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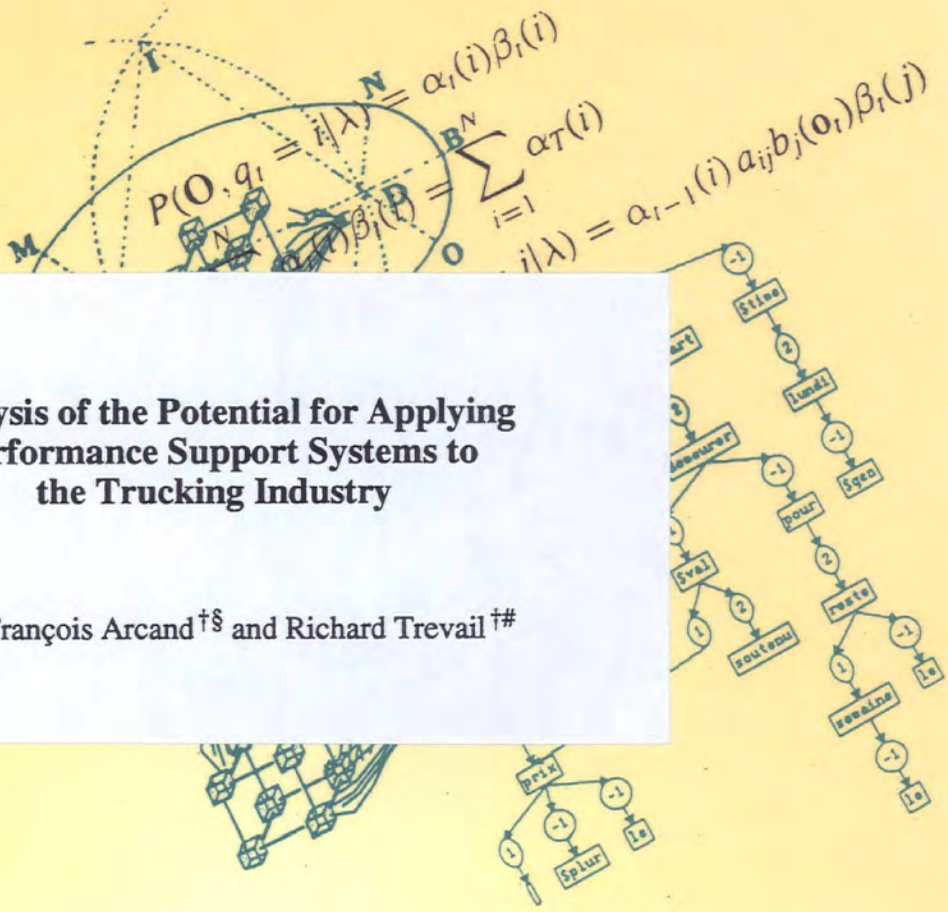

Analysis of the Potential for Applying Performance Support Systems to the Trucking Industry

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Analysis of the Potential for Applying Performance Support Systems to the Trucking Industry

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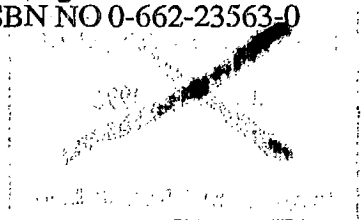

INTRODUCTION

The transportation of goods occupies an important niche in the North American economy. In Canada, trucking generates revenues approaching five per cent of the Gross Domestic Product (GDP) (Braxton Associates, 1994). The moving of goods fuels the national economy.

However, the trucking industry consists of much more than moving a load from point A to point B. The growing interest in logistics[1] in the 1980s, and the consequent widespread use of the term, are evidence enough that the manner in which business manages the physical flow of goods should be questioned (Fabbes-Costes, 1992 [a]). As well, how the trucking industry perceives information technology should be examined. There are also matters of equipment availability, routing, communication, safety, tracking and customer service which must be addressed.

The core of this study consists of *Needs Analysis, Technology Analysis, Transferable Technologies* and *Task Analysis*.

Needs Analysis attempts to identify areas which represent opportunities for Canadian trucking competitiveness. Three cultures within the industry were examined: Management, Drivers and Dispatchers. *Technology Analysis* reviews computer-based products available in North America and Europe for the trucking industry. It touches upon tools for routing, scheduling, dispatching, fleet management, etc. As well, this phase looks at products that are currently under development (primarily expert systems and decision support systems for dispatching, scheduling, planning and safety). *Transferable Technologies* looks at Decision Support System concepts, Performance Support System concepts and User Interface concepts in other domains which have potential for application in the trucking industry. Finally, *Task Analysis* was carried out to discover what tasks trucking managers are required to perform.

In order to conduct this study, it was vital to find out what products are available that could help increase performance for the trucking industry (*see* Appendix 5 & section 4.4). To do this, a number of on-line databases were consulted (Table 2). As well, a number of companies and associations were contacted. Appendix 7 summarizes the contacts with these companies. A number of companies (approximately 50%) supplied product information. The information received was evaluated and is included in Appendix 5.

An increasing number of variables make it necessary for the trucking industry to develop "tools that operate in real-time mode and assist companies' executives in making decisions that improve its bottom line" (CTRI, 1993). Performance Support Systems (*see* Appendix 1) offer just those tools (*see* Appendix 2). This technology was selected as the focus of this study because of its ability to offer just-in-time support, when, where and in the format needed.

[1]Often called supply chain management, logistics involves all areas linked to the successful and punctual delivery of raw and finished materials. Logistics includes both "the physical flow of goods and the complementary flow of information" (Denham, 1993; Fabbe-Costes, 1992 [b]). The goal of logistics in the trucking industry is to equip companies with competitive advantages by: a) providing cost controls over the entire "transportation and displacement process"; b) allowing higher product reliability and higher product quality; c: allowing businesses to immediately react to market demands (Fabbe-Costes, 1992 [b]).

2. NEEDS ANALYSIS

2.1 What Are The Areas of Opportunity?

In 1993, *Peat Marwick Stevenson & Kellog* (KPMG) submitted a report to the Canadian Trucking Research Institute (CTRI) titled *Trucking Industry Management Training Needs Analysis.* This report was a continuation of a 1989 study on human resources in the trucking industry by Employment and Immigration Canada. The report outlined areas that require improvement in order for the Canadian trucking industry to become more productive and remain competitive with US. carriers. KPMG found that, in general, " a significant gap exists between the expectations of shippers and the capability of motor carriers" (1993). This gap can lead to friction between carrier and shipper. It was found that carriers often perceive value as an ability to reduce transportation costs for the shipper.

Customer service, customization and other value-added services can affect a shipper's decision to engage a carrier (KPMG, 1993). Those who seek the services of a carrier interpret the value of that service in other than monetary terms. They see "quality and speed of response, flexibility and responsiveness, and reliability and dependability" (KPMG, 1993) as equally if not more important than cost. Companies, now more than ever, are "competing on the basis of quality of service, flexibility, responsiveness, reliability, and time compression.....Consequently, if a carrier wishes to serve this type of enterprise, it must also complement the shipper's strategy if it is to be successful" (KPMG , 1993).

Lack of adaptability to customer needs is cited as one reason why shippers are engaging the services of US. carriers (KPMG, 1993). For Canadian trucking firms to remain competitive, they must move in the direction of a market-driven, rather than production-driven, culture (KPMG, 1993). The Canadian trucking industry must respond to the needs of its customers in order to build market confidence, else risk losing business south of the border.

Trucking companies, as in any other organization, have a hierarchical construction. The breakdown of this hierarchy is represented in Appendix 4. Each level has needs that are not only specific to that level, but has links to the levels above or below it. For example, customer service is just as important for a dispatcher as it is for a vehicle operator or sales representative.

The KPMG report identifies four areas, each broken down into subsets, in which the Canadian trucking industry could use improvement (1993). The major areas are:

- Customer service and quality
- Strategic planning and logistics
- Leadership skills
- Costing, cost control and budgets

The opportunities, clearly, are many. A number of the above mentioned problem areas require specialized formal education. Others can be addressed with the implementation of job-aids.

2.2 Training

2.2.1 Management

"Training is becoming an increasingly important aspect of the everyday life of road haulage contractors. The introduction of new technology, stricter requirements from the authorities, and not least the higher expectations of the customers, are making ever-stiffer demands on the know-how, abilities and skills of the haulage firm and its staff" (FDE, 1993).

There is little doubt that today's managers face much more complex problems than did their predecessors. Because of these complexities, it is necessary for managers, in order to be effective, to possess some form of specialized training or post-secondary education, whether it be in the form of industry sponsored training seminars or university programs directed at management degrees.

For a variety of reasons, managers eventually leave their jobs, either temporarily or permanently. This can cause a number of problems, as a manager's knowledge is directly proportionate to experience (Goetschalckx, 1988). Managers who acquire a degree of proficiency are difficult to replace, or rather, their knowledge is difficult to replace. Knowledge lost is not easily recovered .

Problems can be compounded by the fact that today's trucking executive requires knowledge of a number of domains: accounting, management control, marketing, administrative technology, human resource management, consumer relations, vehicle safety and maintenance, and logistics, not to mention the latest industry developments. Managers, because of their levels of responsibility, must be able to communicate with people both inside and outside the domain (Ministère de la Main d'oeuvre..., 1992). This means that a deeper understanding of the needs of those that must be dealt with, must be achieved.

The majority of trucking personnel are informally trained on-the-job (Ministère de la Main-d'oeuvre..., 1992). However, some post-secondary courses are specifically targeted to the trucking professional.

The goal of these courses is to ensure that trucking company managers (as well as other industry professionals) are able to operate at efficiency levels that meet market demands. This means providing training in the use of the latest methods and technologies. A large number of companies are run by managers whose decisions are based solely on experience and whose tools include nothing more than pocket calculators, Gantt management charts and look-up tables (Goetschalckx, 1988). This puts them at a distinct disadvantage when competing against more technologically advanced companies.

KPMG states that a number of university courses on transportation management are available, however, their report does not include them "because they require participants to enroll in the corresponding degree program" (1993). The report does, on the other hand, make mention of several short courses, offered primarily by US. universities (one Canadian university, York, is included). Three professional associations are also mentioned.

While short courses are better suited to the needs of the industry than longer ones (they do not require businesses to liberate employees for extended periods of time), one must question the comprehensiveness of information that can be delivered. For example, York University offers a three-day Logistics Management course[2] that is designed primarily for shippers, though it often attracts middle and senior managers from within the trucking industry. The range of topics is quite vast, from Logistics Strategy to Information Technology (KPMG, 1993). The time frame within which this course is offered permits only an overview of a domain which is really quite large. For this reason, the goal of the course is to provide a bare-bones understanding of logistics issues.

A further problem with the above mentioned courses is that , with the exception of the York program, they are offered primarily by American institutions. This requires additional expenditures on the part of the Canadian companies seeking training. Add the cost of initial training to the cost of training new personnel as a result of employee turnover and one is left with what could easily amount to large sums of capital.

CAMO-ROUTE (*Comité sectoriel de main-d'oeuvre de l'industrie du transport routier au Québec*), a Quebec provincial organization, has recognized that the opening of North American markets, deregulation, economic recession and the advent of new technologies has increased the need to supply training to those who already make their livings in the trucking industry, or wish to (CAMO-ROUTE[a], 1993). For these reasons, CAMO-ROUTE has developed a four month, 15 credit program leading to a Certificate in Road Transport Management. This program has been available at *Université du Québec à Montréal* (UQAM) since September 1994.

The course covers a range of subjects of value to trucking professionals: industry knowledge, dispatch communications, dispatch/assignation problems, supervisory skills and negotiation skills (CAMO-ROUTE[b], 1993), billing, sales and marketing, vehicle security and maintenance, and financial management (CAMO-ROUTE[a], 1993) to name but a few.

Other than those courses mentioned above, and practical on-the-job experience, we have not found other avenues through which trucking professionals are able to upgrade their skills.

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[2]The course is offered three times a year at York and once a year at both McGill University and the University of British Columbia.

2.2.2 Drivers

The question of whether training for drivers is adequate must be addressed. At present, it must be taken at face value that truck drivers are prepared for the problems they encounter while on the road. To become licensed, drivers must first undergo training which has met government standards. As well, drivers must obtain certification for such things as the use of air brakes and the transport of dangerous materials. Some of the certification courses offered are available as Computer Based Training (CBT).

Once licensed, drivers are considered competent at their task: Their level of skill is considered sufficient for the tasks they are required to perform. A number of organizations offer such training to aspiring drivers, and an effort is underway to develop a national curriculum.

Despite this, evidence exists that indicates the trucking industry is aware of deficiencies in the driver training process. A number of organizations are currently involved in the research and development of truck simulators; Microsim, Atari and Professional Truck Driving Simulators being among the players in the market (Tardif et al, 1991).

Simulators are designed to teach the 'hard' driving skills. That is, the practical, physical operation of a vehicle. Damages and injuries caused by unsafe driving practices is on the decrease, however, there are suggestions that even this situation could be improved. Stevens cites, "more traffic of all kinds, intense competition, sections of poor highway, larger less stable trucks, and other changes suggest that more skilled and careful truck drivers would improve safety and lower operating costs," and that "better evaluation and training should happen if the industry is to ensure an adequate supply of skilled and safety conscious drivers" (1993).

Still in the developmental stage, simulators offer an attractive alternative to on-the-road training. However, at this point in time, no devices which meet all driver needs are available (Stevens, 1993).

Though the trucking industry has taken great strides toward improving driver qualifications, areas exist , other than licensing, in which the industry can improve the skills, efficiency and effectiveness of drivers. These areas are related to customer service and human relations, as well as a number of others. Both training and job-aids, integrated into a single package, are potential solutions.

Technology can be used to teach these 'soft' skills, that is, knowledge of laws and regulations, public relations, professional knowledge, emergency techniques, vehicle component identification etc. (Friesen, 1990). All the cognitive skills that are needed to be an effective and efficient driver, can be delivered via a computer-based medium. Technology can also help the trucking industry polish its image. The industry has stated that it wishes to eliminate potential candidates with 'macho' tendencies from the driver training selection process (Tardif et al, 1991). "Electronic evaluation tools could be used to help the trucking industry learn whether a driver possesses the attitude and skills needed to safely operate a large truck" (Stevens, 1993).

2.2.3 Dispatchers

Dispatchers find themselves in the unique position of being between both managers and drivers. They must have knowledge of both aspects of the business. In order to offer a service that is at once efficient and effective, they must be aware of the limitations and capabilities of those above and below in the business hierarchy. It is their task to make sure that trucks are properly scheduled and routed. The first objective of the dispatcher is to "satisfy all service requests within the customer-specified time windows" (Goetschalckx, 1988).

Dispatchers are constrained by a number of variables. Sudden changes in the weather, traffic congestion and road closures can all affect scheduling and routing. "Truck despatching[sic] systems are subject to quickly changing conditions which affect the vehicle schedules" (Goetschalckx, 1988). The heuristic nature of routing prevents it from being taught within the confines of a classroom. In this case, the straightest line between two points is not always the most efficient.

In the case of dispatchers, it is the 'hard' skills, the hows, along with some of the 'soft' skills, the whats and the whys, which lend themselves well to computer-delivered training.

Some of the 'soft' skills—the whens and wheres—are acquired over a period of time. These dispatch needs would best be served by real-time job-aids and tools. Tools such as: routing software which helps lay out the best route to travel, given a set of known conditions, or which helps alter routes when new conditions are applied; and communications tools in order to receive and deliver real-time traffic information, which would help dispatchers run their operations more efficiently and more profitably by reducing the need for driver generated decisions in the face of unknown traffic conditions (TRANSCOM/ATA, 1991). As well, dispatchers can make use of dock management, stock management and inventory management tools. These fall into the 'hard' skills category, but that does not limit their value to the busy dispatcher.

Documentation exists on decision support systems and expert systems which were designed to aid dispatchers, but, to date, we have not located any documentation which describes their real needs Given the amount of research in the area of decision support systems for dispatchers, it can be assumed that the market perceives dispatchers' decision-making capabilities as either lacking or inefficient.

3. TECHNOLOGY ANALYSIS

3.1 Introduction

Under the impetus of the logistics movement, the trucking industry has developed to the point where two phenomena stand out: 1) hierarchical organizations[3] and 2) specialization within the domain[4] (Fabbe-Costes, 1992[c]). For this reason, it is important for the trucking industry to develop systems which facilitate their evolution. "New technology is an indispensable implement in the day-to-day activities in order to meet the customers' increasing requirements for precision and flexibility" (FDE, 1993).

Shippers, realizing the growing importance of technology, have already made the move to developing systems. The shippers in possession of the most technologically innovative systems are those who: are able to spare the resources, in terms of both monetary and personnel investment, to develop technology; and are able to make their investment pay off by spreading it over a network of clients and partners. These same shippers tend to choose their carriers based on the same criteria they desire in a system: 1) quality; 2) reliability; 3) cost; and 4) open communication (Fabbe-Costes, 1992[c]).

Trends show technology suppliers as playing a key role in providing future logistics services. Trade shows over the past five years have demonstrated a marked increase in the number of products offered by engineering and computer firms. IBM and DEC have even made the transportation sector one of their short-term target markets by offering "complete" computer and telecommunication solutions (Fabbe-Costes, 1992[c]).

This analysis focuses on products, either currently available or under development, for the trucking industry. All data come from literature searches in on-line databases. Information for commercially available products has been extracted from the *Computer Select* database where 45,452 computer products are briefly analyzed and summarized. Of these, 65 specifically address the needs of the trucking industry. For products under development, the major transportation and computer science publications of last five years were scanned. Table 2 gives a partial list of the on-line databases interrogated.

The results of this analysis are presented by domain of application.

3.2 North American Commercially Available Products

Table 1 summarizes the main areas covered by commercial applications dedicated to the various aspects of the trucking industry in North America. A short analysis of these products is given below. A complete list of all the software considered can be found in Appendix 5. Table 2 gives a list of all the tasks mentioned in the description of each commercial application. A few large US-based companies offer 'complete solutions' through an array of software products covering fleet maintenance, dispatching, routing and Electronic Data interchange (EDI).

Domain	Number	(%)
Fleet maintenance	44	68
Dispatching	7	11
Routing	8	12
Other	6	9
Total	65	

Table 1
NUMBER OF COMMERCIALLY AVAILABLE SOFTWARE PRODUCTS FOR THE TRUCKING INDUSTRY, BROKEN DOWN BY MAIN TYPE OF APPLICATION

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[3] In this case, hierarchical organizations refers to trucking companies which form alliances with other actors in order to provide "competitive and flexible logistic service" (Fabbe-Costes, 1992 [b]). This allows larger companies to increase both the number and variety of services it can offer to customers.

[4] Specialization within the domain refers to transport companies which specialize in one form of trucking, i.e. LTL, and whose logistical knowledge is transferable to companies who share the same logistical characteristics (Fabbe-Costes, 1992 [c]).

3.2.1 Fleet Management

Almost 70% of all available commercial products are job aids which support the various tasks related to fleet management (*see* Appendix 6). These systems generally consist of a database management system (DBMS) with various extraction and analytic capabilities. Preventive maintenance, tire management and inventories appear to be the main categories of functions provided by these systems.

3.2.2 Dispatching

A few products are designed to support dispatching operations. These include communication hardware and software. Some of these are among the most advanced systems in operation.

Coverage Plus, for example, is used with *Global Positioning System* (GPS) hardware and a Geographical Information System (*GIS, Mapstar*) to provide dispatchers and truck drivers with a sophisticated communications system that reportedly helps increase profits. The main reasons for the increase in gain is the lowering of the number of empty trailers and an increase in driver and customer satisfaction. The main performance issues addressed by the system include the difficulty of quickly giving precise information to the customer as to exact delivery times and dates, as well as the unnecessary waiting for drivers to be called to make a delivery. The system works on *Macintosh* computers and costs $3,750 per truck, plus $15,000 for a centralized computer at the home office (Anon, 1993).

A large US company uses a combination of specialized hardware, a database program and communication software to conduct Just-In-Time (JIT) inventories to inform customers on the status of a delivery. The main problem addressed by the system was customers' demand to access up-to-the-second data allowing them to know exactly when a shipment should arrive. The program seems to have worked. The company now responds to an average 209,000 phone calls a month, which indicates just how much their customers needed immediate information (Laplante, 1993).

Westinghouse has developed a product it calls *Sure Choice* (Westinghouse, 1993). Its structure closely resembles that of a PSS. It has multiple functions and levels of support which allow users to make dispatch decisions which facilitate the minimzation of shipping costs and ensures there is no deviation from promised delivery time. This is the only tool we have found which fits closely with the performance support paradigm.

3.2.3 Routing

A few products are designed specifically to support routing. They generally offer the possibility of specifying the origin and destinations of a truck, automatically calculating the optimal route and displaying a schedule. *PC*MILER*, for example, allows calculation of the optimal route and its display on an electronic map. Written reports describing the way to reach a destination can also be printed out and distributed to the driver. Another product called *LoadLogic* is designed specifically to help plan the loading configuration of a truck, taking into consideration the various stops along the way.

3.2.4 Other Specialized Applications

A few other software packages have been developed for more specialized needs. *BBARN* has been designed to provide information on bus garage space requirements.

*PC*Hazroute* helps choose the best route to transport dangerous goods on US. Highways. Calculations are based on safety data and population statistics, such as the localization of commodities available, area population and places where accident rates are high.

Ultramain Fleet Maintenance suggests ways to maximize the use of warranty plans and maintenance contracts.

Omnitracs is mainly a satellite communication package that allows the automatic calculation and display of a vehicle position. Such a system has been used in conjunction with GIS technology and communications tools in the specialized dispatch system described above.

3.3 European Commercially Available Products

Most information in this section comes from an inventory of existing software published by the "*Conférence européene des ministres des transports*" (1990). A lot of the available software is tailored to the European market, and cannot be realistically used, without modification, in North America. The domains covered by these products are similar to those of the North American market, mostly fleet management. The rest of this section describes a few interesting products.

EPSEM, is a system that allows the recording and display of events occurring in a truck. This information can then be analyzed for various management purposes, such as pay allocation, maintenance planning, etc.

A portable terminal, called FMS132, can be installed in a vehicle and automatically record and transmit such information as engine RPM and distances covered. It can also be used to display addresses and record breakdowns. A PC based centralized system can analyze the information for management purposes.

In 1990, the Laboratory for Information Processing of VTT (Technical Research Centre of Finland) initiated the TOP (Transport OPtimization) Project[5]. The goal of the project was to develop methodologies and software components for optimizing dispatch operations in the trucking industry. In Finland, transportation costs are extremely high due to distances which must be covered. Transportation costs represent the second largest portion of industrial costs (Linnainmaa et al, 163), and it is for this reason that vehicle dispatch optimization was chosen as the application area.

The dispatch problem , as it is addressed by the TOP project, is based on the traveling salesman problem. It is broken down into four sub-domains: 1) ORDERS - the material to be transported; 2) DELIVERY or PICK-UP - task to be effected; 3) FACTORIES - the destination or origination of material; and 4) VEHICLES - the type used. All sub-domains have common constraints. The constraints considered are as follows: TRAFFIC ROUTES - including railways, speed limits and seasonal road conditions; TIME - when deliveries must be made, including variables such as destination office hours, man-hour regulations, etc.; VEHICLES - capacities, materials to be transported; and FACTORIES - their location and what must be delivered to each.

TOP addresses a number of the concepts prevalent in Performance Support Systems. It provides just-in-time information in an easy to approach format, using a number of windows and pop-up menus which can be accessed using a mouse or other pointing device. Decisions which are reached by the system can be overridden by the user (User Control). On-line help is included for providing timely information (procedures for releasing assignments and redistribution of assignments) in unexpected situations , i.e. vehicle breakdown or roads blocked due to accidents. It can be used collaboratively, either between dispatch centres within the same company or between companies that use the same vehicles for transporting materials.

The system uses knowledge-based methods "implemented using object oriented techniques" (Linnainmaa et al, 167) to assign orders to factories and to assign orders to vehicles. The developers of the system recognize that numerous constraints exist and that because of this "there cannot be a universal method that could handle all the problems" (Linnainmaa et al, 167). The developers argue that the system is limited to solving only simplified problems or sub problems because of the complexity of the traveling salesman problem. However, they overlook the success that neural networks have had in solving similar problems.

3.4 Products Under Development

A literature review was conducted in order to seek out software development projects involving various aspects of the trucking industry. Table 2 summarizes the main on-line databases that were used for the investigation. Very few recent projects relate directly to the development of technological tools applicable to the trucking industry.

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[5] All information from:
Linnainmaa, Seppo et al. "Advanced Computer Supported Vehicle Routing for Heavy Transports."

Asia-Pacific	Japio
TRIS	
Transin	Pascal
Urbamet	

Table 2
LIST OF THE ON-LINE DATABASES CONSULTED FOR INVESTIGATING ONGOING RESEARCH AND DEVELOPMENT ACTIVITIES

The European DRIVE research program (Commission of the European Communities, 1992) also covers research and development in the following seven areas of major operational interest for road transport: demand management (6 projects), travel and traffic information (11 projects), integrated urban traffic management (8 projects), integrated interurban traffic management (12 projects), driver assistance and cooperative driving (10 projects) and freight and fleet management (5 projects). Table 3 lists pilot projects of interest to trucking.

Project Name	Goal
PLEIADES - Paris - London Corridor	To demonstrate an integrated driver information and network management system in the Paris-London corridor
COMBICOM - Combined Transport Communication System	To monitor the status of combined traffic units (swap bodies or containers)
FRAME - Freight Management in Europe	To control and monitor hazardous goods shipment
CITRA - System for the Control of Dangerous Goods Transport in International Alpine Corridors	To optimize hazardous goods transport from an international point of view
METAFORA - A Major Testing of Actual Freight Operations using RTI on an Axis	To test in a realistic environment mobile data communications and electronic data interchange
IFMS - Integrated Freight Logistics Fleet and Vehicle Management System	To implement an open systems architecture for computer aided and integrated transport

Table 3
EUROPEAN *DRIVE* RESEARCH PROGRAM

3.4.1 Expert Systems

Research in the field of expert system as aids for vehicle repairs is currently being carried out by a number of organizations. The problem here seems to be related to the growing use of electronically controlled engines and transmissions, and the corresponding shortage of skilled mechanics (Ferrone, 1992). Some work on the use of expert systems for preventive maintenance is also being carried out. A diagnostic system for evaluating the remaining life of a motor-operated valve was designed by a Japanese team (Takahiro and Koichi, 1991). Such systems could help determine optimal inspection times.

There is one study describing an emergency response system for the transportation of dangerous goods (Wilson et al, 1990).

A PC based system called "Ride Expert" was developed to diagnose rough ride problems in heavy trucks (Rawicz and Jiang, 1992). This system helps reducing the time necessary to find and fix the causes of rough rides.

3.4.2 Truck Simulation

The Canadian Trucking Research Institute recognizes that driver safety and productivity "are of vital local and national interest" (Stevens, 1993). With this in mind, it is currently involved in research into the feasibility of truck simulators for the evaluation and training of professional drivers. The Institute is also investigating the types of simulators which are under development or in use, together with their areas of application.

3.4.3 Safety

The Large Truck Safety Decision Support System (LTSDSS) was developed to provide access to information concerning truck safety (Chow and Opiela, 1993). The system may be used to assist in producing strategic construction programs to eliminate dangerous traffic conditions due to faulty road design.

A study by Beroggi and Wallace (1991) describes a prototype decision support system supporting the dispatcher of a truck fleet in assessing hazardous driving conditions and selecting safe and cost effective routes for the transport of dangerous goods. The system uses geographical information system and satellite global positioning technology.

3.4.4 Dispatching and Planning.

A few studies examined certain issues in dispatching (Goetschalckx, 1988) and freight network evaluation (Rahman, 1990).

Decision support system designs for planning are discussed by Denno and Brail (1993). They emphasize the fact that transportation planning is a discipline "ripe for DSS development" due to it's traditional dependence on computerized models. Sound, full motion video, 3-D virtual reality, cartoons of transportation operations, traditional charts and graphs as produced by spreadsheets, and annotated maps produced by GIS packages are stated as seven representational aids that could be applied to the field.

The architecture of a fleet management system integrating a planning support environment with a mobile communication system is presented by Schrijver and Sol (1992).

A study by Roy et al (1991) described the structure and components of a system designed to assist the tactical planning of activities of an intercity multimode multicommodity freight transportation system.

The organizational effects of the implementation of a computer-based process planning system was the subject of an ergonomic study (Krell and Gencoglu, 1989). This study showed the impact of increased work load on manual labor (loading and unloading), and the necessity to take this factor into account in order not to overstress workers.

Potvin et al (1992) evaluated how linear programming methods could be used in a system that would dynamically learn vehicle dispatching skills.

3.4.5 Scheduling

A special area of research lies in the incorporation of time-dependent travel speed in scheduling software (Frederking and Muscettola, 1992; Arthur and Benton, 1992).

4. TRANSFERABLE TECHNOLOGIES

Transferability refers to tools and concepts which can be used immediately and directly within the trucking industry in order to improve the efficiency and productivity of trucking professionals. This section of the report treats the transferability of Decision Support Systems[6] (DSS), Executive Information Systems[7] (EIS) and Performance Support Systems[8] (PSS) technologies and concepts.

A number of tools were examined in order to determine their degree of transferability (*see* Appendix 9). Each of the tools examined meets at least one of the following criteria: 1) it is a good example of general usage or; 2) it has concepts which could possibly be transferred to the trucking industry. The concepts were broken down into three distinct categories: DSS concepts; PSS-specific concepts; and User Interface concepts. They were chosen according to their originality and their pertinence to this study.

DSS concepts are those concepts designed to aid in the decision making process. They include: 1) data sources, both internal and external, in the form of data bases, spreadsheets, etc.; 2) data analysis, effected by tools designed to perform simple evaluations and multidimensional forecasts; 3) administration, through business tools for managing logistics, inventory, scheduling, etc.; and 4) use of artificial intelligence, as in expert systems, through the integration of "intelligent" components.

All the DSS concepts examined—use of existing data sources, use of data from heterogeneous sources, use of CD-ROM, outside communication, multidimensional analysis, the use of various report formats, the ability to test alternative solutions to problems, the optimization and automation of human resource management, the detection of inconsistencies, the automation of contract management and the analysis of organizational effectiveness, the use of artificial intelligence—can be immediately applied to the trucking industry. They are concepts which fit well into the scheme of any business seeking to increase both its efficiency and productivity. The solutions offered by a number of the tools respond to needs that are present in most organizations. As well, they require no development costs as they can be purchased off-the-shelf.

PSS-specific concepts are those concepts which are characteristic of any effective performance support system, the most important of which are: 1) navigation, which is not restricted by linear movement (i.e. following an obligatory operating sequence); and 2) integrated help and advice systems.

At present, PSSs are not off-the-shelf tools. They are built according to the needs of the individual organization. System components of any one PSS may not necessarily fit in with needs of every organization. Nevertheless, all the PSS concepts presented—freedom to navigate throughout the system, context sensitivity, various levels of integrated help—are easily transferable to any PSS. In fact, they are crucial to the success of a system.

User interface concepts are those concepts tied to effective interface design: 1) ease of use, regardless of computer experience; and 2) clear and concise presentation of content.

The key to success of any computer-based system often rests on the design of the user interface. Interface designs must "be well thought out if they are to be easy to use and understand" (Sullivan and Tyler, 1991). A good interface presents a system in a way that does not force users to change the way they think. "Each feature of an interface should be presented using terms and conventions familiar from previous experience working without the computer-based support" (Bonar and Liffick, 1991).

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[6]Defined by the Microsoft Dictionary as: "A set of related programs and the data required to help with analysis and decision making within an organization. A DSS is similar to a management information system (MIS) or an executive information system (EIS) but provides the user with more help in formulating alternative decisions and choosing the most appropriate course. A DSS includes a database of information, a body of knowledge about the area in which decisions are to be made, a 'language' that can be used to state problems and formulate questions, and a modeling program that can be used to test alternative decisions" (1991).

[7]Defined by the Microsoft Dictionary as: "A set of tools designed to provide executives and managers with accurate, timely information about their organization and products. An EIS organizes data into categories and reports. Because its primary focus is information, an EIS differs from a decision support system (DSS), which is designed to help with analysis and decision making" (1991).

[8]*See* Annex #1 for definition.

The use of buttons, icon bars, a mouse, tactile monitors, and hypertext facilitate users' access to the information within a system. If the interface is properly designed, the internal workings of the system will remain invisible to the user. The user will see only those things that are relevant to the task at hand. Any and all of these concepts could be used in applications designed for the trucking industry.

Some thirty domains are covered in the software packages looked at, including: financial analysis, budget management, personnel management, manufacturing, insurance, aeronautics, railway, automobile rental, medical clinics and hospitals, logistics planning, resource management and time management.

Though all concepts could be transferred to the trucking industry, it is difficult to determine which would best be suited to a PSS in the domain. It would be pure speculation to suggest that any given concept should or should not be integrated, because the actual software needs of trucking companies are not yet known. Once the industry's needs are known, it will be possible to match them with compatible technological solutions.

5. TASK ANALYSIS

The last phase of this study consisted of acquiring more detailed information concerning trucking managers' tasks (which could not be directly obtained from the domain literature). Two weeks were allotted for this phase. Because of the rather short period of time, it was decided that a questionnaire, rather than visits to individual managers, would be the most efficient data gathering technique.

The goal was to analyze the trucking manager's activities. The analysis concentrated on two aspects: 1) Task Analysis, which measures what tasks are actually performed, how often they are performed, and the level of difficulty of each; and 2) Performance Analysis, which measures desired performance versus actual performance, the gap between the two, and performance objectives. .

The two analyses, though complementary, are quite different. They do not have the same objectives. Often, during the execution of a task, there are unforeseen variations, errors and individual nuances that take place. The result of this is that Task Analysis cannot anticipate nor predict all activities which may occur during the performance of a task. For this reason, it is necessary for an ergonomist or a knowledge engineer to examine the actual activities.

The questionnaire was sent to 10 companies (*see* Appendix 10 and Appendix 11). The companies are well known in both Canada and the United States and were chosen because it was felt they could provide significant data on the tasks of the trucking manager. The companies cover all domains within the trucking industry, however, it cannot be said that they are representative of the trucking industry as a whole. They are primarily larger companies with the resources at their disposal to develop or purchase computer-based tools.

Data gathering via questionnaires carries a certain amount of risk. The types of risk include: refusal to collaborate; biased responses; and the fear of an eventual loss of employment due to the measure of prescribed task versus effected task. As a method of ensuring participation, it was deemed necessary to guarantee the confidentiality of those participating.

Only one of the ten companies responded. Therefore, an attempt was made to contact those who had received questionnaires and try to elicit information through the verbal process. The participants were reticent when it came to divulging information. Some cited company confidentiality, while others felt their company had nothing to gain through such a study.

This study did not allow us to demystify, with any precision, the trucking manager's tasks. We were aware of the lack of any such study and attempted to rectify, to a degree, the situation. However, our attempt was blocked by the reticence of the managers. Two factors could explain this reticence:

1: The questionnaire was either unclear, inappropriate or poorly designed;
2: Managers saw either no benefit to their companies, or felt threatened by possible loss of employment.

Therefore, two alternatives remain at our disposition: 1—Carry out a large-scale questionnaire study. (This would involve sending questionnaires to approximately 100 companies. A ten per cent response rate would be deemed successful); 2—Carry out an *in situ* analysis. The latter approach is recommended as a follow-up or next phase of this study. As significant reticence exists, this more personalized approach would be more likely to provide information on what managers feel they stand to lose by implementing new technologies.

6. CONCLUSION

Since the majority of trucking professionals appear to receive their training on-the-job, and since the trucking industry is continually evolving, the need for training and skills upgrade and job-aids which can help the Canadian trucking industry remain competitive with its US. neighbours is of increasing importance. Training in various areas of customer service, time and space management, logistics and technology combined with job-aids that permit both management and employees to function more efficiently and effectively, seems to be the avenue best chosen.

The industry appears to have adapted to the lack of formal training available to trucking professionals by developing an informal, in-house, on-the-job approach. That is, professionals learn through trial and error while performing actual tasks. This basically amounts to an apprenticeship-type approach. This approach could serve as a partial explanation as to why few computer-based training solutions exist in the industry.

However, meeting the demand for skilled workers and increased safety are becoming more and more important issues in the logistics of the industry (Tardif, 1993). The abundance of research into: decision support systems; expert systems; communications systems; evaluation systems; and vehicle simulation for the trucking industry, demonstrates that the industry is prepared to accept a computer-based tool that is at once cost-effective, easily updated and easy to use. Performance Support Systems could be the answer (Appendix 9). But before work on such a system can begin, their needs to be a transformation of existing trucking cultures. Innovation no longer lies with traditional technologies, but rather with information technologies: technological innovation (tools yet to be developed); social innovation (development of new know-how); and organizational innovation (new management structures and styles).

The costs involved in operating a trucking company are on the rise, and will continue to do so. Managers, in their attempts to stem the tide, have resorted to a number of cost-saving techniques: lower fuel consumption, maximization of vehicle usage, better vehicle maintenance, both before and after a problem occurs, and fuel substitution (IBI, 1993). However, management is not the only area in which savings can be realized: more effective and efficient dispatching and vehicle conduct can contribute to an improved bottom line. Technology affords that opportunity.

In order for technology to be effective, it must meet a couple of criteria: it must be inexpensive, it must improve skills, it should minimize operating costs, it must be more cost-effective than using instructors, it must be easily updated, and it "should not require a human instructor for effective use" (Stevens, 1993). At the present, we have been unable to find any one system that meets these needs. Individual job-aids do exist, as does training, but nothing that ties the two together into a package that could be easily accessible to all levels of the industry hierarchy is available. To further complicate matters, the use of information technology for training professionals in the trucking industry is neither well developed nor widespread.

Creation of a generic PSS , adaptable to the trucking industry as a whole, would require considerable effort given the lack of uniformity in the use of information technology within the industry. This lack of uniformity can be attributed, in part, to a number of factors. For example, the geographic layout of a country may necessitate a high degree of dependence on communication technologies; the meteorological makeup of a country may necessitate a high dependence on navigational tools; and cultural differences between countries may bring scheduling technologies to the fore.

In Canada, all of the above mentioned factors come into play, thereby complicating the task of developing a generic tool. Canada has a total land mass of 9,220,970 km^2 composed of plains, mountains and lowlands which are covered with 712,936 km of surfaced highways. It shares a 8,893 km boundary with the United States (including Alaska), with 80 per cent of its population living within 160 km of that border (CIA Staff, 1991).

Developing a PSS to meet the needs of everyone within the Canadian trucking industry would represent a monumental effort at the levels of needs analysis, performance analysis, and task analysis, only to discover that it would be a near-impossible undertaking. The only viable solution is to develop a generic tool which could be adapted, or customized, to the needs of individual trucking companies: their way of working and their way of training.

Before such an undertaking, it is necessary for the Canadian trucking industry to define the areas best served by such an implementation. This study has shown that management is the sector of the trucking community that would most benefit from PSS implementation. It appears that dispatchers are already well served by the wealth of tools at their disposal. As for drivers, standardization of certification curriculum is probably the best step to be taken.

Lack of standardization on how trucking professionals do their jobs fits hand-in-glove with the lack of formal training available through public institutions, as well as the lack of computer-based training tools. This study has allowed us to determine that training and technology weaknesses within the trucking industry exist. Performance Support Systems offer an alternative to formal training.

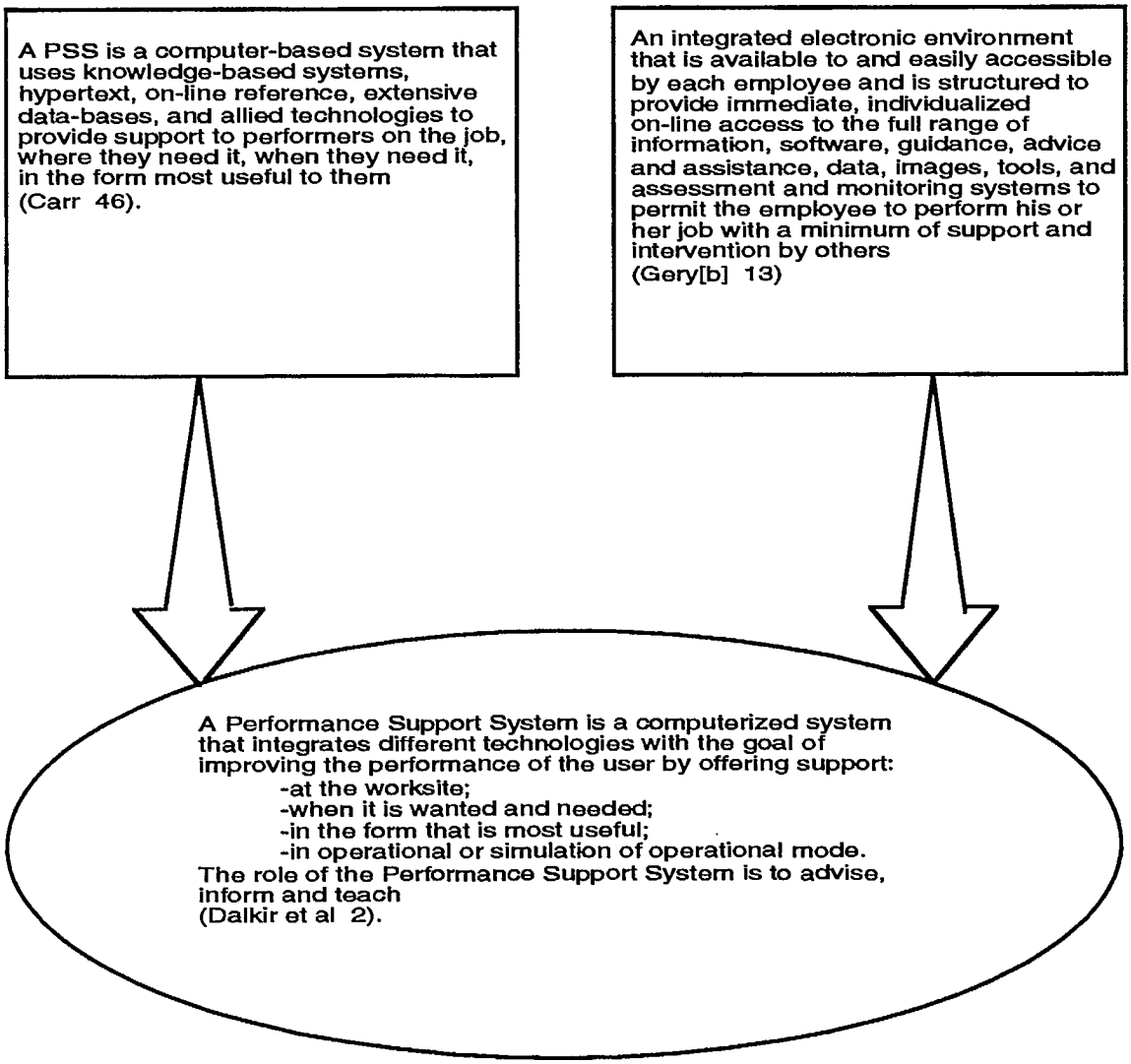
In 1990, Canadian industrial production grew by 2.7 per cent (CIA Staff, 1991). All indications are that it will continue to grow. Such growth will necessitate an increase in trucking industry capabilities, and by extension, an increase in the capabilities of trucking management. Before this can be done, the role of the manager must be more clearly defined. In depth task analysis of trucking managers must be conducted, in order that the exact nature of the role can be understood and appropriate tools developed.

An important opportunity exists for the Canadian trucking industry to carve out a niche in the technological marketplace. The development of Performance Support Systems, Decision Support Systems and Executive Information Systems will allow Canadian trucking companies to better respond to clients' needs, and thus ensure a healthy and competitive environment.

APPENDIX #1

Performance Support System Definition

Over the course of the past few years, the scientific community has struggled with defining the exact nature of Performance Support Systems (PSS). Clay Carr, chief of the Defense Logistics Agency's Civilian Personnel Services Office in the United States, and Gloria Gery, author of the book Electronic Performance Support Systems, are both highly regarded as experts in Performance Support System technology. CITI has integrated, refined and simplified their definitions to come up with one it feels accurately reflects the PSS concept.



APPENDIX #2

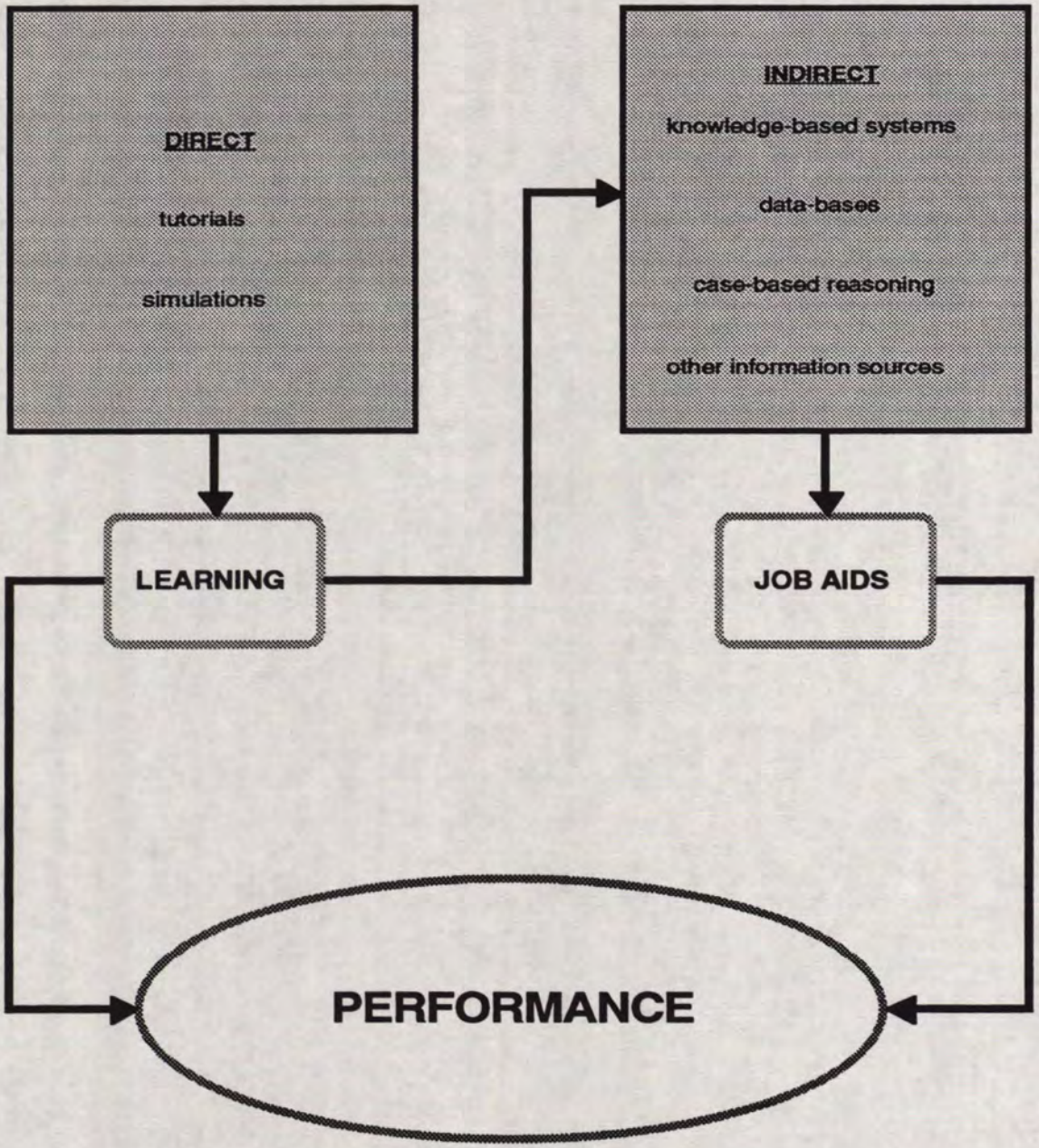
Possible PSS Components

PSSs can be composed of a number of technologies. What and how much goes in is determined according to the needs and budget of the organization sponsoring development. Possible components include (Dalkir et al, 1993):

Case-Based Reasoning	Cases of past pertinent situations, and the measures taken to correct them, which are used to 'reason' solutions to new problems.
Computer-Based Training	Linear or branched training, administered by a computer. The emphasis is on an end result or knowing the solution to a problem.
Data-bases	Banks of information that can be accessed by a system user at any time.
Decision Support Systems	Computerized tools which support, rather than replace, the user in the decision-making processes involved in the completion of non-structured tasks.
Hypertext	A method of embedding text within text. An infinite number of text 'layers' can be embedded and interconnected (cross-referenced).
Image Processing	Systems which allow documented information to be scanned and stored.
Intelligent Learning Environments	Environments which facilitate learner-directed exploration of knowledge-rich environments.
Knowledge-Base Systems	Also known as 'Expert Systems,' computer programs which have been encoded with the knowledge of an expert in the domain to which they are applied.
Multi-Modality	More commonly known as 'Multi-Media,' the integration of various media into a system.
Neural Networks	Artificially intelligent programs structured to emulate the brain's problem-solving process.
Virtual Reality	Computer generated 3-D environments.

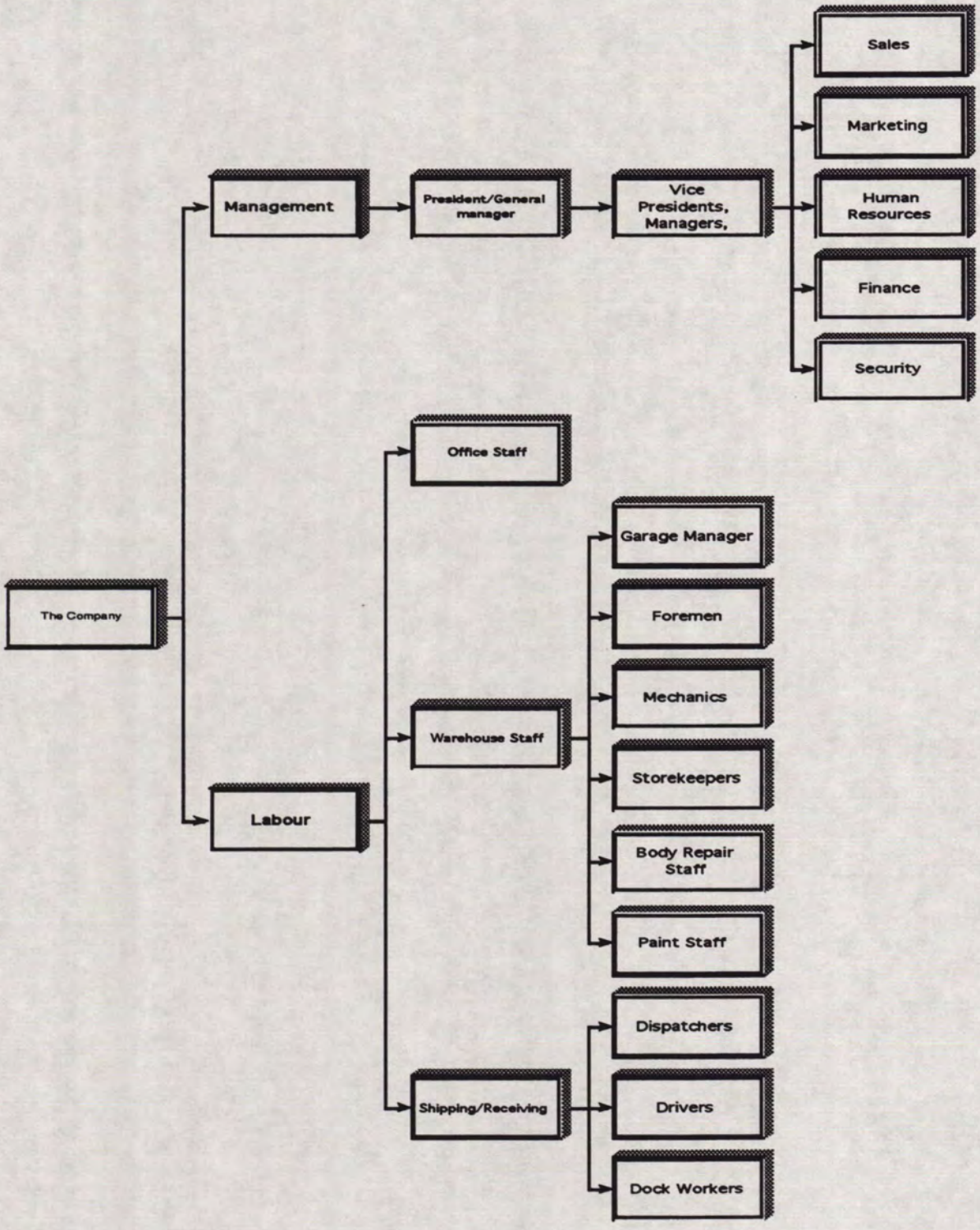
APPENDIX #3

The Performance Support System Learning Paradigm
(adapted from Dalkir et al, 1993)



APPENDIX #4

Trucking Company Hierarchy



APPENDIX #5

List of software products available to the trucking industry in North America

Product name	Year of release	Cost min	Cost max	Amount sold	Domain	Type	Operating System	Country
Direct Computer Concept	1991	4950	7500	600	Accounting, billing	DSS	DOS	US.
BBARN	1992	695			Bus Garage Space Requirement	Analysis; Modeling; forecasting	DOS	US.
CARS+	1983	2000		275	Car and truck rental; maintenance	DBMS, Communication	UNIX	US.
Alpha Pager/Mobile Data Interface	1993				Dispatching	Communication	UNIX	US.
Coverage Plus					Dispatching	DBMS, Communications	Macintosh	US.
Dynamic III Dispatch	1993				Dispatching, Communication	DBMS Communications	DOS	US.
MapStar, Coverage Plus					Dispatching, Communication	GPS, GIS, Communication		US.
Innovative Transportation System (ITS)	1993	50000	150000		Dispatching; costing	DBMS; communication	IBM s/36	US.
Scheduled Courier Parcel Service					Dispatching, Scheduling, courier management		UNIX	US.
LoadLogic	1990	35000		60	Dispatching; scheduling; load building; routing	DSS; Optimization	DOS; XENIX	US.
AutoInput	1993	NA			Fleet maintenance	DSS Automatic data collection	NA	US.
Equipment Management System	1992	9500	20000	138	Fleet maintenance	DBMS	IBM AS/400	US.
Fleet Control	1992	200	200		Fleet maintenance	DBMS	DOS	US.
Fleetmax (V.5.0)	1992	995		85	Fleet maintenance	DBMS	DOS	US.
Fleet assistant	1993	NA			Fleet maintenance	DBMS	DOS	US.
RTA Fleet Maintenance System	1992	4000	19000	600	Fleet maintenance	DBMS	DOS; UNIX; VMS	US.
RFT-2000	1993				Fleet maintenance fuel control	DBMS communications	DOS	US.
Vehicle Maintenance	1992	2500	4500	3	Fleet maintenance	DBMS	UNIX	US.
Vehicle maintenance Administrator	1992	5900		100	Fleet maintenance	DBMS		US.
CFAVMRS Phases I, II, III and IV	1991	400	4700	950	Fleet maintenance	DBSM; Stats. analysis	DOS	US.

APPENDIX #5 (cont'd)

Product name	Year of release	Cost min	Cost max	Amount sold	Domain	Type	Operating System	Country
Fleet Maint	1991	4950		425	Fleet maintenance	DBMS; stats	DOS; UNIX	US.
Main/Tracker					Fleet Maintenance	DBMS	IBM Mainframe	US.
Vehicle Maintenance Reporting System Plus	1991	3995		25	Fleet Maintenance	Analysis, DSS	DOS	US.
VMSYS Plus	1991	295	795		Fleet maintenance	DBMS,DSS	DOS	US.
System 90, System one, System two	1990	2000	15000	2500	Fleet maintenance	DBMS	DOS	US.
Fleet management system (FMS)	1988	75		100	Fleet maintenance	DBMS	DOS	US.
Fleet Plus	1987	2000	26000	76	Fleet maintenance	DBMS	DOS	Canada
Maintenance Dossier	1987	295	3995	975	Fleet maintenance	Database management	DOS	US.
Maintenance Dossier	1987	295	3995	975	Fleet maintenance	DBMS	DOS	US.
ShopFax	1987	10000		25	Fleet maintenance	DSS	DOS, UNIX	US.
Road Scholar	1986	4500	12500	5000	Fleet maintenance	DBMS; analysis	DOS	US.
Self-Control Fleet management	1986				Fleet maintenance	DBMS	DOS	US.
Utilifleet	1985	495		32	Fleet maintenance	DBMS; Analysis	DOS	US.
Fleet*Mate	1984	2500		42	Fleet maintenance	DBMS	DOS; UNIX	US.
VehicleCTRL	1983	1195	1195	800	Fleet maintenance	DBMS; Stats analysis	DOS	US.
Fleet Controller	1982			200	Fleet maintenance	DBMS	DOS	US.
Maintenance Control and Management System	1982			80	Fleet Maintenance	DBMS, DSS		US.
Maintenance Control and Management System	1982			80	Fleet maintenance	DBMS	IBM mainframe	US.
Vehicle Maintenance and Efficiency System	1982			10	Fleet maintenance	DBMS	DOS	US.

APPENDIX #5 (cont'd)

Product name	Year of release	Cost min	Cost max	Amount sold	Domain	Type	Operating System	Country
Faster	1981	7500	15000	90	Fleet maintenance	DBMS	DOS; UNIX	US.
Fleet Control	1981	295	295	7	Fleet maintenance	DBMS	DOS	US.
TMT TRANSMAN System Equipment Maintenance Software	1981	995	100000	1000	Fleet maintenance	DBMS	DOS	US.
Vemaint/3000	1981	4000		10	Fleet maintenance	DBMS, DSS		US.
Princeton Transportation Network Model & Graphic Information System	1980	20000	75000	15	Fleet maintenance	Database management;simulation	DOS; VM/CMS	US.
Transportation Management System	1980	5000	50000	68	Fleet maintenance	DBMS	UNIX	US.
ARFLEET/3000	1979	7500		27	Fleet maintenance	Database management		US.
C.E.V.S.					Fleet maintenance	DBMS	DOS; XENIX	US.
Fleet Maintenance Management System					Fleet maintenance	DBMS	DOS	US.
TMS Equipment Maintenance					Fleet maintenance	DBMS	DOS	US.
FleetCare					Fleet Maintenance	DBMS	DOS	US.
Vehicle Maintenance System		1195			Fleet maintenance	DBMS	DOS	US.
Transyst	1980	30000	100000	27	Fleet maintenance; dispatching	DBMS	DOS; UNIX	US.
DOT System	1991	595		150	Fleet maintenance; personnel management	DBMS	DOS	US.
Pavement Management System					Planning; design; construction	DSS; analysis; GIS; DBMS		US.
PC*HazRoute	1993	20000			Risk analysis	DSS	DOS Windows	US.
MileMaker	1992	NA			Routing	DBMS, DSS	DOS, UNIX	US.

APPENDIX #5 (cont'd)

Product name	Year of release	Cost min	Cost max	Amount sold	Domain	Type	Operating System	Country
PC*MILER 7.00	1993	995	4450		Routing	DBMS, GIS, DSS	UNIX, XENIX, DOS, WINDOWS (soon)	US.
RoadShow	1993				Routing	DBMS, GIS, DSS	DOS	US.
TOOLKIT				44	Routing	DBMS, GIS, DSS	Windows, DOS	US.
Optimal Pathfinder	1986	25000	25000	3	Routing; Cost optimization	Simulation; Analysis	DOS	US.
LoadLogic	1990	35000		60	Routing; dispatching	DSS; Optimization; GIS interface	DOS	US.
EDGAR Transportation System	1991			12	Routing; Scheduling	Analysis; GIS; DSS	UNIX	US.
VSCS	1991			14	Routing; scheduling; driver performance	Database management		US.
OmniTRACS					Satellite communication	GPS;		US.
Ultramain Fleet Maintenance	1992				Warranty plans and maintenance contracts	DBMS; Analysis	VMS; DOS; UNIX	

Abbreviations:
DSS: Decision Support System
GIS: Geographical Information System
DBMS: Data Base Management System

APPENDIX #6

List of the domains and tasks covered by the available commercial software in the trucking industry (numbers correspond to the number of times the task was mentioned)

Distribution modeling and simulation	1		
Transportation costing	1		
Operations control	10		
Order entry	1	Mobile communications	1
Driver advance	1	service failure monitoring	1
Dispatch and equipment pallet control	1	budgeting	1
sales analysis	1	telemarketing	1
Preventive maintenance	1	Electronic Data Interchange	1
Traffic volume analysis	1		
Pavement management	1		
Rail/truck/water inter-modal analysis	1		
Communication	6		
Analysis of fleet operations	2		
best mix of transportation resources	1	load selection	1
Strategic planning	1		
Routing	6		
Risk analysis for shipping hazardous materials	1		
Scheduling	2		
Calculation of work loads	2		
Dispatching	6		
Bus garage space Requirements	1		
Optimization of warranty plans	1		
Freight rating	1		
Driver performance	1		
Fleet maintenance	68		
Costing	5	Job estimating	1
Traffic costing	1	Service scheduling	4
Accounting	1	Preventive Maintenance scheduling	7
Payroll	3	Preventive maintenance (PM) Analysis	1
Work orders	1	Analysis of repairs	1

(Appendix #6, cont'd)

Equipment performance	1	Analysis of repair costs	3
Equipment history		Analysis of road calls	1
Vehicle life cycle costing	2	Garage/mechanic record	1
Fleet inventory	4	Mechanic performance analysis	4
Vehicle maintenance	7	Equipment location	1
Driver tracking	2	Equipment management	1
Overtime tracking	1	Bar coding	1
User billing	1	Vehicle status tracking	1
Vehicle replacement	1	Fuel control	1
Fuel inventory	1	Fluids management	1
Usage reporting	2	Fuel/usage history	7
Parts order	3	Repair order	1
Parts inventory	13	Repair history	10
Parts history	1	Work pending	2
Tire management	7	Operating costs	1
Labour reporting	1	Analysis to reduce vehicle acquisition, operations and disposal costs	1

APPENDIX #7

Preliminary Product Search

Company	Contact	Location	Phone
ALK Associates, Inc.	George Cummings, EXT.123	New Jersey	609-683-0220
American Phoenix Computer Services, Inc.	Mike Cahill	Pennsylvania	215-275-2727
Analysis, Inc.	Robert P. Burkey	Illinois	708-361-2880
Applied Information Systems, Inc.	Timothy C. Ponder, CDP	Georgia	404-953-1903
Applied Transportation Solutions, Inc.	Joseph D. Walker	Missouri	314-994-7070
ARIEL Company	Gordon Strahan	California	916-344-4897
Arsenault Associates	John Sentman	New Jersey	609-767-6690
Automation, Inc. (FleetFAX)	.	Nebraska	402-339-9500
Bell Atlantic Corporation	.	Pennsylvania	215-466-2915
BENDER Management Consultants, Inc.	Paul S. Bender	Virginia	703-920-0407
Blue Diamond Systems, Inc.	Barbra Delp	New Jersey	609-627-1234
Bluebird Systems	.	Georgia	404-921-0018
Caliper Corporation	Jack MacDougall	Massachussetts	617-527-4700
CAPS Logistics, Inc.	John Bunker	Georgia	404-432-9955
Carrier Logistics, Inc.	Mike Piccininni	New York	914-592-0101
ComGrafix, Inc.	Robert Cooper	Florida	813-443-6807
Computer Publications, Inc.	.	Oklahoma	918-298-9000
Consultec	.	Pennsylvania	215-249-9751
Control Module, Inc.	Edward Squires	Connecticut	203-745-2433
Control Software, Inc.	Joe Morgan	Pennsylvania	215-687-9202
Creative Systems Corporation	David Haidle	Illinois	708-323-9099
Custom Systems Co.	Kevin Madden	Ohio	216-546-1400
EDS Corporation	.	Texas	214-604-3331
Elke Corporation	.	Minnesota	612-559-9394
Epic Data International, Inc.	.	British Columbia	604-273-9146
Freightliner Corporation	Joe Richie	Oregon	503-735-8671
FREIGHTpro Carrier Systems, Inc.	Ralph Harvey	California	310-325-7171
GE Information Services	.	Maryland	301-340-5707
Hand Held Products, Inc.	Tim McDonell	North Carolina	704-541-1380
Harbinger*EDI Services	Ray Moore	Georgia	404-841-4434
ICS Corporation	Judy Downes (Sales Manager)	Colorado	303-674-0700
Infinity Systems, Inc.	.	Michigan	616-392-8442
Information Solutions, Inc.	.	Colorado	303-694-9180
Innovative Computing Corporation	Carlene Morrison	Oklahoma	405-949-9070
International Business Machines Corp(IBM)	.	Virginia	703-790-4643
JFC Software	.	New Jersey	908-232-6365
Keystone Systems, Inc.	.	Washington	509-535-5026
Lockheed, IMS	.	New Jersey	201-996-7000
Manugistics	.	Pennsylvania	215-668-0660
Marathon Business Systems, Inc.	.	Pennsylvania	215-373-7300
Marcam Canada	.	Ontario	416-632-6015
McCormick & Associates, Inc.	.	Indiana	317-248-2000

APPENDIX #7 (cont'd)

Company	Contact	Location	Phone
Millentitech	.		800-574-3218
Monarch Marking Systems	.	Ohio	513-865-2123
National Software Services / LIS	.	Washington	206-883-0115
Princeton Transportation Consulting Group, Inc.	Evan Eggers	Massachussetts	617-229-1565
Qualcomm, Inc.	.	California	619-587-1121
Racotek	David Smith	Minnesota	612-832-9800
Rand McNally - TDM, Inc.	Brian Lama (708)329-6136	Illinois	708-673-0470
ROADSHOW International, Inc.	Kathy Stanuck	Virginia	703-790-8300
Ron Turley Associates, Inc.	.	Arizona	602-581-2447
Softshop Associates	John A. Houck	New Hampshire	603-887-4887
Software Options, Inc.	.	Colorado	303-694-2349
Software Systems Unlimited, Inc.	.		706-367-5297
Synergistic Systems, Inc.	Dennis Rudy	Florida	904-249-0201
Tank Tech Corporation	Roberta Swanson	New York	914-268-8265
Tom McLeod Software Corporation	.	Alabama	205-823-5100
Tran-Soft International, Inc.	Reeve Fritchman	Florida	813-855-2440
Transportation Consulting Group, Inc.	Bill Schultz	Maryland	301-718-6330
Transportation Management Techniques, Inc.	.	North Carolina	919-760-7100
VerTechs Associates, Inc.	.	Massachussetts	413-253-7535
VOCAM Systems, A Pitney Bowes Co.	.	Minnesota	612-888-4890
ZCS, Ltd.	.	Indiana	219-282-4540
Zenisoft Corporation	.	Texas	214-922-8111

APPENDIX #8

PSS Benefits (Dalkir et al, 1993)

On-the-Job Support	Users are able to access help when it is needed and wanted, as well as in the form that is best suited to user needs. Help is immediate, due to the non-linear nature of the PSS which allows the user to go directly from point A to point D without stops at points B and C. Also, support is interactive and user-driven. User-driven support allows the user to direct queries in accordance with user needs. This elevates the user to a position of control and eliminates the automatron factor that is often feared by users.
On-the-Job Learning	Classroom training, while not without merit, is designed to meet the needs of a group of people whose needs are seen to be homogeneous. Because of this homogeneity, individualization can not easily be achieved. Classroom training does not provide the same context-rich environment that can be supplied by a PSS. One must be able to practice skills (transfer of learning) in order to improve performance. Adult learners must be able to see the consequences of their actions in order to ascertain if their training objectives have been met. Training that is built into a PSS can provide a safe practice-field, as well as immediate feedback on one's progress. "Knowledge without practice rarely, if ever, translates into skill or specific behaviour" (Gery[a] , 1991).
Cost-Effectiveness	is achieved through a decrease in training costs. These savings are possible for several reasons, chief among them: The system is constantly up-dated through usage, thereby negating the need to invest in "up-to-date" classroom training. The system is bought once, whereas classroom training can be bought over and over again; The system does not teach what the user already knows. Few, if any, employees want to be bothered with instruction in areas in which they feel competent; The system can tie several functions into one system (i.e. training and job-aids). Organizational knowledge is preserved in the system, thereby negating the "brain-drain" that can be brought about by employee turnover.
Ease of Use	is directly related to efficient system design and an effective interface. An interface that is simple, yet ergonomically sound, is often seen as the key to PSS success. These traits translate into user acceptance which results in widespread use of the system. Ease of use also allows an employer to assign less experienced staff to tasks they were before unable to perform without some sort of formal training. This frees up expert staff for work on more complicated tasks.
Consistency of Performance	is accounted for through uniform decision making. Everyone using the system has access to the same information, therefore, eliminating potential conflict in customer response.

APPENDIX #9

Transferable Technologies: Concepts and Tools

The information presented does not attempt to describe the content of the tools, but rather to identify, and sometimes describe, concepts. The fact that a number of concepts have been used in systems from a variety of domains indicates that they could also be useful in the trucking industry. Information comes from literature sources only. No tool was tested. Therefore, the study does not include the notion of quality, only the pertinence or originality of concepts.

DSS CONCEPTS

Despite the number of domains affected by DSSs, common elements of interest can be found in many of the tools examined.

Data Sources

Use of existing data sources:

A number of DSSs use resources which are already available within a company (central data bases, electronic spreadsheets, etc.). The use of centrally available data promotes data integrity and allows access to the most recent information. The system can integrate data from various corporate data bases, if they are available. This technique is known as data warehousing.

> *ex.: Analect Decision Support System (Finance), CFO Advisor (Accounting), Acumate Enterprise Solution (Data Analysis), Holos (Data Analysis), Forest and Trees (Business Analysis), CA-Compete! (Business Analysis)*

Use of data from heterogeneous sources:

DSS data sources can vary. Some use data from Data Base Management Systems (DBMS) of various scales, of various types (object, relational) and from various companies. Some DSSs draw their data from both database management systems[9] (DBMS) and electronic spreadsheets. This is particularly advantageous when constructing a system which must use data from outside sources or data from independent systems.

> *ex. : HARRY (Business Analysis), Analect Decision Support System (Finance), Informak for Windows (Marketing), Forest and Trees for Windows (Business Analysis)*

Use of CD-ROM:

The use of CD-ROM data bases is gaining popularity for DSSs which must manage large volumes of static data (governmental data, tariffs, third-party data). This medium can store large quantities of data and is much quicker and more practical than traditional data support media such as diskettes and magnetic tape.

> *ex.: Infomark for Windows (Marketing)*

Outside communication:

Some DSSs allow users to consult outside data sources. Examples of these data sources include electronic mail, electronic news services and public data bases which may hold information about competitors.

> *ex.: Discern (Health), Holos (Data Analysis), Commander Desktop (EIS)*

Data Analysis

Many DSSs specialize in analyzing data for decision-making purposes. These data analyses range from simple evaluations to multidimensional forecasts spread over several years. Several of these tools' strong points are outlined below.

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[9] "A data base management system (DBMS) provides a resource to manage and control a company's data base. A DBMS incorporates not only software but hardware and procedures that enable the organization to view data in different ways. A DBMS is able to integrate data from different physical files in such a way that different users of the data base can work with different information" (Edmunds, 1987).

APPENDIX #9 (cont'd)

Multidimensionality:
Data analysis is usually performed in dimensions. A dimension refers to a data classification element. In the case of trucking, an element could be a geographic region, the size of a truck, a time period, etc. An example of a 3-dimensional analysis would be the classification of truckers according to the size of the truck they drive, the types of load they carry and the geographic region in which they travel. Multidimensionality, therefore, implies the addition of more dimensions. In this case, a multidimensional analysis could include mileage, regional road hazards and driver experience.

ex.: Analect Decision Support System (Finance), Healthcare Decision Support System (Health), Personal AS/2 (Business Analysis), Corporate Vision (Data Analysis), FCS for Windows (Finance)

Various report formats:
Analysis reports are often presented in one or more of the following formats: text, chart or graph. The user can easily chose the presentation format which best suits the needs of the report to be produced.

ex.: Holos (Data Analysis), Command Center Plus for Windows (EIS)

Testing of alternatives:
Most DSSs allow the user to effect queries based on a variety of scenarios ("what-if analysis"). The user can then test the various results for profitability or effectiveness.

ex. : Analect Decision Support System (Finance), CFO Advisor (Accounting), System W DSS (Finance), Quant IX Portfolio Evaluator (Finance and Banking), Crystal Ball (Data Analysis), Optimal Scheduler (Scheduling), FYPlan for Windows (Finance)

Automation and optimization:
Some DSSs are equipped with scenario optimization data. This allows the user to automate scenario testing by varying one or many parameters (i.e. How many additional trucks are required to attain the maximum profit margin? And if we take into account the special needs of client X?). Optimization is done according to domain-related criteria. Optimization systems are used as much for human resource management as they are for materials management (warehouse management, logistics, scheduling, etc.). Generated data can then be visualized in the form of independent or comparative graphics.

ex.: Optimal Planner (Logistic Planning), Locate3+ (Wholesale/Retail/ Distribution), China Railways management (Railways), Master Distribution Scheduler (Scheduling/Resource Allocation)

Detection of inconsistencies:
Some DSSs clearly identify data they consider inconsistent with the whole, either through use of highlighting or some other mechanism. Inconsistencies are detected using models that are well known in the domain. Highlighting is also used to draw the user's attention to critical situations.

ex.: Business Insight (Business Analysis), Media (EIS)

Administration
Some DSSs present interesting concepts in the area of business management.

Automation of contract management and analysis of organizational effectiveness:
Health Care Decision Support System (Health) manages information which effects contracts between a company and a third party, and follows-up on revenues associated with those contracts. The system also offers the possibility of measuring employees' performance according to tasks effected in an allotted time period. This facilitates the analysis of expenditures and organizational effectiveness.

Integrate logistics and client complaint follow-up:
Water Distribution Management Module (Public Utilities) integrates inventory management, maintenance scheduling and customer orders. The system also allows customer complaint follow-up.

APPENDIX #9 (cont'd)

Help the user organize:
Contact (Sales/Marketing) helps the user organize "to do" lists according to priority.

Use of Artificial Intelligence
Though techniques vary, few DSSs improve their performance, or even efficiently exploit the expertise needed to resolve problems, through the integration of "intelligent" components. The following are examples of DSSs which do use intelligence.

Expert&/7 (Finance and Banking) is an expert system to guide the decision-making process. Using intuitive or subjective information provided by the user, the expert system evaluates various alternatives and classifies them in order of preference.

Employee or Independent Contractor Advisor (Human Resources Management) automates employee classification based on a 550 case knowledge-base.

Business Insight (Business Analysis) uses a knowledge-base, constructed using 35 domain experts, in order to analyze a company's financial data. Analysis points out the company's 10 strengths and 10 weaknesses. During analysis, the tool integrates non-numeric data, like demographic or cultural tendencies, conformity with industry standards, distribution networks, etc.

Quantum Leap's (Finance/Marketing/Manufacturing) knowledge-base uses electronic spreadsheets or data bases to find solutions to financial problems, resource allocation problems, scheduling problems and budget planning problems.

Lotus Notes 4.0 (Groupware), whose release is expected at the beginning of 1995, will integrate intelligent agents. An example of the use of such intelligent agents is the redirecting of messages and assigned tasks when the user is absent.

Discern (Health) uses fuzzy logic and a rule-based system to assist users in risk management, costs management and quality assurance management.

NeuralEdge Index Trader (Market Analysis) is a hybrid system (neural network and expert system) trained to recognize trends in American financial markets. The expert system evaluates risks and the monetary situation. These data are then fed to the neural network to survey market trends.

Top of Mind Help Desk for Windows (Help Desk) is also a hybrid system, composed of neural networks and fuzzy logic. The data base evolves dynamically as a result of training effected by the mediation of neural networks and fuzzy logic.

Transferable tools include:
Accounting: *CFO Advisor*

Data Analysis: *Acumate Enterprise Solution*; *Holos*; *Corporate Vision*; *Crystal Ball*

Business Analysis: *Forest and Trees for Windows*; *CA-Compete!*; *HARRY*; *Personal AS/2*; *Business Insight*

Marketing: *Infomark for Windows*; *Quantum Leap*

EIS: *Commander Desktop*; *Command Center Plus for Windows*; *Media*

Scheduling: *Optimal Scheduler*; *Master Distribution Scheduler*

Logistics: *Optimal Planner*

Human Resources Management: *Employee or Independent Contractor Advisor*

APPENDIX #9 (cont'd)

Groupware[10]: *Lotus Notes 4.0*

Help Desk: *Top of Mind Help Desk for Windows*

PSS-SPECIFIC CONCEPTS

Few PSSs are currently in existence since the concept is relatively new and since PSSs are not off-the-shelf products. As a result, only a small PSS sampling is catalogued in this study.

Navigation

A PSS must help the user accomplish a task. For this reason, most PSSs are designed to reflect how people complete tasks when working in a non-computerized environment. However, people must not be restricted to linear movement, i.e. following an obligatory sequence. They should be permitted to navigate throughout the different components of the system, with help available when it is needed. Some of the PSSs examined reflect this concept.

iKNOW (Quality Control) is a PSS designed to help salespeople by bringing uniformity to their sales techniques. The tool is developed along the lines of a product-line presentation. The PSS allows salespeople to make step-by-step presentations to their clients, yet also allows more experienced personnel the possibility of navigating throughout the system in order to create more personalized presentations (EDventure Holdings Inc., 1993).

NCR's *I.D.E.A. Consultant (Project Presentation)* (Samuelsen et al.) is a PSS, which helps present new ideas according to standardized concepts and methods. It has three phases which the user is asked to complete. Ideally, the three phases should be completed in order, however, the user is given the freedom to navigate between phases if that is the method most desired. Regardless of the method chosen, the system alerts the user to the percentage of the task completed.

Context Sensitivity:

Context sensitivity is another navigation aspect promoted by PSSs. It refers to the ability of the system situate the user's needs and the user's actions when logged into the system, regardless of which module is used. This promotes ease of use and thus a smaller learning curve (*see* Appendix 3).

Source (Sales) is a PSS designed to help Prime Computer Incorporated's salespeople. It offers a type of navigation based on "manually created indexes." The user is able to link an index to each of the system's modules. The index allows the user to directly access other modules by clicking on the index's corresponding entry. The content of the index varies according to the module and is context sensitive . *Source* also uses hypertext as an alternative navigational method (Raybould, 1990).

Integrated Help

A well conceived PSS should provide the user with help, when and where it is needed. Some developers have shown ingenuity when designing on-line help systems.

Offer several levels of help:

Different levels of help allow the system to better respond to the needs of a variety of users. I.D.E.A. *Consultant (Sales)* offers 3 levels of help to the user: help for navigating through the system, help with specific concepts, and help through examples. The three are available to the user at all times and can be called up through the click of a mouse.

An answer for everything *and* legal advice:

iKNOW (Sales) integrates two original help components. The first is a module which integrates the knowledge of the experienced salespeople in order to supply arguments to clients' most frequent criticisms during sales presentations. The second is the "Lawyer in a Laptop." Available through a menu, this help module guides

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[10]"Groupware is a collection technologies that can be applied to specific business problems....The fastest growing segments of the groupware market are e-mail and workflow" (Coleman, 1994).

salespeople in legal aspects related to sales. Amusing vignettes and animation are integrated, to overcome the somewhat dry content of the module (EDventure Holdings Inc., 1993).

Always available access to an up-to-date expert:
Source (Sales) provides an intelligent help module to help salespeople select products which may prove interesting to their clients. The module is based on an expert system and is accessible via hypertext links. The salesperson navigates through the module and provides it with information, implicit and explicit, about the client. The salesperson can consult the expert system at any time to help choose which products to sell to clients. For each consultation, the expert system constructs a decision tree which is accessible by the user, in order to avoid the "black box" effect of automated decision making. The system allow the user to accelerate the decision-making process (Raybould, 1990).

TAFT (Car Rental) was designed to help Avis employees make automobile reservations. An intelligent help system, based on an expert system, is one of the system's strengths. Whenever the user calls upon the help module, the expert system takes into consideration known data in order to supply information. If the known data is insufficient, the expert system will ask questions aimed at reaching a solution to the given problem (EDventure Holdings Inc., 1993).

USER INTERFACE CONCEPTS
Most of the software tools looked at have highly graphic interfaces. A well designed graphic interface makes a software tool more accessible to a wider variety of users (Karat, 1988). The elements of a graphic interface should: a) help the user understand how the software works, regardless of the user's computer experience; and b) make the software's content clear-cut.

Graphic Interface
In order to facilitate understanding or learning, most software tools use one or many of the following interface elements:

Buttons: Buttons help the user navigate throughout the system's different modules

ex.: I.D.E.A. Consultant (Project Presentation)

APPENDIX #9 (cont'd)

Icon Bars: Use of an icon bar, or single icons, gives the user direct access to a software's different tools

ex DTree (Data Analysis), PowerPlay (Business Analysis), Forecast Pro for Windows (Forecasting)

Mouse (or other pointing devices): using a mouse to access information via the point-and-click method facilitates the exploration of a tool .

ex.: Holos (Data Analysis), Command Center Plus for Windows (EIS), CrossTarget for Windows

Tactile Monitors: Tactile monitors are becoming more and more popular, particularly when software necessitates little data entry and must be used by people with little computer knowledge.

ex.: Command Center Plus for Windows (EIS), Executive Information System for Windows (EIS)

Other elements are added to an interface in order to facilitate access to a software's contents

Hypertext: "Hypertext is a method of electronically linking chunks of information. Users can access these chunks by selecting live cross-references, or buttons, on the screen" [Raybould]. The integration of hypertext allows the user to directly access help systems or to follow up data according to its context. *Corporate Vision (Data Analysis)* allows the user to create hypertext links between graphical data and text files.

Drill-down Mechanisms: Help systems and navigation across data or information is often designed in a drill-down fashion. The user is able to access information at different levels of detail and in different contexts. The user can pass from one level to another, using either buttons or hypertext links.

ex.: Holos (Data Analysis), PowerPlay (Business Analysis) EISToolKit for Windows (Business Analysis), Forest and Trees for Windows (Business Analysis)

Monitoring: Some systems allow the continuous graphical monitoring of parameters in cases where data interpretation in real time is crucial. This allows rapid detection of critical situations.

ex.: Great Plain Edition of Forest and Trees for Windows (Business Analysis)

Graphics: Graphics can help the user understand and interpret numerical data. Some software tools use the "dashboard" concept for showing data to the user.

ex.: Marcam Executive Information System for Windows (EIS), PowerPlay for Windows (EIS), Vital Signs 2000 (EIS), Business Plan for Windows (Business Planning)

APPENDIX #10
Questionnaire Cover Letter

Name
Company Name
Street Address
City, State/Province
Postal/Zip Code

March 25, 1994

Dear Name:

Your experience is needed to help us define fields of application for new technologies as they apply to the trucking industry.

The Centre for Information Technology Innovation's (CITI) mandate is to conduct advanced applied research in information technology, in collaboration with others, in order to improve Canada's economic competitiveness. CITI promotes the dynamic application of information technology to all areas of human endeavour, especially in business, and in social and cultural organizations.

In collaboration with the Canadian Trucking Research Institute (CTRI), CITI is investigating the use of technology to improve the Canadian trucking industry's productivity.

To this end, a questionnaire has been prepared that should provide some insight into: how managers do their jobs; the consequences of job-related decisions; what managers think of technology that is already in place; and managers' concerns when technological solutions are proposed.

It is hoped that you will respond to this questionnaire in order that we may help better position the Canadian trucking industry. All responses will be held in strictest confidence.

Sincerely

Jean-François Arcand
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CITI
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APPENDIX #11

CTRI©

Centre for Information Technology Innovation
Industrie Canada Industry Canada

General Information

Please Fax your responses to Jean-François Arcand at (514)973-5757 by March 15, 1994. Telephone follow-up will take place after this date.

Company Name:

Address:

Tel: **Fax:**

Number of employees:

What is the size of your company?

- O Large (125+ tractors)
- O Medium (75-125 tractors)
- O Small (less than 75 tractors)

What type of trucking does your company do? (check all that apply)

O LTL: General Freight	O P&D	O Other (specify) _____
O TL: General Freight	O Specialized Heavy Machinery	
O Pin to Pin	O Specialized Gravel Aggregate	
O Courrier	O Specialized Livestock	

What is your title?

To the best of your knowledge, how many managers are there within your company?

All responses are and will remain confidential

APPENDIX #11 (cont'd)

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Industrie Canada Industry Canada

Task Performance

Please Fax your responses to Jean-François Arcand at (514)973-5757 by March 15, 1994. Telephone follow-up will take place after this date.

Q1. Managers within every organization are required to perform a number of tasks designed to ensure that the organization runs efficiently, effectively and profitably.

A: What tasks are you required to do on a daily basis, what is the objective of each task and approximately how much time is devoted to each task, again on a daily basis?

- Strategic Planning
- Structuring the Organization
- Setting Goals and Objectives
- Business Planning
- Marketing Planning
- Customer Service Management
- Operations Management
- Costing
- Sales Management
- Financial Planning
- Budgeting and Cost Control
- Asset Management
- Human Resources Planning
- Work Scheduling
- Labour Relations

All responses are and will remain confidential

APPENDIX #11 (cont'd)

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Q1: (CONT'D)

B: Rank these management issues, from 1 to 8, with 1 being the most important and 8 the least important.

Delegating	_____
Quality Management	_____
Performance Management	_____
Leadership	_____
Motivating	_____
Communicating	_____
Problem-Solving	_____
Information Systems and Technology	_____

All responses are and will remain confidential

APPENDIX #11 (cont'd)

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Industrie Canada Industry Canada

Technology

Please Fax your responses to Jean-François Arcand at (514)973-5757 by March 15, 1994. Telephone follow-up will take place after this date.

Q2. A number of technologies have already been implemented in the trucking industry, most notably for drivers and dispatchers. To a degree, computer-based tools exist that allow managers to better perform. Research into this area is an ongoing effort.

A: What, if any, computer-based tools do you use on an everyday basis?

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B: What is the nature and role of these computer-based tools (Decision Support Systems, Expert Systems, etc.)? How effective are they?

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C: What tasks that you are now doing would you like to see computerized? Why?

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D: What do you perceive to be the problems with current computer-based tools (content, interface, etc.)?

All responses are and will remain confidential

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Industrie Canada Industry Canada

Technological Concerns

Please Fax your responses to Jean-François Arcand at (514)973-5757 by March 15, 1994. Telephone follow-up will take place after this date.

Q3. The goal of technology in the workplace is to support and empower its users. Research into a number of technological domains is an ongoing concern.

A: How do you see the link between technology and your workplace?

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B: When implementing a new technology or computer-based tool, what criteria do you consider most?

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C: What do you see as potential areas of management-related research for the trucking industry as it moves into the 21st century? Why?

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All responses are and will remain confidential

APPENDIX #11 (cont'd)

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Centre for Information Technology Innovation
Industrie Canada Industry Canada

Other Comments

Please Fax your responses to Jean-François Arcand at (514)973-5757 by March 15, 1994. Telephone follow-up will take place after this date.

We would appreciate it if you would point out any of the 5Ws (WHO, WHAT, WHEN, WHERE and WHY) that you feel should be addressed and that may have been omitted from this questionnaire.

Thank you very much for your participation.

All responses are and will remain confidential

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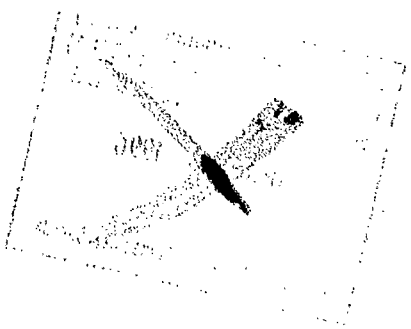

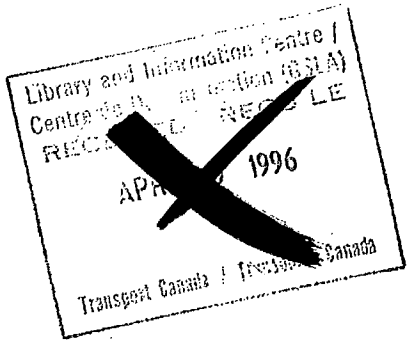
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