Dynamic project control utilizing a new approach to project control

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A new system has been developed for dynamic project management and control known as Planning Orientated Evaluation Methods (POEM) which has been considered as a core project evaluation system incorporating cost and time analysts. The performance control gives the manager a direct influence on the project completion date and rate of spend.

Keywords: project planning, financial analysis, CIB Montreal

Introduction

The fundamental principles associated with the development of network-based project management control systems have remained largely unchanged since the 1950s. This has resulted in the proliferation of computer software which does not meet the needs of the project manager. As a consequence, planning specialists are required to prepare and monitor project programmes, utilizing one of the many software packages available. Hence the project manager and the project planner must have the ability to achieve a high level of communication relating to complex processes and decisions in order that the project programme can be used as an effective management tool [2].

Difficulties exist with the preparation of the network programme and the considerable amount of data input which is both time consuming and to some extent error prone. This situation does not assist those project managers who wish to examine the effect of adopting different courses of action in order to select the best solution to a problem. In addition, the monitoring and updating process is too slow and the facility to predict outcomes only exists in a very limited number of packages. Although development is progressing at the current time, there is no effective commercial project management system which utilizes a knowledge base to determine construction methods, work sequences and the allocation of resources.

Research aim and objectives

The aim of the research is to develop a powerful project planning and management system which will allow the project manager to undertake full planning and monitoring of the project as part of the management and decision-making function. The planning and management system proposed is based on a powerful personal computer running under MS DOS. Software is written in 'C' and Clipper 5, but this is subject to review.

The prime objective is that the system allows for project programmes to be prepared on screen by the project manager utilizing libraries of standard data relating to the activity breakdown of the project.

Project activities are presented in a hierarchical framework which permits the preparation of a timescaled network analysis with automatic activity numbering. Hence the user simply schedules the project

activities and indicates the dependencies with a mouse. Up to 99 links can be made for any one activity. Dependent links between activities can be made based on either percentage completion or percentage expenditure. In this manner the rate of progress or expenditure can be plotted for each activity and for the project as a whole.

Another objective associated with the above methodology is to provide interactive planning and control which allows the manager to iterate solutions to project-based problems at sufficient speed to meet the dynamic demands of the project. This has been further developed by the production of a prototype which incorporates risk analysis based on selected milestones and overall project completion, together with the production of a criticality index [3].

Development and concepts associated with the planning orientated evaluation method (POEM)

The prototype developed to test and validate the principles and concepts referred to above has established the feasibility and practicality of an on-screen interactive planning and control system utilizing existing PC hardware and operating systems [5]. A major problem has been the amount of information which can be shown on screen at any one time. This is particularly relevant to the introduction of zooming, scrolling the screen and changing the timescale. However, it is intended to provide a navigation system to show the user at any time which part of the overall project programme is being analysed. One way of achieving this is to trace the earliest and latest start sequence, together with the critical path and that part of the programme currently under consideration being shown in a box.

Cost optimization is seen to be an optional feature of POEM whereby the resource allocated project programme can be expedited step by step to an optimal solution in accordance with the determined criteria. It is intended that the optimization process will be controlled by a heuristic algorithm. The function of the selected algorithm will be in accordance with determined normal and crash activity times, together with their respective cost slopes.

Resource scheduling will be supported by POEM in two stages. Firstly, the incorporation of constraints when allocating resources to individual activities and the determination of links between activities. Secondly, the rescheduling or spreading of float activities together with complete manipulation of the programme and the introduction of target starts and completions. In this manner the issues and problems directly relevant to the project will be properly accounted for and several iterations may be needed before a solution is found. Theoretical pool limit rescheduling is not seen as an ideal solution to the majority of resources scheduling problems, but it is accepted that this approach might be useful in a limited number of applications. It is therefore proposed to include this as an optional feature where appropriate in order to establish resource utilization factors.

A further extension is envisaged to provide multi-project scheduling for those clients requiring a number of projects to be procured at the same time. The prime use of this facility is considered to be in the area of cash flow analysis, but other critical resources will also be handled by the system. Up to ten links will be allowed between projects and the individual project schedules will be utilized to provide the master schedule. In cases where more than ten links are required the

programme will be treated as a `Superproject' with the first level of breakdown representing individual projects.

The implementation of risk analysis is based on the application of Monte Carlo Simulation and the user is required to make use of experience to assess the probability of achieving a range of completion times or element cost. This is achieved by assigning two point estimates (minimum and maximum) and selecting one of the pre-determined probability density functions [1]: Normal, Regular 'S', Optimistic, Pessimistic and Even, together with a user defined option which enables the user to model alternative distributions graphically utilizing a mouse. The advantage over PERT is that a whole range of possibilities can be taken into account and the user has complete freedom in selecting probabilities [6].

A random number seed generator is built into the software with a consequence that each run will be unique. The accumulation of simulation runs will produce a distribution of results which can be subject to statistical analysis utilizing measures of central tendency. This can be undertaken for the final project completion, or it might relate to any intermediate point in the completion of the project. The selection of random outcomes relating to activity times causes a variation in the critical path. Such a variation may be limited, but in circumstances where there are many near critical paths, there will be a considerable variation in the route that the critical path takes. Consequently, the criticality index becomes an important factor in assessing the influence of non-critical activities as the project progresses. The system also features 'Hot Path' analysis to quantify the likely occurrence of all possible critical paths and display them graphically along the original program plan.

POEM Version 1 has been developed as a core project evaluation system incorporating cost and time analysis. It has been further developed to provide a system for target cost reimbursable contract cost and progress control. The system supports cost and progress recording, control, management overview and reporting. It supports strict financial and progress control throughout the project and aids the final out-turn costs. The performance control gives the manager a direct influence upon the project completion date and rate of spend.

Progress is recorded and reflected on trend analysis. The featured 'what if' dynamics permits structured scenario modelling on different categories of activities and thus facilitates the achievement of the optimum project plan. An heuristic algorithm was adopted to expedite a section of a project within an 'acceleration window', thus providing a solution to the dynamic environment of projects. Activities and their expedited durations are evaluated by the system so that specific target deadlines could be achieved when progress slips behind.

Modules relate to: Programme, Labour, Materials, Plant, Supervision, Sub-Contractors, Asset Realization, Variation Schedules and Cash Flow Forecasting.

It is envisaged that a number of versions of POEM will be developed to meet particular user requirements. The underlying principle is that the system will offer a `no nonsense' implementation designed to optimize the input, effort and time committed by the user, The options described will form the basis of the standard system, but it is anticipated that the needs of individual users can be accommodated by adding to, or amending the basic software.

The human-computer interface (HCI)

Considerable attention is being given to the development of the human—computer interface and the ability of the system to meet the natural needs of the project manager in the decision-making process. This implies that information displayed by the system is comprehensive and clear, in a form which will support the decision-making process.

Because the system is being actuated through a screen capable of presenting limited information at any one time, considerable attention is being given to movement and navigation. Hence the principle of consistency is paramount in the design, coupled with logical development and the absence of irrelevant actions and procedures.

Attention is also being concentrated on the input and output of data, together with the presentation of information. The most important feature of the system is the graphics screen which must produce reactions by the user which will ensure efficient use of the system in achieving the objectives. The system must also be easy to use and although the instructions will be fully documented, there will be adequate help screens to provide the user with immediate answers to problems and queries.

The proposed POEM knowledge base

Concurrent with the final development of the system will be the incorporation of a knowledge base to determine forecasts of costs and durations relating to activities and cost centres. Much information already exists in the form of published data, construction indices and company based information in both quantitative and qualitative forms. Unfortunately because there is a general lack of facility to conserve knowledge and research relating to individual projects, this is often lost once the initial project demand of the task has been fulfilled. A means needs to be established where this knowledge is captured and stored in such a manner that it can be readily recalled to assist the determination of future project methodologies and plants [4].

The research will concentrate on the most appropriate means of constructing a knowledge base which can be interrogated by the project manager in order to facilitate initially the formulation of adequate project plans and subsequently the efficient monitoring and control of the project.

Conclusion

The research previously conducted has provided the basis for the development of a prototype which has fully tested the methodologies and supporting algorithms. It has been proved that the planning process can be simplified to allow dynamic interaction between the manager of the project and the system software without the need for an expert planning engineer. Further, the dynamic nature of the system allows the project manager to adopt a 'what if' approach, otherwise unsurpassed by software currently available. The effect of decisions relating to the construction methodology and the rescheduling of activities, or the allocation of resources can be readily appreciated before a final selection is made, The facilities incorporating cost optimization and risk analysis will also add to the ability of the system to approach ultimate project management decision making.

Finally, it is anticipated that the financial analysis developed in POEM Version I will be further enhanced to incorporate development

feasibility, multi-project evaluation and financial outcome predictions.

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