavera and PowerProject are amongst the most popular used by contractors.

Due to the ranking of these software packages, and the results of previous research that has demonstrated that Microsoft Project, PowerProject and Primavera are widely used, these systems can be short-listed for potential use in the VIRCON. These three packages demonstrate potential technical capability to be used as an integral part of the system, in addition to being identified as widely used by UK contractors.

Each of the packages chosen provides critical path analysis with the ability to schedule unlimited tasks. In addition, all support the exchange of data in database format, whilst using ODBC technology to ensure interoperation with database systems. Due to the database being the central component of the VIRCON framework, this is essential. These packages also allow for database information to be exported using customised maps, allowing the planner to export only prudent temporal information without generating numerous records.
4.0 DETAIL SPECIFICATION OF SHORTLISTED SOFTWARE

In order to establish detailed information about the each of the short-listed scheduling software packages, contact was made with the developers. These interviews provided more in depth detail about the planning software whilst also providing insight into potential future developments of the software that could affect the VIRCON system. Due to the nature of the subject not all of the detail regarding future developments was made available by the software developers, as these enhancements are subject to confidentiality.

4.1 Developer’s questionnaire

In order to ascertain direct information from the software developers regarding the technical capabilities and limitations of the CPA software a questionnaire was devised. The purpose of the questionnaire was to obtain accurate technical specifications whilst acquiring information relating to possible future developments of the planning software packages.

The questionnaire was divided into 3 sections, each representing various aspects of the planning process. The first section concentrated on the technical capabilities of the software package. This section obtained information relating to the varying constraints of the package. Additionally, information pertaining to application programming interfaces and the capabilities of the software to interact with the World Wide Web was obtained.

The second section of the questionnaire reviews connectivity issues associated with the software package. This section investigates the possibility of exporting schedule information directly with database file formats, as well as obtaining information relating to the customisation of the exported information. This section also requests details of data exchange formats that may be utilised in future versions of the software and may affect the transfer of information within the VIRCON system.

The final section of the questionnaire reviews spatial aspects of the planning process. At present 4D simulations provide methods to link temporal information to 3D objects (reviewed in Volumes 1 and 3 of this report) however, should this ability be available within CPA software packages, producing these simulations would become effortless. In addition the ability to specify space as a resource during the planning process would be beneficial. At present resources can be specified during the planning stage within the software, however the ability to specify space in the planning software could facilitate easier operation of the VIRCON system. The results of the questionnaire can be found in Appendix B of this report.

4.2 Known Future Developments

In order to ascertain how the VIRCON system may interact with future versions of the short listed software, information was requested regarding possible future developments. The issue of data exchange is one of great importance to the construction industry in particular. This has been highlighted by work such as that undertaken by the International Alliance for Interoperability reviewed further in Volume 3 of this report. Information was requested in the questionnaire as to whether further developments would be made to assist the exchange of scheduling data.
As highlighted in Volumes 1 and 3 of this report, 4D CAD simulations are becoming rapidly diffused throughout the construction industry and are becoming a commercially viable tool to assist the project planning process. Recently, various CAD vendors have developed software packages that provide the ability to link drawing objects to activity schedules. In order to ascertain how this area may progress in the future, information was requested that stated if it was possible to link temporal data with 3D drawing objects via the planning software.

The main aim of the VIRCON is to assess space usage on the construction site and analyse potential spatial conflicts. The space required to undertake a construction activity can be viewed as a resource required for the successful completion of the activity. Should space be included as a resource in future developments of the CPA software, this could greatly enhance the VIRCON system. This would allow planners to assign space as an integral part of their resource and temporal scheduling.

4.2.1 Microsoft Project Future Developments
Microsoft Project achieved the highest score in the functionality testing that was undertaken (described in the previous section). Previous research has also shown that Microsoft Project is currently the most widely diffused planning software package with an estimated user base of 5 million people (Microsoft, 2000).

A questionnaire was issued to Microsoft and the responses can be viewed in Appendix B of this report. Information was provided from Microsoft relating to the technical capabilities of the software package at present. However, no information was provided relating to potential future developments of Microsoft Project as these were classed as confidential and could not be discussed prior to the release of new software.

4.2.2 PowerProject Future Developments
Currently PowerProject is the second highest ranked planning package according to the methods used in the previous section. From research carried out in previous studies earlier in the VIRCON program (Kelsey et al, 2001), it is concluded that PowerProject is utilised by construction planners scheduling small to medium sized construction projects.

The responses received from the developers of PowerProject demonstrate that potential future development could be in the area of data exchange and transfer. The possibility of utilising the eXtensible Markup Language (XML) could provide further functionality in future versions of the software, allowing greater data transfer facilities. This could be used in conjunction with the work being undertaken to develop the Industry Foundation Classes (IFC’s) discussed in Volume 3 of this report.

Future developments of the software will also include the capability to utilise ActiveX Data Objects (ADO) to provide high-performance access to virtually any source of data.

No plans are envisaged for a facility to provide a link between 3D objects and the schedule data via the PowerProject engine and no future plans are imminent for the addition of space as a resource to construction tasks. The responses from the questionnaire do however highlight the potential to undertake some of the functions...
using the customisable data tables that can be exported from PowerProject. These can be used in conjunction with the VBA interface to compile links and customisation.

4.2.3 Primavera Future Developments
At present Primavera is rated third behind Microsoft Project and PowerProject. The main reason for this is its limitation on Work Breakdown structures allowed within a project and the limitation of 100000 tasks per project.

No responses were given relating to the future of data exchange of Primavera schedule information. At the present time Primavera can exchange data seamlessly using CSV, MPX and ODBC file formats. No details were given regarding the extension of the file formats to incorporate emerging standard of data exchange such as XML.

No responses were provided by Primavera that suggested future developments of the software would take into account the ability to link 3D objects to the schedule data via the Primavera interface. Additionally no future developments were planned to enhance the resource options with the addition of space usage by resource.
5.0 CONCLUSIONS AND RECOMMENDATIONS

This report has provided an in depth review of currently available project planning software that provides the ability to undertake the critical path analysis of a construction project.

The first section of this report details an overall review of prominent project planning software packages that are available in the current commercial field. A detailed analysis was undertaken on each of the software packages identified to establish the practical limitations of the package and provide a quantitative analysis of the functions available.

A benchmark style scoring system was utilised to rank the twelve software packages reviewed in terms of their capabilities. The highest three performing packages were then short listed for possible inclusion as the Critical Path Analysis engine for the VIRCON system. The highest scoring was Microsoft Project followed by PowerProject and Primavera. Each of these packages has been identified in preliminary research (Kelsey et al., 2001) as being utilised by practitioners within the UK construction industry. The main reason for the high scoring of these packages was their ability to exchange data effectively with other software packages including databases and the provision within the software of an application-programming interface. This would facilitate easier development of add-on modules and customisation.

In order to determine the software that should be utilised during the development stages of the VIRCON project, other factors also have to be taken into account in addition to the technical capabilities discussed. The future developments have to be analysed to see if there may be potential conflicts with the VIRCON system and also the current diffusion of the software within the industry and worldwide should be reviewed.

In 1995, the user market for Microsoft Project was approximately 500,000 worldwide (Roberts, 1995) however this has expanded widely over recent years and Microsoft Project now has a user base of approximately 5 million users worldwide (Microsoft, 2000). Primavera currently estimate a worldwide usage of approximately 350,000 users (Stoddard, 2000) and the projected usage of PowerProject is approximately 30,000 users worldwide (Asta Developments, 2000).

Due to the technical capabilities of the software and also the large diffusion of the software it is recommended that Microsoft Project be utilised for the initial development of the VIRCON system. This software scored the highest in the functionality test but moreover has a considerably larger diffusion worldwide. The software provides the capability to undertake critical path analysis of a project program. Microsoft Project also has the capability to exchange data in numerous formats including support for various database structures including ODBC and this will assist the development of VIRCON. One disadvantage of the software is the inability to foresee potential problems due to future developments, as Microsoft withheld this information.
6.0 REFERENCES


7.0 APPENDIX A

Software review questionnaire issued to CPA software developers
The Virtual Construction Site  
Software Questionnaire

Background
The University of College London, University of Wolverhampton, University of Teesside and various industrial collaborators are currently developing a virtual construction site system (VIRCON) to address the space-time conflict of activities on construction sites. This project is funded by the Engineering and Physical Sciences Research Council (EPSRC) and industrial collaborators. It is planned that the VIRCON system will combine task schedule information in the form of CPM along with a developed Critical Space Analysis (CSA) tool to provide a space-time broker that will identify potential time-space conflicts before they occur and assist in providing a solution.

Aims
An integral part of the VIRCON system is the project planning software. This provides the temporal sequence of events, as they occur on the construction site. The aim of this questionnaire is to determine the software capabilities and how it would behave / interact with other aspects of the VIRCON system.

Instructions
The research team would be extremely grateful if you could assist in answering the following questions. Where necessary please provide details in the space provided.

Software Capabilities

a) Does the software have the capability to perform a full critical path analysis of a project program?
   Yes ☐ No ☐

b) What is the maximum number of activities that can be analysed by the software?
   0-2500 ☐ 2500-5000 ☐ 5000-7500 ☐ 7500-10000 ☐ >10000 ☐

c) Which method(s) can be used to input activities into the software?
   Spreadsheet ☐ PERT ☐ Bar Chart ☐ Other, (Please specify) ☐
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................

d) Can the project be accessed and edited by multiple users?
   Yes ☐ No ☐

e) If yes what is the maximum number of users per project.
   0-20 ☐ 20-40 ☐ 40-60 ☐ 60-80 ☐ >80 ☐
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................
f) Please select the planning software packages from which information can be directly linked?
- MS Project
- Primavera
- PERTMaster
- Microplanner-Xpert
- Powerproject
- CA-SuperProject
- Other (Please specify) ………………………………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………………………


g) Does the software have an API (Application Programmer's Interface) or scripting language that allows the easy development of add-on components?
- Yes ☐
- No ☐

h) If Yes, please detail the programming language and architecture used
……………………………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………………………


i) Does the software have in-built features for publishing reports/tables to the World Wide Web?
- Yes ☐
- No ☐

j) If Yes, please provide details
……………………………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………………………

Database connectivity

a) From which database packages can the software export / import data?
- Microsoft Access
- Dbase
- Oracle
- FoxPro
- Other (Please specify) ………………………………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………………………

b) When exporting to the database does the software provide a fixed export map or is it customisable by the user?
- Fixed ☐
- Customisable ☐
c) If fixed please specify the fields which are used?
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………

d) When exporting is there any field(s) that are specifically related to the Critical Path Analysis carried out by the software?
Yes ☐ No ☐

e) If yes please specify the names of these fields?
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………

f) Is the software Open Data Base Connectivity (ODBC) compliant?
Yes ☐ No ☐

g) If no are there plans to make it compliant in the future?
Yes ☐ No ☐

h) What other data exchange format does the software support
OLE ☐
CSV ☐
Microsoft Excel ☐
Microsoft Word ☐
XML ☐
MPX ☐
Other (Please specify)
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………

What are the plans for future developments in data exchange?
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………

Spatial Aspects

4 dimensional planning in the construction industry is the theory of linking the activities specified in the program to 3 dimensional objects produced in Computer Aided Design (CAD) or Virtual Reality (VR). This provides a visualisation of the project over time.

a) Does the software provide any support for linking the activities in the program to 3D objects?
Yes ☐ No ☐
b) If no, are there any plans to develop this area? Please give any details.
Yes □  No □
...........................................................................................................................................................
...........................................................................................................................................................
...........................................................................................................................................................

c) In a similar way to assigning resources to a particular task is it possible to assign execution space to an activity (i.e. the space required to undertake the activity)?
Yes □  No □

d) If no are there any plans to provide this facility in future versions of the software?
Yes □  No □
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...........................................................................................................................................................

Many thanks for your time and assistance in filling in this questionnaire.
8.0 APPENDIX B

Completed questionnaire responses for short listed CPA software packages
The Virtual Construction Site
Software Questionnaire

Background
The University of College London, University of Wolverhampton, University of Teesside and various industrial collaborators are currently developing a virtual construction site system (VIRCON) to address the space-time conflict of activities on construction sites. This project is funded by the Engineering and Physical Sciences Research Council (EPSRC) and industrial collaborators. It is planned that the VIRCON system will combine task schedule information in the form of CPM along with a developed Critical Space Analysis (CSA) tool to provide a space-time broker that will identify potential time-space conflicts before they occur and assist in providing a solution.

Aims
An integral part of the VIRCON system is the project planning software. This provides the temporal sequence of events, as they occur on the construction site. The aim of this questionnaire is to determine the software capabilities and how it would behave / interact with other aspects of the VIRCON system.

Instructions
The research team would be extremely grateful if you could assist in answering the following questions. Where necessary please provide details in the space provided.

Software Capabilities
a) Does the software have the capability to perform a full critical path analysis of a project program?
   Yes ☒ No ☐

b) What is the maximum number of activities that can be analysed by the software?
   0-2500 ☐ 2500-5000 ☐ 5000-7500 ☐ 7500-10000 ☐ >10000 ☒

c) Which method(s) can be used to input activities into the software?
   Spreadsheet ☒ PERT ☒ Bar Chart ☐ Other, (Please specify) ☐
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………

d) Can the project be accessed and edited by multiple users?
   Yes ☒ No ☐
e) If yes what is the maximum number of users per project.
0-20 □  20-40 □  40-60 □  60-80 □  >80 ☑  Unlimited

f) Please select the planning software packages from which information can be directly linked?
MS Project ☑
Primavera ☑
PERTMaster □
Microplanner-Xpert □
PowerProject □
CA-SuperProject □
Other (Please specify)
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

 g) Does the software have an API (Application Programmer's Interface) or scripting language that allows the easy development of add-on components?
Yes ☑  No □

h) If Yes, please detail the programming language and architecture used
Delphi, using ODBC connectivity

i) Does the software have in-built features for publishing reports/tables to the World Wide Web?
Yes ☑  No □

j) If Yes, please provide details
Reports and information can be published in HTML format for instant publishing to web pages

Database connectivity

k) From which database packages can the software export / import data?
Microsoft Access
Dbase □
Oracle ☑
FoxPro □
Other (Please specify)

Microsoft SQL, Interbase
l) When exporting to the database does the software provide a fixed export map or is it customisable by the user?
   Fixed ❌ Customisable ☑

m) If fixed please specify the fields which are used?
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................

n) When exporting is there any field(s) that are specifically related to the Critical Path Analysis carried out by the software?
   Yes ❌ No ☑

o) If yes please specify the names of these fields?
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................

p) Is the software Open Data Base Connectivity (ODBC) compliant?
   Yes ☑ No ❌

q) If no are there plans to make it compliant in the future?
   Yes ❌ No ☑

r) What other data exchange format does the software support
   OLE ❌
   CSV ☑
   Microsoft Excel ☑
   Microsoft Word ☑
   XML ❌
   MPX ❌
   Other (Please specify)
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................

What are the plans for future developments in data exchange?
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................

Spatial Aspects

4 dimensional planning in the construction industry is the theory of linking the activities specified in the program to 3 dimensional objects produced in Computer Aided Design (CAD) or Virtual Reality (VR). This provides a visualisation of the project over time.
s) Does the software provide any support for linking the activities in the program to 3D objects?
Yes □ No ☒

If no, are there any plans to develop this area? Please give any details.
Yes □ No ☒

u) In a similar way to assigning resources to a particular task is it possible to assign execution space to an activity (i.e. the space required to undertake the activity)?
Yes □ No ☒

If no are there any plans to provide this facility in future versions of the software?
Yes □ No ☒

Many thanks for your time and assistance in filling in this questionnaire.
The Virtual Construction Site
Software Questionnaire

Background
The University of College London, University of Wolverhampton, University of Teesside and various industrial collaborators are currently developing a virtual construction site system (VIRCON) to address the space-time conflict of activities on construction sites. This project is funded by the Engineering and Physical Sciences Research Council (EPSRC) and industrial collaborators. It is planned that the VIRCON system will combine task schedule information in the form of CPM along with a developed Critical Space Analysis (CSA) tool to provide a space-time broker that will identify potential time-space conflicts before they occur and assist in providing a solution.

Aims
An integral part of the VIRCON system is the project planning software. This provides the temporal sequence of events, as they occur on the construction site. The aim of this questionnaire is to determine the software capabilities and how it would behave / interact with other aspects of the VIRCON system.

Instructions
The research team would be extremely grateful if you could assist in answering the following questions. Where necessary please provide details in the space provided.

Software Capabilities
a) Does the software have the capability to perform a full critical path analysis of a project program?
   Yes ☒ No ☐

b) What is the maximum number of activities that can be analysed by the software?
   0-2500 ☐ 2500-5000 ☐ 5000-7500 ☐ 7500-10000 ☐ >10000 ☒

c) Which method(s) can be used to input activities into the software?
   Spreadsheet ☒ PERT ☒ Bar Chart ☒ Other, (Please specify) ☐
   ...........................................................................................................................
   ...........................................................................................................................
   ...........................................................................................................................

d) Can the project be accessed and edited by multiple users?
   Yes ☒ No ☐

e) If yes what is the maximum number of users per project?
   0-20 ☐ 20-40 ☐ 40-60 ☐ 60-80 ☐ >80 ☒
   ...........................................................................................................................
f) Please select the planning software packages from which information can be directly linked?

- MS Project
- Primavera
- PERTMaster
- Microplanner-Xpert
- PowerProject
- CA-SuperProject
- Other (Please specify)

*Can be linked to most planning software packages using either the Microsoft MPX or Microsoft MPD file formats.*

g) Does the software have an API (Application Programmer's Interface) or scripting language that allows the easy development of add-on components?

- Yes
- No

h) If Yes, please detail the programming language and architecture used

*The package makes use of Visual Basic for Applications (VBA) to allow for programming.*

i) Does the software have in-built features for publishing reports/tables to the World Wide Web?

- Yes
- No

j) If Yes, please provide details

*Information exported to HTML format can be customised using customisable tables therefore information can be controlled*

**Database connectivity**

k) From which database packages can the software export / import data?

- Microsoft Access
- Dbase
- Oracle
- FoxPro
- Other (Please specify)

l) When exporting to the database does the software provide a fixed export map or is it customisable by the user?

- Fixed
- Customisable

m) If fixed please specify the fields which are used?

n) When exporting is there any field(s) that are specifically related to the Critical Path Analysis carried out by the software?

- Yes
- No
o) If yes please specify the names of these fields?

Field name = Critical

p) Is the software Open Data Base Connectivity (ODBC) compliant?
Yes ☒ No ☐

q) If no are there plans to make it compliant in the future?
Yes ☐ No ☐

r) What other data exchange format does the software support

- OLE ☒
- CSV ☒
- Microsoft Excel ☒
- Microsoft Word ☐
- XML ☐
- MPX ☒
- Other (Please specify)

Microsoft Access, Microsoft Project Database (MPD)

What are the plans for future developments in data exchange?
NO RESPONSE

Spatial Aspects

4 dimensional planning in the construction industry is the theory of linking the activities specified in the program to 3 dimensional objects produced in Computer Aided Design (CAD) or Virtual Reality (VR). This provides a visualisation of the project over time.

s) Does the software provide any support for linking the activities in the program to 3D objects?
Yes ☐ No ☒

NO RESPONSE

t) If no, are there any plans to develop this area? Please give any details.
Yes ☐ No ☒

NO RESPONSE

u) In a similar way to assigning resources to a particular task is it possible to assign execution space to an activity (i.e. the space required to undertake the activity)?
Yes ☐ No ☒

NO RESPONSE
v) If no are there any plans to provide this facility in future versions of the software?
Yes ☐ No ☐

**NO RESPONSE**

Many thanks for your time and assistance in filling in this questionnaire.
Background
The University of College London, University of Wolverhampton, University of Teesside and various industrial collaborators are currently developing a virtual construction site system (VIRCON) to address the space-time conflict of activities on construction sites. This project is funded by the Engineering and Physical Sciences Research Council (EPSRC) and industrial collaborators. It is planned that the VIRCON system will combine task schedule information in the form of CPM along with a developed Critical Space Analysis (CSA) tool to provide a space-time broker that will identify potential time-space conflicts before they occur and assist in providing a solution.

Aims
An integral part of the VIRCON system is the project planning software. This provides the temporal sequence of events, as they occur on the construction site. The aim of this questionnaire is to determine the software capabilities and how it would behave / interact with other aspects of the VIRCON system.

Instructions
The research team would be extremely grateful if you could assist in answering the following questions. Where necessary please provide details in the space provided.

Software Capabilities

a) Does the software have the capability to perform a full critical path analysis of a project program?
   Yes ☒ No ☐

b) What is the maximum number of activities that can be analysed by the software?
   0-2500 ☐ 2500-5000 ☐ 5000-7500 ☐ 7500-10000 ☐ >10000 ☒

c) Which method(s) can be used to input activities into the software?
   Spreadsheet ☒ PERT ☐ Bar Chart ☐ Other, (Please specify) ☒

   Full support of VBA allows users to write their own UI. Import from Excel, Word and structured text files (CSV) is also possible to create tasks.

d) Can the project be accessed and edited by multiple users?
   Yes ☒ No ☐
e) If yes what is the maximum number of users per project.
0-20 □ 20-40 □ 40-60 □ 60-80 □ >80 □

f) Please select the planning software packages from which information can be directly linked?
MS Project □
Primavera □
PERTMaster □
Microplanner-Xpert □
PowerProject □
CA-SuperProject □
Other (Please specify)


g) Does the software have an API (Application Programmer’s Interface) or scripting language that allows the easy development of add-on components?
Yes □ No □

h) If Yes, please detail the programming language and architecture used

Program has built in VBA allowing users full access to the business objects. We also provide a developer’s toolkit which is essentially the product without the API – this allows full client/server application building with complete support for all the products business objects. Complete extensibility is possible.

i) Does the software have in-built features for publishing reports/tables to the World Wide Web?
Yes □ No □

j) If Yes, please provide details

Asta has a read-only web based project viewer as a separate product. Also the main product will export to HTML for publishing. In addition we have a web based timesheet for project members to view tasks and report progress.
Database connectivity

k) From which database packages can the software export / import data?
- Microsoft Access
- Dbase
- Oracle
- FoxPro
- Other (Please specify)

Product using DAO (and shortly ADO) allowing complete connectivity via ODBC driver compatible databases – SQL server for example.

l) When exporting to the database does the software provide a fixed export map or is it customisable by the user?
- Fixed
- Customisable

m) If fixed please specify the fields which are used?

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n) When exporting is there any field(s) that are specifically related to the Critical Path Analysis carried out by the software?
- Yes
- No

o) If yes please specify the names of these fields?

We run on all the databases natively so our full object content is available.

p) Is the software Open Data Base Connectivity (ODBC) compliant?
- Yes
- No

q) If no are there plans to make it compliant in the future?
- Yes
- No

r) What other data exchange format does the software support
- OLE
- CSV
- Microsoft Excel
- Microsoft Word
- XML
- MPX
- Other (Please specify)

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s) What are the plans for future developments in data exchange?

XML possibly – not definite – driven by user and market requirements.

Spatial Aspects

4 dimensional planning in the construction industry is the theory of linking the activities specified in the program to 3 dimensional objects produced in Computer Aided Design (CAD) or Virtual Reality (VR). This provides a visualisation of the project over time.

t) Does the software provide any support for linking the activities in the program to 3D objects?
Yes ☐ No ☒

u) If no, are there any plans to develop this area? Please give any details.
Yes ☐ No ☐

Our database tables are all user customisable and hence can be extended to include any user data – combined with the VBA and our OCX this allows all these types of links to be written

v) In a similar way to assigning resources to a particular task is it possible to assign execution space to an activity (i.e. the space required to undertake the activity)?
Yes ☐ No ☒

w) If no are there any plans to provide this facility in future versions of the software?
Yes ☐ No ☒

My comments above are equally valid – our data and UI is so customisable that almost anything can be seamlessly added as and when needed.

Many thanks for your time and assistance in filling in this questionnaire.
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