OUTDOOR MANAGEMENT DEVELOPMENT: A CRITICAL APPRAISAL

Norman Crawford and Richard Mapstone*

Those familiar with the training of managers, either within companies or through training agencies, will be aware of the increasing provision during the last decade of management training programmes which use the natural environment as an instrument for the development of managers. This type of programme has experienced substantial growth in the United States and Great Britain, where the resources of Outward Bound centres are often used to provide programmes for managers. Formerly established for young people, Outward Bound schools and outdoor pursuits centres have had broadly similar objectives of character development through exposure of trainees to an unfamiliar and often hostile environment. These centres are, for the most part, residential and involve both the environment and the trainee group as a learning medium.

Recent Research

Research on the influence of Outward Bound School training is relatively sparse and of little direct assistance to managers and trainers. There are, however, a number of studies which focus on the impact of outdoor programmes in terms of physchological factors. These studies are often based on examination of the influence of programmes on young people. Fletcher and Strutt (1970) argue that outdoor pursuits training increases the ability of young people to manage difficult situations. They also found that females who participate in outdoor training programmes develop greater self-awareness. Such trainees, they found, become more assertive and independent.

It is the individuals concept of 'self' that appears to develop most through this training medium. Clifford and Clifford (1967) argue that exposure to the hostility of the environment, and the challenge of the training associated with it, generates a positive effect on the individual's understanding of her/himself and awarenesss of her/his 'potentiality'. Where this type of training is used for young offenders it has been found that

*The authors are Lecturers in the Department of Applied Economics and Human Resource Management at the University of Ulster, Jordanstown.

IBAR—Irish Business and Administrative Research, Volume 10, 1989, pp 59-65

there is a significant drop in recidivism. This is related directly to the nature of the training experience which enables the young offender to achieve and develop self-awareness through the environmental challenge.

Evaluation procedures are extremely difficult to develop, especially when the evaluator is confronted with the problem of establishing objective measures of such vague concepts as "character development" and "personal awareness". The studies outlined above suggest that the outdoor training medium has proved particularly useful to certain types of young person. We may not be surprised therefore that both Newsom (1963) and Plowden (1966) recommended this type of activity for the deprived delinquent or educationally below average young person. Moreover, this type of training has a particular attractiveness as a social work medium.

There are certain problems, however, in the translation of this training environment to the context of 'management'. Outward Bound schools have traditionally aimed their programmes at young persons in their late-school, or early post-school years. During the 1950s and 1960s the schools received considerable sponsorship from business and industrial interests who needed the centres to develop junior entrants and managers at different levels.

Indeed interest in this form of training — as an integral part of management development — has grown considerably since this period. There are now many management training companies specifically concerned with outdoor training programmes (for example — Brathay Hall Trust, Challenge Training, Endeavour Training and The Leadership Trust). Arguably these organisations are more able to adjust their training objectives (and courses) in the light of recent research. Cranfield (1982), for example, describe the successful integration of training agency and outdoor instructors in the achievement of a programme of management training. Braid (1982) used an outdoors pursuit centre to run courses for supervisors. This enables groups to act out practical team and leadership situations within an unfamiliar environment. He argues that the courses result in "encouraging signs of improvement". Supervisors, when asked for their evaluations, recognised the need to apply effective team techniques to group situations. Krouwel (1980) argues that the outdoor environment provides a framework for exercises within which managers can test their powers to cope with accelerated rates of uncertainty and change. Similarly, Reeve (1982) sees the advantages of outdoor training in providing a useful environmental vehicle for developing the skills of problem-solving and decision-making, which are the necessary tasks of individual managers.

There is little evidence in these articles of any attempt at systematic evaluation of the training experience. The works by Shrank (1977) and Magee (1983), for example, are purely descriptive accounts of experiences within an outdoor training environment. Although Krouwel (1980) and Rice (1979), for example, place considerable emphasis on the need for post-course evaluations, many describe the training from an evangelistic standpoint — that the medium of the outdoors itself leads to the design of particularly stimulating experiences which are assumed to be transferable into the place of work.

To take a further example, Mossman (1982) outlined an impressive list of possible achievements obtainable by managers on outdoor programmes. His review of such programmes suggests that 'gains' range from personal development (such as increasing self-awareness and personal confidence), through team development, to the possible development of managers and organisations. Mossman also suggests that although these courses are particularly relevant to the 'bright intellectual and conceptual thinker', there are few managers who cannot participate with advantage.

Outdoor training is seen by many writers to be successful because it involves the processes of 'discovery' and 'reflection' within a risk environment. The high 'process reality' of the training leads to the possibility of a high transfer of learning to the workplace. Such training posseses qualities which make it superior to action-learning techniques or to joint-development activities. This is because outdoor training is 'holistic' in nature and demands substantial commitment from participants who undertake tasks that have a tremendous impact. Much of the relevant literature suggests that the experience of outdoor activity courses — as an integral part of management development programmes — can inject fresh, creative thinking in individual managers, provide insight into personality and assist individual awareness. Rice's description of such courses in the United States suggests that their primary benefit lies in their encouragement of self-reflection and the exploration of the possibilities for change in direction for individuals. It is clear that in all these programmes the trainee is confronted by activities which may require substantial physical and intellectual energy.

However, analysis of outdoor programmes, in terms of possible achievements, may deny the qualitative value of this type of training which is, for many, the unusual challenges of group and environment. The papers reviewed generally assume that the absence of the artificial, classroom-bound game processes will provide greater opportunity for carry-over of

the learning into the business environment. Rice and Cranfield note, however, that there is not an automatic transfer but, as in other types of programme, that this requires the somewhat artificial role of management 'facilitator'. The facilitator's function is thus to intervene and extract from the trainee the managerial implications of the experiences. More critically, the outdoor training philosophy assumes that the business organisation will be sufficiently flexible to respond to the learning that has taken place. It is however quite problematic as to whether the business will benefit. The study by Roberts (1974) suggests that the training objectives of companies' outdoor training were often vague. The invitation for individuals to use outdoor centres was sometimes based on good job performance, or as a 'natural' aspect of a junior management programme. Roberts found that the positive 'organisational' effects of outdoor training were negligible. There were also found to be negative effects upon organisations through, for example, a loss in job satisfaction. Many trainees returned to the work environment to experience frustration at being unable to use their new-found abilities. Roberts found that relationships deteriorated after such training programmes, and trainees had become more prepared to move to other employers for only small financial inducements.

For approximately eight years outdoor management development programmes have been operated by the Department of Applied Economics and Human Resource Management of the Faculty of Business and Management at the University of Ulster's Jordanstown Campus. These programmes have been of two main types: programmes designed for postgraduate students with little business or management experience and programmes designed for experienced postgraduate students engaged in part-time study for postgraduate management courses — particularly for qualifications in personnel management.

For the purposes of this article, analysis will be directed towards assessment of the latter type of programme. Crawford's study (1988) looked at expectations, achievements, problems (and suggestions for their resolution) in a typical 5 day outdoor experience designed for a post-graduate junior management programme and is concerned with evaluation of the former type of programme. The following brief analysis is derived from the results of recent three day programmes for postgraduate personnel management students. This evaluation, by its very nature, was limited in scope. The expectations were that it would provide no more than an indication of the areas for longer-term research.

Evaluation of Outdoor Programmes

Our outdoor programmes take place in the wild countryside of North Antrim and Fermanagh and involve such outdoor activities as canoeing, climbing, sailing, orienteering and navigation. The programmes are built upon team-based problem-solving activities, using the outdoor environment. Evaluation was by means of a formal questionnaire upon immediate completion of the course. However experience has led the University team to carry out follow-up evaluations some 8 weeks after course completion. Some of the findings relating to the two most recent programmes — involving 30 personnel managers — are outlined below. The findings of the latter method of evaluation suggests that the work environment serves to constrain severely the organisational benefits gained from the outdoor experience.

Participants were first asked to consider whether the experience of the outdoor programme would assist them in their inter-personal relationships at work. This question derived the most positive response. Almost 90% of the respondents believed that the outdoor experience would be of great or very great assistance to them. This reflects the general post-course euphoria that is associated with completion and the recognition of personal and group achievements. This question also demonstrates the greatest contrast in responses. When asked the question after a period back at work, over 40% of the participants see the outdoor experience as being of limited value to them in their workplace. There appears, therefore, to be a common assumption that since the 'trainee' has undergone the therapeutic outdoor experience and gained new 'insights', then the organisation ought to be able to accommodate the new-found capabilities.

In contrast, the participants were also asked whether the experience gained on the outdoor programme would assist them in their inter-personal relationships on the Postgraduate Diploma Course itself. Our findings indicate that this type of residential programme activity is of considerable and lasting benefit to the students. Over 80% of respondents at both stages of evaluation regard this feature of the training as being most beneficial. The training enables the students to explore relationships and attempt to understand one another in a non-academic environment. It must be borne in mind, however, that this does not reflect the competitive situation of the world of work, but rather the exploring of friendship groupings in a new environment.

Considerable emphasis has been placed on the contribution of the outdoor training experience to the development of the skills of problem-solving, decision-making and leadership. Braid (1982) writes of the

advantages of this training as "demonstrating the value of planning and a systematic approach to decision-making." Reeve (1982) describes the revitalising of managers' skills of problem-solving and leadership. Magee (1983) sees these aspects as a major factor in his own personal development through the course.

It should be borne in mind that our participants came from a range of different organisations (public and private sector). Thus, we are not able to carry out detailed in-company performance analysis over any significant period of time. However, participants did regard the outdoor training experience as contributing to the development of their skills in the areas of problem-solving, decision-making and leadership. Over 70% of our respondents regarded the course experience as assisting in these areas at work. However, once again, follow-up evaluations produced more negative responses. After two months less than 40% regarded the course as assisting them to any great degree in these skills at work. Thus the problem re-emerges of the failure of organisations to reinforce the learning achieved on the training experience.

Conclusion

The problem of 'retention of learning' appears central to this type of training experience. Few experienced in this type of development activity would dispute Braid's comments that "there is a visible difference of behaviour toward the end of the course compared with the beginning". The training provides a distinct, exacting and consequently stimulating experience for participants. It has not been demonstrated, however, that the qualitative rewards of such experiences can be maintained once the fulfilled trainee returns to work. We may therefore set goals for this training which are not directly work-related. The real advantages of the training may well lie, therefore, in the development of individual awareness and the understanding of people in groups. If, in conjunction with trainees, the problem of 'retention' is addressed and somewhat more limited goals are established then the outdoor experience may be qualitatively more valuable.

REFERENCES

Braid, J. "Using Outdoor Pursuits for supervisory training". *Training Journal,* Jan, 1982, vol. 1. pp 18-20.

Clifford, T. and Clifford, N. *The Outward Bound Movement.* Macmillan, 1970.

Cranfield, I. "Training thrugh endeavour". *Industrial and Commercial Training.* Oct, 1982, vol. 3. pp 1-16.

Crawford, N. "Outdoor Management Development — a practical evaluation". *Journal of European Industrial Training,* 1988, vol. 12, No. 8. pp 17-20.

Fletcher, T. and Strutt, J. *Outward Bound Study.* London, 1970.

Krouwel, B. "Management Development using the outdoors". *The Training Officer.* Oct, 1980. vol. 3. pp 12-26.

Magee, D. "One executive experience with Outward bound" *Record.* Feb, 1983. vol. 12. Pt. 1. pp 6-8.

Mossman, A. *IPM National Conference Paper.* 1982.

Reeve, D. "Revitalising Managers". *Personnel Management.* April, 1982. vol. 2. pp 18-19.

Rice, B. "Going to the mountain". *Psychology Today.* Dec, 1979. vol. 2. pp 18-19.

Roberts, K. *et al. The Character Training Industry — Adventure Schemes in Britain.* David and Charles. 1974.

Shrank, R. "Two women, three men on a raft". *Harvard Business Review.* May, 1977. vol. 1. pp 13-18.

Report of Minister of Education's Central Advisory Council. *Half Out Future.* (Chairman, Mr. J. Newsom). HMSO 1963.

Report of Minister of Education's Central Advisory Council *Children and their Primary Schools* (Chairman, Mr. J. Plowden). HMSO 1966.

DECISION SUPPORT SYSTEMS FOR PHYSICAL DISTRIBUTION

Martin Butler and Les Foulds*

Introduction

The Vehicle Scheduling Problem (VSP) is one of the classical problems of Operations Research (OR). It is a simplification of many practical distribution scenarios in which a planner must schedule the delivery or collection of goods or services for a number of customer points, from a central depot, in an efficient fashion. In the VSP it is assumed that the distribution will take place via a number of vehicles, each with a known capacity to carry the goods or to perform the services. Further, each customer has a known output or demand for the goods or services. Also the travel cost, in terms of time, distance, or some other criterion, is known between all pairs of locations. The VSP involves clustering the customers into groups, each group to be visited in sequence by a vehicle which begins and ends its route at the central depot. In later refinements of the VSP, a few extra practical considerations are allowed, such as time windows which allow vehicles to visit customers only during certain time intervals.

The traditional OR approach to this problem is to formulate it as a mathematical model and to attempt to solve it by applying various mathematical programming techniques. Despite the intricacy of some of the VSP models, and the innovative nature of their solution techniques, their resulting solutions are often criticised by experienced schedulers who attempt their implementation.

The purposes of this article are to discuss what the authors believe are pitfalls with the above approach when it is applied in practice, and to suggest an alternate procedure that combines the skills and specialised knowledge of an experienced scheduler with a microcomputer-based interactive scheduling decision support system (DSS). A later paper by the authors (Butler and Foulds[1989]) describes the implementation of such an approach in the milk collection department of an Irish dairy cooperative. We now review the literature on the VSP and discuss the commercial vehicle scheduling packages that arose from it.

*The authors are, respectively, Lecturer in Management Information Systems, University College Dublin, and Professor of Management Studies, University of Waikato, New Zealand.

IBAR—Irish Business and Administrative Research, Volume 10, 1989, pp 66-74

VSP Literature and Packages

One of the first studies of the VSP was reported by Dantzig and Ramser (1959) who formulated it as a linear programming model. Since then many others, including Clarke and Wright (1964), Gillet and Miller (1974), Foulds et al. (1974, 1977a, 1977b), Christofides et al. (1981, 1984), Mingozzi and Toth (1981), and Fisher and Jaikumar (1981) have contributed to the area. The VSP literature has been surveyed by Golden, Magnanti and Nguyen (1977), and by Foulds and Watson-Gandy (1981).

Increased commercial interest in practical vehicle scheduling has motivated various groups to commercialise the academic findings in the form of marketable vehicle scheduling computer packages. The first was developed by IBM. It is termed VSPX and is based on the VSP procedure developed by Clarke and Wright (1964). Since the early 1970s, several other packages have been marketed, including: ROUTEMASTER, TRANSIT, PARAGON, IRG, and MOVER. We now discuss what the authors perceive to be serious drawbacks to these packages when they are applied to practical routing problems.

Practical Problems with VSP Computer Packages

VSP computer packages attempt to find a feasible solution to a mathematically defined model. In the mathematical model, the objective function is usually concerned with optimising a single criterion, such as the cost of calling on all customers, or the total distance driven to service all customers. Several types of constraints are also sometimes included such as: vehicle capacities, maximum route lengths, route start times, route finish times, time windows, the sequence in which suppliers are visited, and the ability of different vehicle types of gain access to suppliers. When they are included, these constraints are invariably expressed as inequalities which cannot be violated in any feasible solution.

It appears, however, that the models which underpin these VSP packages are invariably very poor approximations of practical vehicle routing scenarios. This is because these scenarios cannot be represented by a single well-defined optimality criterion together with families of well-defined constraints, expressed in mathematical form.

In practice, the total cost of the servicing of all customers is only one of many considerations in the comparison of possible scheduling options. Often it is only a secondary consideration of the busy planner who is under pressure to produce a satisfactory schedule. Combinations of other factors such as the level of customer service, equity of route duration —

including driving and visiting times, rostering arrangements for drivers, efficient vehicle and driver utilisation, the total schedule time, company financial strategies, and political considerations are often given precedence.

Also, in practice, the majority of constraints, especially of the time or capacity variety, are indicators of desired operation, and minor violations are usually tolerated. For example, a schedule with a single route marginally over eight hours is often accepted, not withstanding the fact that a work practice arrangement dictates that all routes should be less than eight hours in duration.

The majority of practical vehicle routing problems involve a multitude of considerations which are sometimes difficult to quantify. Examples include driver preference for customers, routes, and vehicles, access problems involving certain vehicle — customer combinations, road inclinations in winter snow, queueing at the depot, accidents and breakdowns, geographical obstacles which complicate distance and time estimation, vehicle cleaning and maintenance, union rules, labour and traffic codes, company and customer policies, political considerations, and unpredictable human behaviour. Thus, the scheduler is typically faced with a multitude of ill-defined objectives and constraints, the relative priorities of which may change markedly in a short space of time. These factors are seldom captured in the VSP computer package models.

VSP computer packages require sophisticated computer systems which are expensive to purchase and to maintain. These packages require the input of a very large amount of detailed data in order to produce meaningful results on practical problems. They are also inflexible in the sense that they provide a single response for each senario, with little opportunity for human interaction or sensitivity analysis. In contrast, a DSS of the type of described later in this article, requires only a standard personal computer with colour graphics capability, far less data input, and is menu-driven, user-friendly, and interactive. For an informative introduction to the concepts underlying the DSS and its uses see Davis (1988).

The most significant failing of the VSP computer packages is that they do not attempt to utilise the knowledge and intuition of the experienced scheduler. The aim and philosophy behind the majority of packages is to replace the scheduler by a computer system. However, the scheduler has an intimate knowledge and understanding of the problem that is completely ignored by the computer packages.

To summarise, the authors suggest that the currently available computer systems suffer from major deficiencies. First, they attempt to optimise an unrealistic objective function. Second, they impose constraints which cannot be violated, and ignore many other vital consideratins, some of which are nonquantifiable. Third, they require sophisticated computer systems, large-scale data input, and are inflexible. Most importantly, however, they ignore the talents of the experienced scheduler.

In 1984 the EEC investigated several computer packages for vehicle routing, including: VSPX, PARAGON, ROUTEMASTER, IRG, and TRANSIT. This study was concerned with quantifying the potential savings within Europe's dairy sector if computer packages were used to generate routes to be used by bulk milk tankers. The study findings, reported by Herligh, Butler and Pitts (1984), concluded that, because of the complexity of the practical vehicle routing problems, the human scheduler is capable of producing routes as good, if not better, than any of the currently available VSP computer packages.

Vehicle Scheduling Decision Support Systems: Motivation

Because of the problems associated with the currently available VSP computer packages, we now review the role of the computer in the area of practical vehicle route generation.

We start from the premise that a vehicle scheduling computer system should be developed in order to aid, rather than to replace, the scheduler. This is because it is difficult to see how any automatic VSP computer system, designed to produce, unaided, a complete schedule, could cope as well as an experienced scheduler, with the practical considerations discussed in the previous section. Hence we believe that the current computer packages are too optimistic in what they attempt to achieve, and that a more realistic goal is to develop an interactive computer system that will support the scheduler in carrying out the day-to-day decision-making activities.

Traditionally, a large map of the customers' area, together with coloured pins displaying customers and routes, have been of high utility to many schedulers. Using the map and pins the scheduler can tell, at a glance, what route services each customer, and in the event of a customer having to switch routes, the map will indicate other routes closest to that customer and what options are available. In order to construct the required routes the scheduler, using a detailed knowledge of customers, terrain, drivers, and other relevant factors, will then decide upon which option to select.

This map-and-pin procedure serves the scheduler well in some ways, but

suffers from deficiencies. First, each pin does not usually provide any inkling of the characteristics of the customer it represents, such as supply level. Thus, for example, in the event of the over-capacity of a route, the scheduler may have to remove a customer from a particular route. The map and pins will indicate which customers are closest to other routes, and therefore candidates to be removed from the existing route. However, before the scheduler can decide which customer to remove, the service level of each customer on the overloaded route must be ascertained. This information is usually not available from the map and a detailed search through invoices or dockets may be required.

Second, over time, the map may become overloaded with pins, many representing locations whose customers are no longer serviced. This problem of map overloading can be avoided by having pins tied to an invoice or delivery system, with only customers requiring immediate service being displayed.

Because of the reliance of the majority of schedulers on the map-and-pin approach, the authors believe that a computerised scheduler's aid can be fruitfully based on a computer-generated map of the customers' area displayed on a high resolution graphics screen. Geographical features, and all relevant locations can be represented on that screen as a result of digitising their coordinates. Once the "map" and "pins" are computer driven, it is then possible to control what customers are displayed. Relevant customer information can be represented by using a colour graphics display system.

The authors believe that the computerisation of the map will allow a complementary combination of the skills of the scheduler with the power of the computer. The scheduler has ability, superior to that of the digital computer, to recognise patterns in the location of customers and routes. These patterns will suggest possible clusters for new routes, and options when routes have to modified. Before these patterns can be translated into new routes, the scheduler needs, among other things, information on individual customer service requirements, and these service levels totalled for any cluster. The generation of this information is a task to which the digital computer is better suited than most, if not all, schedulers. Such a scheduler-computer combination marries the pattern recognition skills, local knowledge, and experience of the scheduler with the numerical and recall ability of the computer. We now discuss the development of a DSS which is based on these considerations.

Vehicle Scheduling Decision Support System: Design

The previous section outlined the motivation behind the development of a microcomputer-based DSS for practical vehicle scheduling problems. The kernel of this system is a high resolution graphics screen which enables a computer map, showing customer locations, to be displayed.

One of the keys to the design of a vehicle scheduling DSS is to first discover the behaviour and strategies of a typcal, experienced scheduler. One must then devise ways in which a DSS can make this person more efficient. The task faced by a vehicle scheduler is typically one of two types. The first, "local" type involves the modification of an existing schedule. This is appropriate when there is relatively little change in the conditions or data. The second, "global" type involves the generation of a complete set of new routes, without reference to an existing schedule. This is appropriate in a start-up situation, or when there are significant changes in conditions or data which trigger a rationalisation of resources.

The local task often involves the clustering or re-clustering of the customers on one route or a limited number of neighbouring routes. The global task can usually be accomplished by carrying out systematically the clustering of customers' regions into which the whole area has been divided. As this is akin to carrying out the local task repeatedly, in one region after another, we deal only with the local task throughout the rest of this article.

Suppose a scheduler wishes to carry out a local task by modifying an existing schedule in order to generate the new schedule. Two key questions should be asked:

i. What are the requirements of the new schedule which differ from the previous schedule? and,
ii. How should the previous schedule be modified in order to create a satisfactory new schedule?

The first question usually involves constraints governing the feasibility of any new schedule. The second question involves not only these constraints, but also the measurement of how satisfactory the new schedule is, in terms of various objectives. We now list some possible main-menu options of a DSS designed to aid the scheduler in the search for answers to these questions.

The Schedule List Option

In order to begin the process of new schedule generation, based on the previous schedule, the scheduler must first be able to access the previous schedule. The DSS should thus have a listing of all the routes for any

previous schedule, along with various of its summary statistics which will be used in the generation of a new schedule. Examples of such statistics are, for each route: total customer service level, excess vehicle capacity, distance traveled, and time taken.

The Parameter Comparison Option
There should be some means whereby the scheduler can ascertain how the previous schedule will not meet the requirements of the forthcoming schedule. Thus a mechanism for the comparison of the parameters of the previous schedule with the new parameters is desirable. This may require the comparison of parameters such as: customer service levels, changes in customer location, and vehicle capacity.

The Schedule Modification Option
Having pinpointed where the previous schedule is deficient, the scheduler must then devise modifications to it which produce a satisfactory new schedule. Thus in answering question (ii), the system must provide for existing schedule modification by such means as:

(a) Adding a new customer to a route,
(b) Deleting a customer from route,
(c) Transferring a customer from one route to another,
(d) Interchanging customers between different routes, and
(e) Creating a new route.

The selection of these options should be guided by the provision of relevant statistics associated with them, such as: vehicle capacity utilisation, and route duration or time. Naturally there must be a mechanism whereby the new schedule can be recorded, usually by overwriting the previous schedule which is being modified.

The logical consequences of adopting any of the above options must be incorporated, in the sense that all relevant parameters and statistics must be automatically updated. Further, the system must not only be able to deal with options inputted by the user, but it is desirable that it displays an intelligence by suggesting relevant options. The system should enable the scheduler analyse the consequence of these options. Routines based on the above options should enable a scheduler to behave as usual when carrying out the scheduling task, but in a more systematic and efficient manner.

Conclusion and Summary
We have discussed the classical OR problem of vehicle scheduling and the computer packages available for its solution which are based on mathematical programming methodology. It is asserted that these

approaches are deficient when used to solve practical vehicle scheduling scenarios, for the following reasons, among others. The models upon which the packages are based assume mathematically defined optimality criteria and constraints. In our experience, such models are largely irrelevant in the practical scheduling scene and more importantly, the computer packages based upon them cannot compete with an experienced human scheduler who has an intimate knowledge of the specific situation. It appears unwise to attempt to replace the scheduler and thus ignore this valuable inspiration and experience, which cannot be emulated by today's packages.

Rather, we suggest a more constructive approach, in the form of a decision support system to enhance the scheduler's unique powers. This allows both human and machine to combine to form a powerful scheduling team, each of the two complementing each other's abilities. This approach has been used in the dairy industry with significant success in a number of countries, in situations where vehicle scheduling packages foundered. A later paper will describe the successful implementation of a DSS for milk tanker route generation in an Irish dairy cooperative.

REFERENCES

Butler, M., and Foulds, L. R., "Milk Assembly via Artificial Intelligence: An Irish Case Study", 1989. Forthcoming.

Clarke, G. and Wright, J., "Scheduling of Vehicles from a Central Depot to a Number of Delivery Points", *Operations Research,* 1964, Vol. 12, No. 4, pp 568-581.

Christofides, N. and Beasley, J., "The Period Routing Problem", *Networks,* 1984, Vol. 14, pp 237-256.

Christofides, N., Mingozzi, A., and Toth, P., "Exact Algorithms for the Vehicle Routing Problem based on Spanning Trees and Shortest Path Relaxations", *Mathematical Programming,* 1981, Vol. 20, pp 255-282.

Dantzig, G. and Ramser, J., "The Truck Dispatching Problem", *Management Science,* 1959, Vol. 10.

Davis, M. W., *Applied Decision Support,* Prentice Hall. 1988.

Fisher, M. and Jaikumar, R., "A Generalised Assignment Heuristic for Vehicle Routing", *Networks, 1981, Vol. 11, pp 109-124.*

Foulds, L. R., Ghare, P. M., and Turner, W. C., "Transportation Routing Problem: A Survey", AIIE Transactions, 1974, Vol. 6, pp 288-301.

Foulds, L. R., Read, E. G., and Robinson, D. F. "A Manual Procedure for the School Bus Routing Problem", *Australian Road Research,* 1977(a), Vol. 7, pp 21-24.

Foulds, L. R., O'Brien, L. F., and Pun, T. J., "Computerbased Milk Tanker Scheduling", *New Zealand Journal of Dairy Science and Technology,* 1977(b), Vol. 12, pp 141-145.

Foulds, L. R., and Watson-Gandy, C., "Vehicle Scheduling: A Survey", *New Zealand Journal of Operational Research,* 1981, Vol. 9, pp 73.92.

Gillet B., and Miller, L., "A Heuristic Algorithm for the Vehicle Dispatch Problem", *Operations Research,* 1974, Vol. 22, pp 340-249.

Golden, B., Magnanti, T., and Nguyen, H., "Implementing Vehicle Routing Algorithms", *Networks,* 1977, Vol. 7, pp 113-148.

Herlihy, P., Butler, M., and Pitts E., "Estimation of Energy and Cost Savings Arising from Rationalisation of Milk Assembly", *EEC Commission,* 1984, Vol. 9272.

UNIVERSITY ENTRANCE STANDARDS, STUDENT PRIOR PERFORMANCE AND PERFORMANCE AT FIRST YEAR LEVEL COMMERCE EXAMINATIONS

Peter J. Clarke*

Introduction

Admission policy to the majority of Irish Universities is based entirely on the students' examination performance at two secondary school examinations namely, the Leaving Certificate and the Matriculation. The former is compulsory. The latter is optional in theory, but in practice the majority of prospective University students will also sit the Matriculation. The grades obtained in individual papers in both these examinations are translated, for admission policy, into "points". The "points" scale for University College, Dublin is shown in Table 1:

Table 1: *"Points" Attributable to Leaving/Matriculation Examinations*

	Leaving Certificate		Matriculation
	Honours paper	Pass paper	Common paper
Grade A	5 points	2 points	5 points
Grade B	4 points	1 point	4 points
Grade C	3 points	Nil	3 points
Grade D	2 points	Nil	2 points
Grade E	Nil	Nil	Nil
Grade F	Nil	Nil	Nil

Note: In the case of Mathematics, 2 bonus points are awarded to the Honours level Leaving Certificate paper i.e. Grade A = 7 points.

For "points" purposes, the students' six best subjects are counted over the two examinations. Thus, the maximum points which can be obtained by a student is 32. (i.e. 6 "A's" including Mathematics).

In recent years two trends regarding incoming University students have been noted. First, the "points" necessary to gain admission to the Commerce Faculty at UCD have risen dramatically. This is because an increasing number of students are selecting Commerce as their preferred choice of study at University. However, the number of admissions has remained virtually static at 300. The growth in entry standards of Commerce students at UCD is shown in Table 2.

*The author is a Lecturer in Accountancy in the Department of Accountancy, University College, Dublin.

IBAR—Irish Business and Administrative Research, Volume 10, 1989, pp 75-85

Table 2: *Entry Standards of Commerce Students at UCD*

Entry time	Year	1st Preference	Min. points
Oct. 1989	89/90	1,556	??
Oct. 1988	88/89	1,315	23*
Oct. 1987	87/88	1,184	22*
Oct. 1986	86/87	882	21
Oct. 1985	85/86	881	21
Oct. 1984	84/85	884	19*

*Not all applicants on these points were offered places.

Second, more students are studying accounting (and other business related subjects) at secondary level. Table 3 provides a proxy measure of this growth since it indicates the total number of University applicants which are processed through the Central Applications Office (CAO) and those with "business studies" subjects.

Table 3: *Number of Leaving Certificate Students on the CAO Examinations file*

	1977		1988	
Subject	Total number of applicants	Total subject	Total number of applicants	Total subject
Accounting	12,041	1,664 (14%)	22,993	6,700 (29%)
Economics	12,041	1,924 (16%)	22,993	3,757 (16%)
Business Org.	12,041	1,659 (14%)	22,993	6,180 (27%)

It is anticipated that the trends in relation to increased entry standards i.e. the "points" and the number of students taking "business" related subjects at secondary school will continue, at least for the short term. (The total number of applications for University places processed through the CAO will probably exceed 26,000 for the academic year 1989/90). Do these trends have any implications for accounting and University educators? Is the "points" only system of admission effective? Does prior study of accounting at secondary level assist in first year University accounting exams? Conversely, do students who are studying accounting for the first time find the course moving too quickly and/or find the subject too difficult?

This article contains results of a preliminary study of the association between secondary school performance and students' first level university commerce examination performance. It is divided into four sections. Section 1 reviews the available literature in this area. Section 2 provides a description of the study and research methodology. Section 3 contains the results and finally, Section 4 discusses the results and suggests areas for future research.

Literature Review

Previous research on this topic, conducted almost exclusively in the United States, has provided contradictory results. Smith (1968) noted significantly higher overall course performance in accounting by students with secondary level accounting background. However, Baldwin and Howe (1982) and Bergin (1983) concluded that overall performance in accounting was not related to the presence or absence of a secondary level background. Both these latter studies observed higher accounting exam scores *early* in the University course by students with an accounting background, but this early advantage diminished and had totally disappeared by the final exam at the end of the first year. Thus, both studies concluded that a secondary level accounting background did not provide a significant advantage to students in the first level University accounting course.

Schroeder (1986) in his sample of 67 students noted no difference in overall course performance in accounting between college students without prior accounting coursework and those with one year or less of secondary level accounting. However, students with *more* than one year of school accounting coursework earned significantly higher scores on all exams in the University introductory financial accounting course.

Mitchell (1985) in a study based in Scotland concluded that it can be potentially rewarding for the first level accounting student to have taken accounting to *Honours* standard at school. In this case the benefits of school accounting were evidenced only in the performance of candidates in the quantitative, accounting university examinations.

More recently, Ramadan (1988) in a Jordanian study, concluded that students with school accounting qualifications performed significantly better than students who did not have such a qualifation.

The extent to which the results of the above studies can be interpreted across international boundaries is open to question. There are, for example, cultural differences in the educational environments and also differences of terminology. For example, Smith (1968) and Baldwin and Howe (1982) use the term bookkeeping to describe students exposure to accounting at school. The time period in some of the studies lasts only for one semester at University. In addition, a feature of many US University accounting examinations is the predominance of multiple choice questions. Moreover, none of the above studies differentiated in relation to the sex of the student.

Description of Research and Research Methodology

The aim of this study is to replicate, within an Irish context, previous research on the issue of whether school accounting is beneficial to students in first year Commerce exams. In addition, this study involved testing the significance, for student performance, of the "points" admission system to the University.

The 1986/87 first year class at University College, Dublin was used for this study. The course offered to this class consisted of three lecture hours per week over a 24 week academic year and forthnightly tutorials. The course is predominately "financial" as is the accounting course available at secondary school level.

The students selected for analysis were first year students at UCD who were admitted under the normal "points" requirement. Thus the sample (arbitrarily) excluded foreign students and transfer students. Finally, students registered for the course but who had not sat the examinations were also omitted. The final sample size was 278. The Leaving Certificate background (in business subjects) for the students surveyed are displayed in Table 4:—

Table 4: *Background of Respondents*

Sex:	Male 177	Female 101:	Total 278
Subject taken at Leaving Certificate	Pass	Honours	Total
Business subjects		No. taking subjects	
Accounting	None	157	157
Economics	None	89	89
Business Organisation	None	71	71

UCD points distribution and number of students

32 points (maximum)	2 students	= N = 278
31 points	2 students	
30 points	2 students	
29 points	4 students	
28 points	3 students	
27 points	10 students	
26 points	15 students	
25 points	14 students	
24 points	33 students	
23 points	51 students	
22 points	65 students	
21 points	77 students	

The situation described above provided the opportunity to test hypotheses on the relationship between University entrance standards i.e. "points", school accounting qualifications, first year University examination performance and the sex of candidates. The following null hypotheses were tested:

★ Hypothesis 1: Relating to entry "points" and first year accounting performance.

"There is no relationship between the UCD entry "points" obtained and the accounting mark obtained in the first year examination."

★ Hypothesis 2: Relating to entry "points" and overall first year performance, defined in terms of credits obtained, the maximum credits obtainable being 16.

"There is no relationship between the UCD entry "points" obtained and the number of "total credits" obtained in the first year examination.

★ Hypothesis 3: Relating to the possession of a secondary school accounting qualification and sex of student.

"Males who have gained a school accounting qualification will not achieve significantly different examination marks in accounting from males with no school accounting qualifications."

★ Hypothesis 4: Relating to the possession of a secondary school accounting qualification and sex of student.

"Females who have gained a school accounting qualification will not achieve significantly different examination marks in accounting from females with no school accounting qualification.

Hypotheses 1 and 2 were tested using simple regression analysis with the t-value testing the null hypothesis Ho:B1 = 0. If there is no relationship between the independent and dependent variables, then B1=0. However, simple regression requires a number of assumptions including the linearity between the dependent and independent variables. As a result it was decided to further test these two hypotheses using the Chi-square (X2) test with a 99% confidence level.

Hypotheses 3 and 4 are more important for the purposes of this study. As the student samples used were independent (not matched pairs) and of differing sizes and the data measurement scale was at least ordinal, a two sample, two tailed Mann-Whitney test was used to test hypotheses 3 and 4. The Mann-Whitney test is based upon a comparison of the rank of the values of one samples in an array of the combined values of the two samples. If the two samples come from the same population, or two populations with equal means, the average rank for each should be equal.

Results

Hypotheses 1 and 2 using regression analysis

Table 5 contains the results of simple linear regression. The null hypothesis is tested using the t test on the coefficient of the independent variable, rather than the more popular F test. It should be noted that in regression models with only one explanatory variable the t test and the F test yield the same results.

Table 5: *Results of Simple Linear Regression*

	Regression No. 1	Regression No.2
Hypothesis	Ho:B = 0	Ho:B = 0
Independent variable	UCD points	UCD points
Dependent variable	Accounting mark (1st year)	Total credits (1st year)
No. of observations	278	278
R2 (coefficient of determination)	0.16	0.07
Constant	19.29	6.63
Beta coefficient (B)	8.98	0.34
Std error of beta coeff. (Se)	1.24	0.07
t-value of beta coeff. (B/Se)	7.24	4.85
Reject Ho if t-value > 2.576		
DECISION	REJECT hypothesis	REJECT hypothesis
Level of significance	a = 0.01	a = 0.01

The computed t-values (7.24 and 4.85) are statistically significant at a 1% level of significance. Thus, the entry "points" is significant in determining both first year accounting mark and total credits obtained in the first year examination overall. However, the idea of linear regression analysis relates to the assumption that the best representation of perfect correlation is a straight (linear) regression line fitted to the observed data. Based on the low coefficient of determination (R2) in both regressions it can be interpreted that the relationship between points/accounting mark and points/ total credits obtained is not linear. In addition, there are other important influences on examination performance apart from entry points.

Hypotheses 1 and 2 using Chi-square

Tables 6 and 7 shows the "points" distribution of respondents, the distributions regarding credits obtained (the maximum being 16), and accouting marks relative to average accounting mark obtained.

Table 6: *UCD "Points" and Credits Obtained by Respondents*

UCD points	No.	No. with maximum credits	No. with less than max. credits
24 to 32	85	72	13
23	51	36	15
22	65	35	30
21	77	41	36
	278	184	94

Null hypothesis: The pass rate (i.e. 16 credits) is independent of the UCD entry "points".

Chi-square = 23.94 with 3 degrees of freedom.

Reject Ho if X2 test > 11.3449

DECISION: Reject hypothesis at a = 0.01.

Table 7: *UCD "Points" and Distribution of Accounting Marks vis-a-vis Average*

UCD points	No.	No. obtaining above avg. mark	No. obtaining below avg. mark
32 to 24	85	72	13
23	51	38	13
22	65	42	23
21	77	46	31

Null hypothesis: The accounting mark (i.e. above/below average) is independent of the UCD entry "points".

Chi-square = 13.72 with 3 degrees of freedom.

Reject Ho if X2 test > 11.3449

DECISION: Reject hypothesis at a = 0.01.

Hypotheses 3 and 4

Table 8 contains the results of the Mann-Whitney test on the accounting examination performance in first year, subdivided by sex of student. The null hypothesis is emphatically rejected in both cases. Given the direction of the average marks it can be concluded that students with a school accounting qualification generally scored more highly than the others of the same sex in the first year accounting examination. Thus, boys with an accounting background score more highly than boys without an accounting background. Likewise, girls with an accounting background score more highly than girls without an accounting background.

Table 8: *Results of Mann-Whitney Test on Hypotheses 3 and 4*

	Students with school accounting		Students with no school accounting		
	No. of students	Average mark in 1st year Accounting	No. of students	Average mark in 1st year Accounting	Results of Mann-Whitney test
Male	108	77.2%	69	62.8%	Reject at a = 0.01
Female	43	78.9%	58	60.5%	Reject at a = 0.01

To further test the above results it was decided to perform multiple regression with accounting mark as a dependent variable and the following as independent variables: (1) UCD "points", (2) work effort during the year, (3) school accounting background and (4) sex of respondent. The immediate problem is how to identify and measure "work effort" during the year. Since no reliable data was generally available it was decided to use the number of credits obtained in the overall examination as a proxy variable for work effort. While this proxy variable was not the most suitable to use it was the only one available for this preliminary study. The results are provided in Figure 9:—

Table 9: *Multiple Regression Results — Accounting Mark as Dependent Variable*

Constant	54.96	R2 = 0.61
Independent variable		Coefficients (t-values in parentheses)
(1) UCD "points"		5.44 (6.18)*
(2) Work effort i.e. credits obtained		9.55 (12.90)*
(3) School accounting		32.31 (8.11)*
(4) Sex of respondent		3.16 (0.79)

*Significant at a = 0.01

The above regression results confirm that the accounting mark obtained in the first year University accounting examination is related to entry points, work effort during the year (as measured by the proxy variable of total credits obtained) and whether the respondent had a school accounting background or not. The sex of the respondent as an explanatory variable was not statistically significant.

Discussion and Conclusions

The primary purpose of this study was to provide some insights (and thus stimulate discussion) into the effect of secondary level performance including accounting performance) on students' performance in first year Univesity Commerce examinations. The exact strength of the relationships at this preliminary stage of research was not considered to be as important as the general direction of such relationships.

The results of this study are entirely consistent with the notion that it is rewarding for the first level accounting student to have taken accounting at secondary school. In this study the benefits of school accounting performance of candidates was evidenced in the first year accounting examination. It could well be that the main advantages of school accounting for the university student derives from the extra experience and practice which school study provides in the technical and computational aspects of the subject.

The results also confirm the strong relationship between entry points and overall first year examination performance. The higher the entry points, the higher the probability is that student will be successful in his first year examinations. In this sense the entry points is an efficient method of administering University admission policy although it must be acknowledged that there may be superior systems of selecting University entrants.

It would be possible to extend this study to other business subjects taught at both secondary level and at first year University courses. Such subjects include Business Organisation (Administration), Economics and Mathematics. If the results of this study were consistent with other subject areas it could mean that a student's performance in the traditional first year business courses taught at University was dependent, to a large extent, on his/her exposure to that subject in secondary school.

It is probable that entry points and prior exposure to accounting are not the only factors that affect performance at first year University examinations. We have ignored the impact of motivation yet research has shown that motivation can explain significant portions of the variance in academic performance (Grabe, 1981). Also, it is possible that socioeconomic factors influence performance. For example, Eskew and Faley (Eskew and Faley, 1988) found that in addition to exposure to accounting at secondary level, ability and effort/motivation are also important variables in explaining performance.

While the ability to generalise from a single study is always limited, these

results confirm the existence of a situation which is of concern to those involved with first level accounting University education.

The indications are that those students without leaving certificate accounting may need extra attention to avoid being disadvantaged in the practical aspect of the subject. This could be achieved by alerting students to the problem at the start of the academic year and providing supplemantary/remedial lectures or additional tests. The extent of this supplementary assistance is a matter of judgement. However, Australian research by Braye and Craig (1980) concluded that remedial tuition appeared to have no effect on students' examination performance. (The respondents were in favour of retaining remedial teaching and its greatest benefit appeared to be in reducing examination stress).

Knowledge of students' previous exposure to secondary accounting may help accounting lecturers change the structure their first year accounting courses. One possibility is to offer one introductory course for those with appropriate secondary level exposure and another for those with no or inadequate exposure. The two courses could examine the same material but in different ways. After all, if these two groups start out as "unequals", should they not be treated as such?

Alternatively, it may be desirable to revise the first year accounting syllabi to incorporate accounting theory and/or managerial accounting. On the other hand, it could be argued that certain first year students will always have some advantage over others, whether it be prior exposure to accounting or something else. As a result, first year students can never be a homogeneous group. Thus the results of this study simply confirm the "natural order of things".

These findings have implications for secondary students (and their career advisors) who are interested in pursuing a University degree in Business Studies. In particular, since first year accounting courses could "make or break" students, exposure to secondary school accounting may help to mitigate the drop or failure rate among first year students during one of their most vulnerable times at college. Indeed, the performance in first year accounting examinations may be an important factor for a student in deciding whether to subsequently "major" in accounting.

In conclusion, the results are based on ONE sample — a sample which may not be representative of other years or other Institutions. Some answers are provided but wait to be verified by additional research using more sophisticated methodology and data. In the meanwhile, the purpose of the paper will have been achieved if it convinces policy makers that the

topic is worthy of further research. After all, the education process begins with having someone to educate!

REFERENCES

Baldwin, B., and Howe, K., "Secondary-level study of accounting and subsequent performance in the first college course." *The Accounting Review,* July, 1982, pp619-626.

Bergin, L., "The effects of previous accounting study on student performance in the first college-level financial accounting course." *Issues in Accounting Education,* 1983, pp 19-28.

Braye, E., and Craig, R., "A study of student performance in introductory accounting." *Accounting and Finance* November, 1980, pp103-118.

Eskew, R., and Faley, R., "Some determinants of student performance in the first college-level financial accounting course." *The Accounting Review,* January, 1988, pp137-147.

Grabe, M., and Latta, R., "Cumulative achievement in a mastery instructional system: The impact of differences in resultant achievement, motivation and persistance." *American Educational Research Journal,* Spring 1981, pp7-13.

Mitchell, F., "School accounting qualifications and student performance in first level university acounting examinations." *Accounting and Business Research,* Spring, 1985, pp81-86.

Ramadan, S., "The effect of school accounting on Students' performance in first level University accounting courses." Paper presented at the British Accounting Association National Conference, Nottingham. 13/15 April, 1988.

Schroeder, N., "Previous accounting education and college-level accounting exam performance". *Issues in Accounting Education,* Spring, 1986, pp37-47.

Smith, J., *Articulation of High School Bookkeeping and College Elementary Accounting.* Unpublished doctoral dissertation, University of Oklahoma, 1968.