An approach to the automation of the scheduling of urban deliveries

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Abstract:

Though there are now many software packages that can develop urban delivery schedules, there is a reluctance on the part of those involved with the management of the transportation systems to use automatic vehicle scheduling packages. The lack of confidence in such packages is, in part, the result of several failed implementation attempts. These failures can often be attributed to factors such as the installation of inappropriate software and the inability to deal with industrial relations problems. This paper describes an approach to the implementation of computerised load planning support. This method places a great emphasis on the 'human' aspects of the system implementation.

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Introduction

Scheduling of trucks to perform urban deliveries is an important logistic function in many industries. It's importance is measured by the cost of the transport system, which takes up a significant percentage of an organisation's total costs. Analysis of the scheduling performed by dispatch managers shows that, in many cases, they are capable of doing an excellent job. The dispatcher usually performs the task of scheduling the next days' deliveries late in the afternoon. Due to the complexity and nature of the load planning problem it is difficult for even the very best dispatch managers to perform consistently at their best. Automating the task of the scheduling of urban deliveries, using computer software packages, has resulted in cost savings in the order of 15 percent in many typical organisations (Demianenko 1986).

Much effort and research in Australia, and internationally, has been aimed at developing procedures that allow more efficient load planning. The results of much of this research can be usefully employed in many Australian organisations. Sadly, though much of the work in this area is now quite old, few Australian organisations attempt to improve the efficiency of their load planning function. In particular, though software packages which can perform the load planning task have been available for sometime, few organisations have successfully adopted an automated approach to the load planning task.

This paper attempts to identify, from a cognitive perspective, reasons why load planning might be inefficient and why attempts to prove load planning efficiency are seldom successful. This paper describes an approach to the implementation of computerised load planning support. The approach suggested attempts to address the problems that in the past have hindered attempts to improve the load planning function.

Urban Delivery Scheduling

Load planning is the process of allocating orders for deliveries to vehicles and creating vehicle schedules. Slater (1983) defines load planning as:

> determining the routes and schedules on a day to day basis for a number of vehicles from one or more depots to supply customer orders to an acceptable customer service level and at an acceptable cost to the company.

Load planning is a common function in many industries. It's importance is measured by the cost of the transport system, which takes up a significant percentage of an organisation's total costs. In Australia, the cost per annum in 1985 of the delivery of urban goods has been estimated to be in the order of $3,000m (Demianenko 1986).

The load planning function involves two related and interacting sub-problems.

These sub-problems are referred to as routing and scheduling (Ronen 1988). Routing refers to the organisation of the route that each vehicle will use. Scheduling refers to the planning of the timing of each delivery on a route.

Ronen (1988) describes three generalised classes of routing and scheduling problems. They are:-

- Passenger transportation (Bus services, taxis),
- Service operations (Repairman services, mail delivery, meter readings), and,
- Cargo transportation.

Further classification of each of these categories is possible by examining factors such as the statistical nature of demand and the time available to satisfy that demand. It is into the last category, cargo transportation, that the load planning problem faced by almost every fleet operator falls.

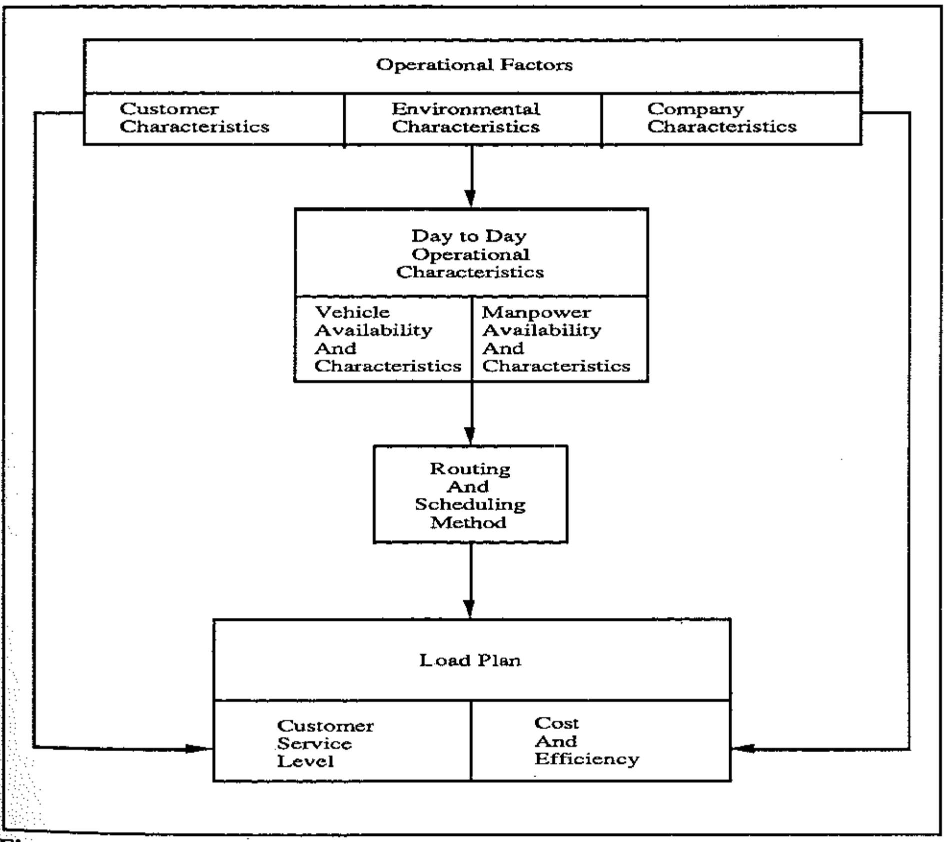

Figure 1 Load Planning Framework (Slater 1983)

Slater (1983) has developed a framework which is provides a useful basis for the classification of the factors which influence the cargo transportation problem (Figure 1)

There are four basic categories of influences on the load planning process They are operational factors, day to day operational characteristics, the techniques used to perform the routing and scheduling task, and the requirements of the load plan The following discussion integrates this framework with a more recent and comprehensive list of the factors influencing the cargo transportation problem developed by Ronen (1988).

The framework allows a description of

- The influence that operational factors such as customer, environmental, and company characteristics have on day to day operational characteristics as well as on the load plan,
- The influence that day to day operational characteristics have on the routing and scheduling method used, and
- The influence that the routing and scheduling method has on the load plan developed.

Included in the operational characteristics that influence day to day operation are such factors as the nature of demand (deterministic or stochastic), the structure of the fleet (the number of vehicles, their physical characteristics, their individual cost structures), the number of depots, the geography of the road network, government regulations, the nature of the product being handled and the type of operation (delivery only or pick-up and delivery). The operational characteristics that have a direct influence on the load plan includes factors as customer location, delivery time restrictions, vehicle restrictions, road works and compatibility between customer sites and delivery vehicle types.

Day to day operational characteristics that influence the routing and scheduling process include the availability of the vehicles and drivers (including shift constraints and rest requirements) on a particular day.

The routing and scheduling method used has a direct influence on the load plan developed. Specific influences on the routing and scheduling process include the objective of the process (satisficing or optimising, and if optimising, optimising what? - costs, kilometres, hours, workload balance or customer service level), the method used (manual or automated, degree and nature of automation) and the estimation of distances and times (measured, estimated using heuristics). The load plan developed has to meet the organisation's customer service and cost requirements whilst utilising truck capacities as efficiently as possible.

The efficiency of the load planning function is often also influenced by other organisational factors which are not the responsibility of the person who develops the load plan The processing of customer orders in typical manufacturing organisations is usually spread across several departments, say, sales, warehousing and transport. Sales staff process orders and the information detailing the order is passed on to the transportation section who develop load plans. These load plans are passed on to the warehousing section who pick the orders and prepare the vehicles for delivery. This interdepartmental interaction creates a problem if these departments do not coordinate closely to ensure accurate exchange of order information No amount of time spent developing load planning procedures will help to ensure that customers receive their orders on time and in full if, for example, the customer's address is recorded incorrectly or the product ordered isn't available. Load planning effectiveness can be effected greatly by any of the following factors

- inadequate order entry procedures (incorrectly recorded customer details, incorrect order details)
- poor communication between sales and the warehouse (sales staff must have knowledge of product availability and any special handling requirements),
- inadequate inventory control in the warehouse, and,
- lack of coordination between warehouse and transport staff.

The development of routes and schedules on a day to day basis is influenced by a great many factors. The list of influences presented here is not exhaustive, however, it does serve to show the complexity of the load planning process

Load Planning: A Cognitive Perspective

Even in small organisations, delivery fleets of 10 to 30 vehicles are controlled on a daily basis by the load planner. Analysis of the load planning performed shows that, in many cases, the load planner is capable of doing an excellent job (O'Donnell and Wilson 1989). However, the load planning task is usually performed late in the afternoon. The person who performs the load planning task is often the transport manager or the warehouse manager. This person by late afternoon is likely to be tired from the days activities and have many things on their mind other than planning the next days loads. The load planning problem is often a very complex one, as previously discussed. It is difficult for even the best load planners to perform this task efficiently all of the time. To understand fully the factors that can influence load planning task one needs an understanding of the way in which humans process information.

Stress and motivation are two important influences on the manner in which humans process information. Figure 2 depicts a useful framework with which the effect of stress and motivation on human information processing can be understood. Stress and motivation, whilst effecting each other, have a strong effect on a human's ability to process information. If a person has a particularly strong motivation to solve a problem then they are likely to develop a better solution to that problem than would otherwise be the case. The effect of stress on a human's ability to solve problems is an interesting one. Stress can have either a positive and a negative effect on a human's information processing capability. Stress can be caused by factors such as social pressure, risk, complexity, and importance of a problem solving situation. At low levels of stress humans tend not to be as good at processing information. At moderate levels of stress, human information processing capability increases. However, as stress increases to high levels, the information processing capability falls again (Arnott 1990).

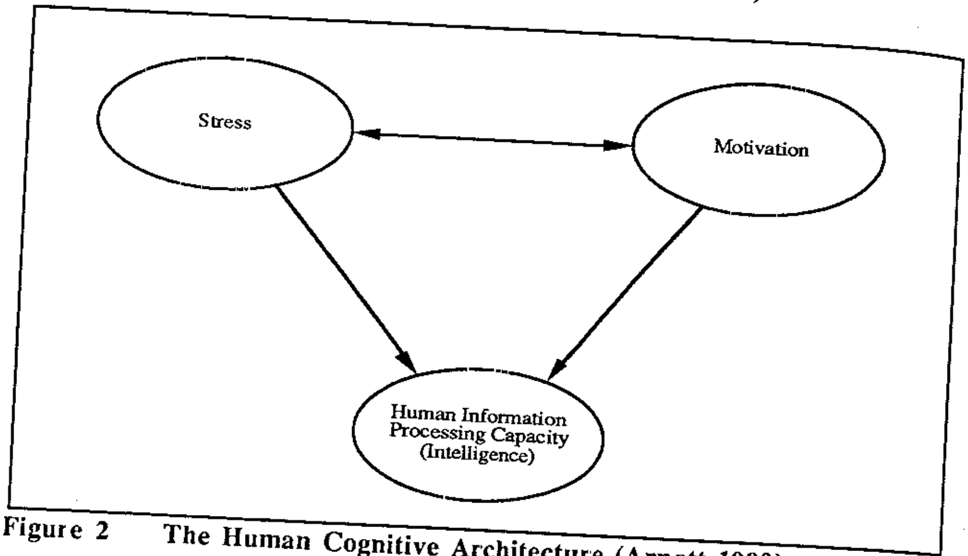

Figure 2 The Human Cognitive Architecture (Arnott 1990)

The relationship between stress and human information processing capability is depicted in Figure 3 It is not possible to develop such a relationship between motivation and information processing capability as results of experiments are often inconsistent The relationship between stress and information processing capability, however, is well establish and agreed upon.

This model of the way humans process information provides an useful explanation of the information processing behaviour observed by people performing the load planning task. The load planning task is an extremely difficult one. In most organisations the task is complicated by many factors and operational constraints (See Figure 1). The complex nature of this problem means that the person responsible for the task is under a high degree of stress. This high level of stress is often exaggerated by the work environment the load planner has to work in.

Because it is usually late in the afternoon when the load planning for the next day occurs the person who performs the task is probably very tired. The activities and dramas associated with the days work are not easily forgotten. This lowers the individual's level of motivation and raises the level of stress.

It is common place for the picking of loads for the next days orders to take place over night, being completed before the drivers leave for their delivery runs the next morning. The warehouse staff, whose shift starts after the order cut-off time, need the load manifests from the load planner before they can start working their shift. Often these workers will congregate near to the work space of the person performing the load planning. Their presence also lowers the individual's motivation to concentrate on the task by adding to the desire to finish the load planning as soon as possible.

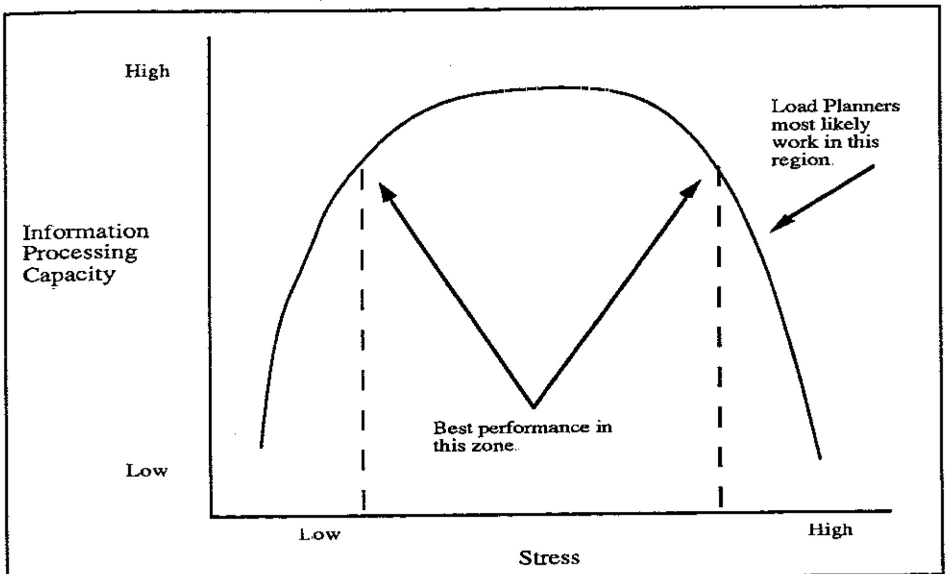

Figure 3 Relationship of Stress to Information Processing Capability

The relationship between information processing capacity and stress is fairly stable across a wide range of medium stress levels. Humans work best when they are under moderate levels of stress, in the middle section of the curve (Figure 3) It would seem, however, that the stress level of a person performing the load planning function is more towards the high end of the stress scale causing a loss in information processing capability. This means that although the people who perform the load planning task are capable of doing the task very well, quite often they don't Slater (1983) reported on an experiment under normal working conditions in which a scheduler developed a delivery plan that required 27 vehicles. Under experimental conditions, with a reduction in stress, the same scheduler working on the same data set was able to develop a set of delivery schedules that required only 24 vehicles. This is consistent with the proposition that under normal work conditions the load planner's ability to process information is retarded by the effect of high levels of stress. It is usual for the performance of an individual performing the load planning task to vary greatly from day to day (Slater 1983, O'Donnell and Wilson 1989).

A school of thought that is held by modern cognitive psychologists is that humans use simplifying strategies and heuristics to help them solve problems (Bazerman 1986). Tversky and Kahneman (1974) have identified three general heuristics that are used by virtually all humans when solving problems The three heuristics are:

- *The Availability Heuristic.* The likelihood of an event is assessed according to the number of times the event can be recalled from memory. An example of the use of this heuristic applied to load planning might be

'The last three times I sent a full truck load to Dandenong the truck was back before lunch time. I expect that if I send a full truck load to Dandenong tomorrow that it should be back around lunch time.'

- *The Representativeness Heuristic.* The likelihood of an event is determined by the similarity of that event to a stereotyped set of events. For example, 'John is a new driver, all new drivers take a bit longer than the more experienced drivers to complete their delivery runs.'
- *Anchoring and Adjustment.* A judgment is made by starting from an initial reference point and making adjustments. This is a frequently used heuristic used by load planners to estimated the time a particular delivery will take. For example, 'John took 6 hours yesterday to travel to Geelong and back, today has has to go to Werribee which is half as far, so he should take about 3 hours.'

The use of heuristics is central to the way humans process information. Without using simplifying heuristics such as the examples given above, load planners would have an almost impossible task.

However, the use of heuristics can, in may circumstances, result in a person making judgments that are irrational and easily shown to be wrong. Cognitive biases have been defined to be decision making circumstances that lead to persistent and systematic decision making errors (Hogarth 1987). Over 43 of these cognitive biases have been identified (Arnott 1989). Typically, several of these biases come into play when an individual develops a delivery schedule.

The most important of the biases that come into play when an individual develops a load plan is called *recall*. The recall bias describes that fact that people tend to only be able to recall from their memory a few recent events. For example, a load planner might remember only that the last time a truck travelled down a particular road that it got stuck in a traffic jam. This piece of information is likely to be used as the basis of a decision not to use that road again. It might be that there was a reason for that traffic jam, perhaps the opening of a new shopping centre, and the congested traffic flow is not a normal situation on that road. However, the load planner suffering the effects of the recall bias call only remember the traffic jam, and forgets about the other times when the route had been used without difficulty.

A further significant bias is known as *habit*. The habit bias causes people to tend to use a technique that has worked in the past without change. This bias degrades the performance of load planners whose knowledge of the road network is not current. For example, one particular route might be favoured by a scheduler because he can remember driving along it many times without any problems. However, it may be that a new road has been constructed and that an alternative route is better. The load planner, however, under the influence of the habit bias, will tend to use the same routes that have worked in the past. The example cited is a common trap for many load planners (Williams 1990).

Many other biases can cause poor load planning performance. In general though, the biases that are relevant to the load planning function tend to be associated with memory and a lack of ongoing learning. Few load planners ever get the chance to review the techniques that they use every day to develop the load plans. Often the person responsible for the development of the load plans is an ex-truck driver. The moment that they stop driving trucks regularly is the moment that their knowledge of the road system starts to become dated. It is not usual for an individual to seek feedback on the load plans that they are developing. When they do receive feedback, the negative comments tend to be ignored in favour of the positive ones (This is a bias known as *confirmation*.) Because there is no motivation or time available for the individual who performs the load planning to update their knowledge of the road network or review their routing and scheduling methods, load planners are particularly susceptible to the recall and habit biases.

Automated Load Planning

Over time manual load planning procedures, due to the complex and difficult nature of the load planning task may tend to be inefficient. Much work, particularly from operations researchers, has centred on the problem of improving load planning procedures. The routing component of the load planning problem has many of the characteristics of the travelling salesperson problem. The travelling salesperson problem simply stated is this:

> Suppose a salesperson is to visit n cities (nodes, customers, etc.) visiting each only once, how does he schedule his itinerary so that he travels only a minimum distance (or pays a minimum travel expense) ?
>
> (Krolak, Felts and Marble 1971)

The complexity of the problem lies in the number of different routes that are feasible. If a machine was to find the optimal solution to the problem it must measure the length of each possible route. If there are n customers to be visited then there are $n!$ possible routes. If there are 5 customers then there are 120 possible routes; for 9 customers there are 54,360 possible routes, for 11 customers there are 4,989,00 possible routes, and so on. After more than a dozen or so customers have been introduced to the problem the time it takes to find the optimal solution becomes prohibitively long. For example, if there are 21 customers, Foulds (1983) calculates that a computer which is able to evaluate one route every billionth of a second, would take over 1600 years to examine all the possible routes and decide which is best. This phenomena is termed combinatorial explosion.

The vehicle routing task is much more complex than the simple travelling salesperson problem. Additional constraints and practical complications involved in vehicle routing and scheduling serve to make the generation of possible routes more difficult. Vehicle routing and scheduling problems, like the travelling salesperson problem, suffer from combinatorial explosion. Brute force evaluation of all the possible routes by a computer (or a human) is impractical and impossible.

Combinatorial explosion is not a phenomenon unique to vehicle routing and scheduling problems. Many of the problems that are addressed by the disciplines of operations research and artificial intelligence are characterised by the enormous number of potential solutions that need to be considered (Phelps 1986). Many techniques and algorithms have been developed which enable computers to find solutions to problems of this type. Workers in the field of artificial intelligence often develop solutions to problems of this complex type by trying to model parts of the way humans solve problems. In particular, one generalised class of problem solving techniques which are usually applied to problems of this sort are based upon the use of heuristics (Foulds 1983). The application of a heuristic technique to the solution of a problem is not guaranteed to always produce the optimal solution. It will, however, on most occasions produce a solution that is near optimal.

An example of a heuristic technique which is can be used to develop load plans is the famous Clarke-Wright savings method (Clarke and Wright 1964). This techniques operates by initially assuming that there are enough vehicles to allocate one to each customer. A savings matrix is created by calculating the savings, in distance, that would be made by combining two trips to two customers into one trip that visits two customers. A savings value is calculated for every possible combination of customers. The actual load plans are then developed by searching this savings matrix for the largest value. Then, subject to any constraints such as vehicle capacity, the tours that involved the two customers are combined. This last steps in the algorithm continue until no further combinations are possible.

This algorithm described briefly above is not necessarily the best or most efficient available. However, it can easily be modified and is easily implemented. The authors have developed an implementation of this algorithm that will run on standard IBM compatible personal computer hardware. This particular program can develop vehicle load plans for several hundred customers in around 15 minutes.

There are available commercially several computer packages which apply heuristic techniques to produce near optimal solutions to vehicle routing and scheduling problems. Demianenko (1986) describes the operation of a computer based approach to load planning. Such systems work by finding the near optimal solution...

> 'to a given scheduling matrix within all known constraints such as amount ordered per customer, the number of vehicles available, drivers' working time, unloading rates at customer sites, alternative vehicle loading combinations and street map references of customer sites. Once this data has been entered, the programme calculates [near] optimal routes for the whole fleet without exceeding fleet capacity, drivers' shift time, allowable delivery times or any specific operational requirement or policy. It generates a schedule for each vehicle showing the sequence of deliveries to each customer, the time of delivery, the distance travelled, and the utilisation of the vehicle in terms of its capacity and the time taken to make deliveries.'
>
> (Demianenko 1986)

Computers are speedy and accurate at computations. Provided a computerised vehicle scheduling system has a reliable and accurate data base, the system should produce load plans that are consistently better than those produced manually. This is not because the manual load planners are not capable of producing excellent load plans, but rather, as previously discussed, their work environment does not allow manual approaches to perform well consistently.

Improvements have also been made to load planning efficiency when the computer has been introduced as a tool to support the manual processes used. This support might take the form of a program that produces graphic displays showing maps of the customers locations (For example Krolak *et. al.* 1971). The vehicle despatcher can see the route plans shown on a computer screen change interactively as the load plans are developed. This approach improves the load planning by helping the load planner visualise the customer locations and routes developed. Usually the first satisfactory load plan developed is used by the vehicle despatcher. However, because of the speed at which the load planner can develop routes when aided by computer support of this nature, they are more likely to attempt to refine their initial solution, resulting in more efficient load plans.

Demianenko (1986) and others (Slater 1983, Ronen 1988, Williams 1990) are unanimous that computerised load planning is able to achieve lower delivery costs than manual load planning procedures. Often the introduction of computerised load planning has resulted in cost savings in the order of 30 per cent or more (Williams 1990) though the figure is more likely to be in the order of 15 per cent (Demianenko 1986). However, there have been many failed attempts (especially in Australia) of implementing automated load planning procedures. Demianenko (1986) points out that the cause of these failures can be traced to factors such as industrial relations problems, lack of management commitment and selection of inappropriate software.

Barriers to Change

Vehicle scheduling packages have been on the market for at least two decades yet surprisingly few companies have used them. Perhaps the major reason is that until recently they existed only on mainframe computers and thus were beyond the reach of all but the largest companies. Even in large companies computer time is a precious resource. However, with the advent of the mini and personal computers nearly all businesses today have access to relatively inexpensive computers. But surprisingly, few inroads have been made into the vehicle scheduling field. There are many reasons why this is the case.

Firstly, most warehousing and transportation staff have no background in computer technology. It is a normal and natural emotion for people to have a strong distrust of anything that they are not familiar with. For this reason many people are scared of and dislike computer technology. In particular a load planner who is unfamiliar with computer technology will not trust or be willing to accept the load plans developed by a computer. Typically, load planners formerly worked as truck drivers. In their day to day work they have authority over their former work mates and friends. Because they are responsible for the load planning they, in effect, decide what work these people will do each day. The introduction of a computer to perform this task, though the load planning is only one aspect of their managerial duties, is seen by them as a threat to their authority and status. Often when the introduction of a computerised load planning system is first suggested, it represents the first time that the performance of the load planner is ever questioned. In discussing the possibility of a computer developing the load plans with the transport staff the load planner is likely to get a great deal of support and sympathy. The possibility of introducing computerised load planning is therefore not often popular with the load planner or the truck drivers. Often the emotion and support associated with this feeling can result in industrial action. It is not uncommon for unions to refuse to allow their drivers to work to computer generated loads plans.

It is argued that the computer removes the drivers' discretion to perform their work in the manner that they see fit. The planned timings of the events of the computer generated load plans are insensitive to day to day circumstances, such as accidents and unusual traffic congestion. It is argued that the computer generated load plans will be used unfairly by management as a tool for productivity measurement. The drivers fear that this will cause them to be held accountable for situations beyond their control.

Another major barrier to the introduction of computerised load planning systems is that the initial results of commercial packages often need to be fine tuned. The software packages often have many parameters which enable the load plans developed to be customised to fit the particular characteristics of an organisations operation. At first the results obtained can appear naive. Scheduling staff and managers may too quickly conclude that the software package cannot adequately perform the scheduling task. Often, even though a package may have been configured to overcome initial problems, the previous conclusion as to it's inadequacy may remain unchanged. This is an example of a bias called *insufficient adjustment* and is associated with the anchor and adjustment heuristic discussed previously. Further, when asked to evaluate computer generated load plans, distribution staff often can point out many areas that might be improved. These problem areas can serve to confirm the belief that the computer cannot do the scheduling task very well. However, only rarely will the solutions generated by existing manual techniques be subject to this sort of scrutiny. If they were, load planners are unlikely to look for as many faults in their own work as they are in the computer's solutions.

The authors have worked with two companies to develop tailor made vehicle scheduling packages. Both of these organisations rejected existing scheduling packages because they felt generic off-the-shelf packages could not adequately perform the task. The distribution staff of these organisations believed they had a unique cargo delivery task. They agreed to allow management to explore a tailor made solution. However, both have been unwilling to commit the resources necessary to go beyond the prototype system stage. In both cases prototype scheduling packages were developed after working closely with scheduling staff. The major reason for rejecting the automated approach appears to be the belief of schedulers and drivers that the computer solution was not as effective as their own manual techniques and judgment.

Management although commissioning the research cannot afford to question or appear to distrust their staff when the risk is a deterioration of customer service or industrial relations. It is easier to suspend development in the face of staff criticism. This is the fate that meets many initiatives to investigate the use of computerised load planning methods.

Faced with opposition to the introduction of computerised load planning the person who first suggested the introduction of a computer, usually the distribution manager, can find little support for the idea. Computer systems are more often than not delivered by data processing departments over budget, late and not to specification. Senior management in most firms having had enough difficulty with the computer systems that organisations already have, are not likely to provide support for the introduction of yet another system, especially when the distribution manager finds it difficult to convince his own staff that such a system is necessary or would be useful. This lack of support is the third major barrier to the introduction of computerised load planning.

A further barrier to the introduction of computerised load planning is a technical one. The scheduling system needs to interface with the company's existing order processing systems. Typically, these operate on systems that are incompatible with the commercially available vehicle scheduling packages and incompatible with one another. Integration can be a time consuming and expensive process that needs the support of several divisional managers: marketing and data processing in addition to distribution. It is often difficult to achieve consensus between other divisions or departments, especially when it may mean changing existing systems.

An Approach to Improving Load Planning

Any load planning techniques that are introduced to improve load planning efficiency must have the support and confidence of both the load planner and the transportation staff. As discussed previously, it is typical for load planners to never get an opportunity to evaluate their own performance. The basis of our approach is is to provide an environment where the load planner is encouraged to do the best job possible. If they are to improve the efficiency of their load plans they must be encouraged to try to find methods and tools that help them to do a better job. Potentially the computer is the tool that can provide the greatest improvements in load planning efficiency. If the load planner wants the load planning to be performed as well as possible the introduction of computer based load planning should be a natural consequence to this desire.

The basis of our method is to set up a laboratory environment in which the load planner is encouraged to reflect on the daily load planning procedure. The load planner may be encouraged to present the technique used as a set of simple rules for training other load planners, such as the person who performs the task whilst the load planner is on leave. The load planner, after 'publishing' this method, is then encouraged to review and improve this method. The environmental setting for this task needs to be clearly non-judgemental with as little interference from management as is possible. The load planner must be provided with the opportunity to develop better skills. Management must set up a small group of people who should meet on a regular basis. This group will work in a simulated task environment conducting experiments in the construction and analysis of loads and routes. Typically, this group will consist of the load planner or planners (and any assistants), and one or two experienced, respected (likely senior) truck drivers. The shop steward, if appropriately experienced and senior would be an ideal member of this work group. Management should set out a 'scientific' framework within which the experiments will be conducted. The major type of experiment performed by the group will be to develop load plans using copies of customer orders from previous days using various manual load planning techniques. (Slater (1983) details some of the manual techniques that might be tried.) Each experiment the group conducts should be presented to management in the form of a simple report detailing the aim of the experiment, the method used, the results of the experiment and any conclusions the group has reached as a result. Copies of the reports should be made available for the other drivers to review and make comments on.

After several group experiments in the simulated task environment, the load planner will have a set of solutions generated by alternative means. Questions will eventually be raised as to how to evaluate which is the best solution. In order to evaluate the results of using different routing techniques a set of load plan evaluation guidelines will have to be developed. Given time, and a non-threatening supportive environment, it is likely that these guidelines will be used by the scheduler to begin to evaluate his own daily solutions to the real routing problem.

Computers should be introduced gradually and slowly, perhaps at first as tools to help evaluate the experimental results. This may take the form of simple spreadsheets which are relatively easy to introduce and use on a day to day basis for routine administration. It is important that the computer is seen as a tool for load planners, so that they find it useful and that it is introduced in such a way that its potential benefits for managers are quite clear. The scheduler should be given the opportunity to go on some introductory computer courses. A course on the use of spreadsheets as a decision support tool would be most productive. The computer used for the simulated task environment should be the 'property' of the scheduler. The computer should be physically located on or near to the load planners desk. In this way it may also be seen as a symbol of status and importance accorded to the load planner.

After several experiments with manual techniques, it is likely enthusiasm may wane as the tasks become repetitive. At this point, automated scheduling procedures can be introduced and explained as adjuncts to the manual processes. The group may then begin to compare manual with automated procedures and suggest parts of their manual procedures that might be automated. This can also improve the teamwork and coordination between drivers and schedulers.

If the results of these experiments are satisfactory, the ground-work has been firmly laid for the introduction of a fully automated system. This may either take the form of purchasing a turn-key system or in-house development.

After undergoing a substantial learning process the perspectives and knowledge of the drivers and schedulers is broadened. The quality of the manual load planning process should improve. Slater (1983) comments that a review of manual load planning procedures can result in improvements of up to 11 per cent. It is likely that the group will feel more in control of their work environment and therefore less threatened by change. As a result the load planners and drivers should become more receptive to new ideas that might help to improve the load planning function. The authors believe this procedure will enhance the quality and reliability of the vehicle scheduling process whether the group finally decides to introduce fully automated procedures or not. Rather than become the victims of change the load planner and the drivers will become the planners and masters of their working environment. The adoption of the development strategy, though slow, is likely to result in improved load planning procedures whether manual, semi automated or automated.

Improving Load Planning: A Challenge

The cost of the delivery of goods to urban customers is enormous to both the economy and to individual organisations. There are many ways in which organisations can improve their load planning function. Load planners, whilst often being highly skilled, are subject to high levels of stress and low motivation. Significant cognitive biases have a role to play in the decision making processes used by a load planner. A review of manual load planning procedures, decreasing stress, increasing motivation and encouraging continued learning and evaluation has the potential to greatly improve the performance of an individual developing delivery schedules. However, the greatest improvements in load planning efficiency come from providing the load planner with computerised support. In the past the introduction of computerised load planning has often resulted in failure. The challenge to transportation based organisations is clear. The benefits to be gained from the introduction of such automated load planning tools, both in terms of cost savings and increased levels of customer service, are clearly well worth the effort. Up to now most organisation have been reluctant to attempt to improve their load planning function. As we move into the new decade, with increasing costs and greater demands being placed upon their services, organisation must seek to make their transportation operations as efficient as possible. Organisations should take up the challenge of improving the load planning procedures We hope that the approach suggested in this paper is useful to any organisations which do accept the challenge.

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