

Comparing resource scheduling in project management packages

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**Comparing Resource Scheduling
in
Project Management Packages**

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Abstract

A survey is given of project management packages running on mainframes, mini's and micro's. The results produced by the packages differed a lot even if they use the same standard techniques.

The prime aim of the study was to compare the resource scheduling efficiencies of the packages only, but it turned out that inputting one and the same network in different packages, gave different network planning results. Hence, before resource scheduling efficiencies could be compared, the network inputs to the different packages had to be adapted to obtain equal results prior to scheduling.

In resource scheduling itself it appeared that packages using, according to their user's manuals, identical scheduling techniques gave different results.

A technique for (Extended) Time Limited resource scheduling is presented that performs better than the standard techniques offered by the packages.

Finally, some observations are made about the lack of uniformity in the various packages and the use of micro's in this field.

1. The case

The case was developed during an investigation carried out by a student for his master's thesis and concerned with the maintenance of a regenerator in an oil refinery [1]. Although the network is small it is representative. The problem was solved on an in-house developed Project Management-system which was based on the extended metra potential method (EMPM) [2].

The network contained 45 activities and 72 relations of which 30

were of the type start-start, or end-end, as the result of the use of parallel chains of activities in order to minimize the number of activities, while maintaining the validity of the model. Furthermore there were two different resources. The time periods used were four hours long. The maintenance was carried out under continuous work.

2. The packages

The above mentioned case was inputted into five packages on main/mini-frames and three packages on micro's (table 2.1). The packages MAPPS and PACIII are currently considered.

table 2.1

Package	Frame	Supplier
ANNETTE	B7900	Eindhoven University of Technology
APECS	DEC10	Automatic Data Processing (ADP)
ARTEMIS	HP1000	Metier Management Systems
ARTEMIS-PC	IBM-XT	idem.
MAPPS	VAX 11/750	Mitchell Management Systems
PACIII	VAX 11/750	AGS Management Systems Inc.
QUICKPLAN	IBM-XT	Mitchell Management Systems
QWIKNET	IBM-XT	Project Software & Development Inc.

On all packages we used the precedence method. The packages for micro's can be run on IBM compatible machines.

3. Adaptation of the network for different packages

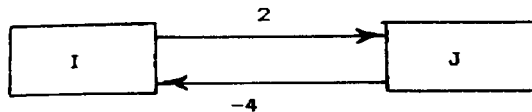
3.1 EMPM versus precedence

As the original model has been set up using the EMPM method, we had to change the model in the following way :

-the variable activity durations had to become fixed .

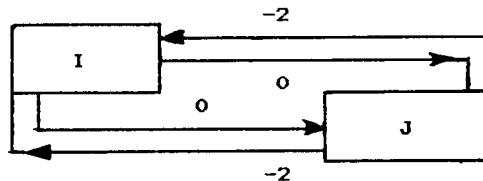
In order to get the smallest project duration, the activity durations have been set by the EMPM method for calculating durations.

-loops had to be eliminated : for example, in EMPM the following construction is possible:



this means that activity J must start between period 2 and 4 after the end of I.

The following structure did actually occur in the case:



this means that activity J must start within the first two periods after the start of I and the completion times of the activities are similarly linked. This problem was solved by concatenation of I and J, but this gave rise to an inhomogeneous resource distribution. Not all packages could handle this problem.

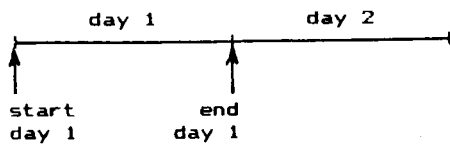
3.2 Differences in calendars

One package had no calendars at all and worked only with periods from zero on. Other packages had the option of working in time periods of minutes, hours, days, weeks, a.s.o. None of the packages could work with a time period of four hours. Thus it was necessary to use periods, if possible, and if not days as being equivalent to a period of four hours.

3.3 Differences in starting and ending times

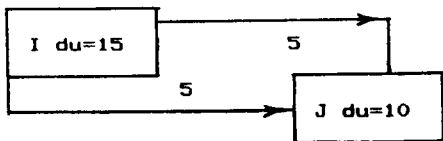
Packages differed in their handling of the starting and ending times of a time period. For example, for an activity with a duration of one time period and a target start of day one,

some packages gave day two as the finish instead of day one.



3.4 Differences in earliest starts

When the following situation occurs:



the earliest and latest starts of I and J should be as follows:

	e.s.	l.s.	target start
activity I	1	1	1
activity J	11	11	

In two packages however the e.s. of activity J was equal to 6. The e.s. of activity J however can be lower than 11 only when it is possible to "split-up" activity J.

As a result of the above mentioned differences, different project durations were obtained which had to be adapted prior to scheduling.

4. Scheduling

As the aim of the investigation was to compare scheduling efficiencies, great care had to be taken of the above mentioned differences to make sure that the same starting model was used, not only in terms of activities and relations, but also in earliest and latest starts, finishes and floats. The in-house built package had no options for automatic

resource scheduling, but gives the user the ability to interact with the resource schedule. The philosophy of the designers of the system was at that time (the late sixties), that as all models and so project-planning models too, are incomplete reproductions of the real world, the project planner with his specific know-how would be better off with an interactive resource scheduling approach rather than an automatic scheduling heuristic.

In my opinion, non-automatic interactive resource scheduling is a good method when dealing with small networks, say under 100 activities and 5 resources, but for large networks, with many resources, it is too time consuming. In that case the planner will be better off with flexible automatic procedures to investigate different approaches.

When resources are to be scheduled one must decide whether the project is time constrained or resource constrained. If the project duration (time) is fixed, resources must be flexible; if resources are fixed, project duration must be flexible.

4.1 Time constrained scheduling

Theoretically it is assumed that resources are unlimited. The scheduling problem is one of reducing the peak level of resources required and reducing the fluctuations in the resource demand. This is called *smoothing*. In practice most of the problems are solved with the so called *levelling method*. This means that levels of resources are set over the fixed project duration and the heuristic then tries to schedule the non-critical activities so that these levels are not violated.

For this investigation the levelling method was used, as most of the packages could handle this method. Furthermore an alternative, the so called *extended time limited scheduling* was used, where it is possible to postpone the project end by a given amount of time.

4.2 Resource Constrained Scheduling

The objective here is to minimize project duration without exceeding the set resource limits. Again there are two different methods, namely the *serial* and the *parallel method*.

The serial method schedules activities one at a time from an ordered priority-list, the parallel method schedules on a time period by time period basis, and in each time period only the activities that are eligible for scheduling are considered. Most packages only handle the serial approach and so this was the method used in the investigation.

4.3 The "Down-hill" planning method.

An algorithm that performs better in time limited and extended time limited problems is the following.

The standard technique in scheduling activities is to, first, sort them in ascending order of earliest start, total float, duration and record number and second, schedule them in this order. When the bottom of the list is reached the scheduler returns to the top of the list and repeats the scheduling for those activities which have not yet been scheduled

When a peak demand of resources occurs and the activities also have small floats, then the problem can be termed one of "Up-hill" planning. For example, if activity 1 (see figure 4.3.1) requires scheduling but only has a small float, then it cannot be scheduled without exceeding the availability level.

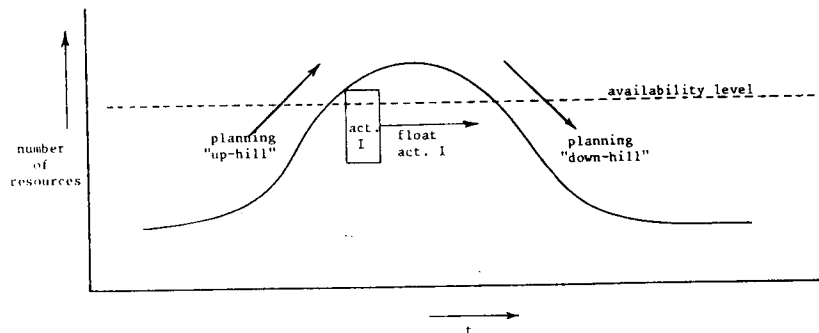


fig. 4.3.1: up-hill versus down-hill planning.

When scheduling is carried out the other way around, namely in the reverse order, that is taking pieces from the back of the

peak by delaying an activity over its float, then the problem can be termed "down-hill" planning.

In addition activities are delayed which do not have an insufficiency of resource availability, because this too can lead to improvements. The example given in fig. 4.3.2 will show this.

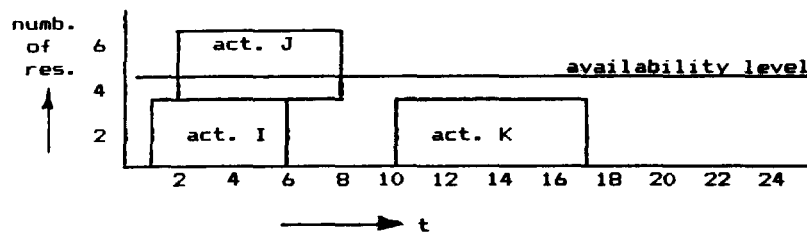


fig. 4.3.2: improvement of the schedule.

The given schedule can be improved by delaying activity J by two time units, but if activity k is delayed by two time units, then activity J can be delayed by another two time units, which does not cause an overload of the resource.

None of the investigated packages could handle this method. In the following we see that this method gives far better results.

5. Results of the resource scheduling techniques

The results are presented in terms of overloads. That means that every unit of resource overload is given a penalty of one. The initial project duration was 119 time periods, the overload penalty was 168.

The Time Limited (up-hill) method (TLUH) gave, with the same availabilities, for the different packages an overload penalty of 59 to 94, the Time Limited (down-hill) method (TLDH) gave a penalty of 29 (see table 5.1)

table 5.1: Results of the (extended) time limited method.

project duration	119	121
not scheduled	168	168
TLUH	59 to 94	-
TLDH	29	-
ETLUH	-	54 to 72
ETLDH	-	0

If the results of the Extended Time Limited Scheduling are considered, it can be seen (table 5.1) that with the new heuristic (ETLDH) an extension of the project by two time units was enough to give zero overload, while with the standard extended time limited techniques packages offered (ETLUH), the overload penalties varied from 54 to 72.

When looking at the resource scheduling it can be seen that all packages gave no overload when the project time was extended by 12 to 19 time units. The best result obtained was an extension of only 2 time units, which was achieved by the down-hill method (table 5.2).

table 5.2: Results of resource scheduling methods.

resource scheduling	project duration.
before scheduling	119
down-hill heuristic	121
other packages	131 to 138

6. Lack of uniformity

As has been explained earlier there are significant differences between packages. In general the following main issues are important:

- differences in the input-process
- differences in data structures
- differences in algorithms and options
- differences in the output-process
- differences in nomenclature.

input-process

If the input-process is considered, it can be seen that all suppliers developed their own standard and have stuck to it. As computer networks become more widely used then it will be evident that some kind of standardization will be necessary. This must also lead to standardization in data structures.

data-structures

There is more and more need to interface with other application packages, like for instance Materials Requirements Planning. At this moment the use of Project Management is a process in itself. Suppliers should be aware that only when developing flexible and transparent data-structures integration with other applications will be possible. The premium will not only be a greater share of the market but also penetration into new markets.

heuristics and options

While the nature of projects and the requirements they place upon the system differ so widely there is a need for many options.

These options must allow:

- activity or event oriented networks
- multi-project situations
- progress updating and reporting
- inclusion of cost data
- resource allocation and/or levelling
- interfacing facilities.

In practice most packages have all/some of these options in one way or another, but not in a standard way and with different nomenclature.

nomenclature

When comparing one package with another it was discovered that options with the same name gave different effects. There ought to be some standard and suppliers ought to work with this. For instance the "Glossary of Terms used in Project Network Techniques" from the British Standard Institution [7].

output-process

In Project Management it is standard practice to use bar-charts, histograms a.s.o. Thus the suppliers ought also to offer this options as standard. But as Project Management is involved with much data it is impossible to develop standard reports that fits all the specific needs of the user. So they must offer a kind of query or command language to create user defined reports and graphics.

7. Use of micro's in the Project Management field

Although Project Management software requires a much larger computer to work effectively the idea can be transported to a micro computer, especially as micros grow in storage and processor capacity. In this current decade megachips will be developed and processors will be made to run much faster than the ones available. As computers will be part of large computer networks, it will be possible to work on a local (micro!) computer and yet be in touch with the world around. To direct for instance management information to other places a.s.o. Interfacing facilities will thus be one of the prerequisites, down-loading and upward-loading of programs and data also.

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