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The Demurrage Project.
A Case Study of Instructional Development within Canadian National, Traffic Systems Training

Stanley Ross Schmidt

A Thesis

in

The Department

of

Education

Presented in Partial Fulfillment of the Requirements
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Abstract

The Demurrage Project.
A Case Study of Instructional Development
within Canadian National, Traffic Systems Training

Stanley Ross Schmidt

A case study and formative evaluation of a training development project is used to analyze the strengths and weaknesses of the instructional development procedures used by Traffic Systems Training, a department within Canadian National, a major Canadian railroad. The study also examines the practicability of instructional technology within a commercial environment. The case study method used was structured, participant observation by the project team leader. The study found the instructional approach followed by Traffic Systems Training to be viable. Indication was also made that, if followed, the application of instructional technology within industry could provide cost-justifiable benefits. Recommendations for application of instructional technology in industrial training development are supplied.

Acknowledgments

I owe thanks to my thesis supervisor, Richard Schmid, for guiding me through this long and sometimes arduous project. I must also acknowledge my colleagues in Canadian National, particularly those in Transportation Training, discussions amongst whom have been the origin of many of the ideas contained herein, and whose reading and criticism of my drafts have made this a better product.

I especially thank Suzanne Lavigne-Schmidt, whose support and encouragement made the completion of this thesis possible.

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Introduction, and Background to the Problem

Canada's geography has determined a leading role for the railway in the country's economic development. Thinly spread population centres along a relatively narrow strip of land adjacent to the U.S. border, almost 4,000 miles in length, create a serious problem for shippers wishing to move their goods to the marketplace. The railway offers a solution to this problem. Trains, over one mile in length, provide a cost-effective method of moving bulk loads of coal, grain, and lumber from the interior to the ports; of moving automobiles, fresh meat and produce, and other consumer goods from town to town; and even moving *piggyback* truck trailers and containers, dozens at a time, over the large expanses that separate the major centres. Even today, in the mid-1980s, and in spite of the competition from air freight, trucking, slurry lines, and other transportation modes, the railway is still essential in maintaining Canada's strength as a trading nation: "Canada moves more freight, in terms of ton-miles per capita, than any other country in the western world, and 40% of these ton-miles move by rail." (Canadian National, 1982, p. 1). Canadian National (CN), a Crown Corporation, is one of the two major railways responsible for this, (Canadian Pacific, a private corporation, is the other major railway company).

Despite being essentially a nineteenth century technology, the railway has kept up-to-date with the technological innovations of the 20th century: The steam locomotive has been replaced by the diesel, some of the wooden ties in the roadbed are being replaced by concrete ties, and the masses of paperwork and bureaucracy, inherent in the transportation industry, are being eliminated by an on-line computer network that

monitors the current location of every railcar, and provides detailed information on every shipment. The ongoing technological advances, of which the above are only a sampling, combined with a workforce of approximately 64,000 employees (Canadian National, 1984), create a tremendous challenge for the training and human resources departments to keep Canadian National employees abreast of the times. A good example of the response to this challenge can be found at the Transportation Training Centre in Gimli, Manitoba, where a computerized locomotive simulator, developed by CN Rail Research, is the most advanced of its kind for training locomotive engineers. Yet another example is the subject of this case study: the application of instructional technology to develop technical training for CN's carload centre employees.

Canadian National

Canadian National consists of a large and diverse group of transportation, communications, and other related companies. Its corporate management philosophy is one of decentralization: each division within the corporation has a large measure of autonomy in making its own decisions, and is financially accountable for its own actions. In keeping with this philosophy, training, or the lack of it, is left to the discretion of the various levels of management within each division. This case study will deal with training within Traffic Systems. Traffic Systems is responsible for the coordination of activities that ensure the timely movement of trains, switching operations, and revenue protection. See Figure 1, where a partial organization chart shows Traffic Systems Training within Canadian National. (To the reader who is familiar with Canadian National, I request your indulgence for simplifying some of the background information that I felt was extraneous to the thesis. For example, although I refer only to *Traffic Systems Training*, this group was originally formed as *Servocentre Training*, and has since merged with *Transportation Planning Training* to become

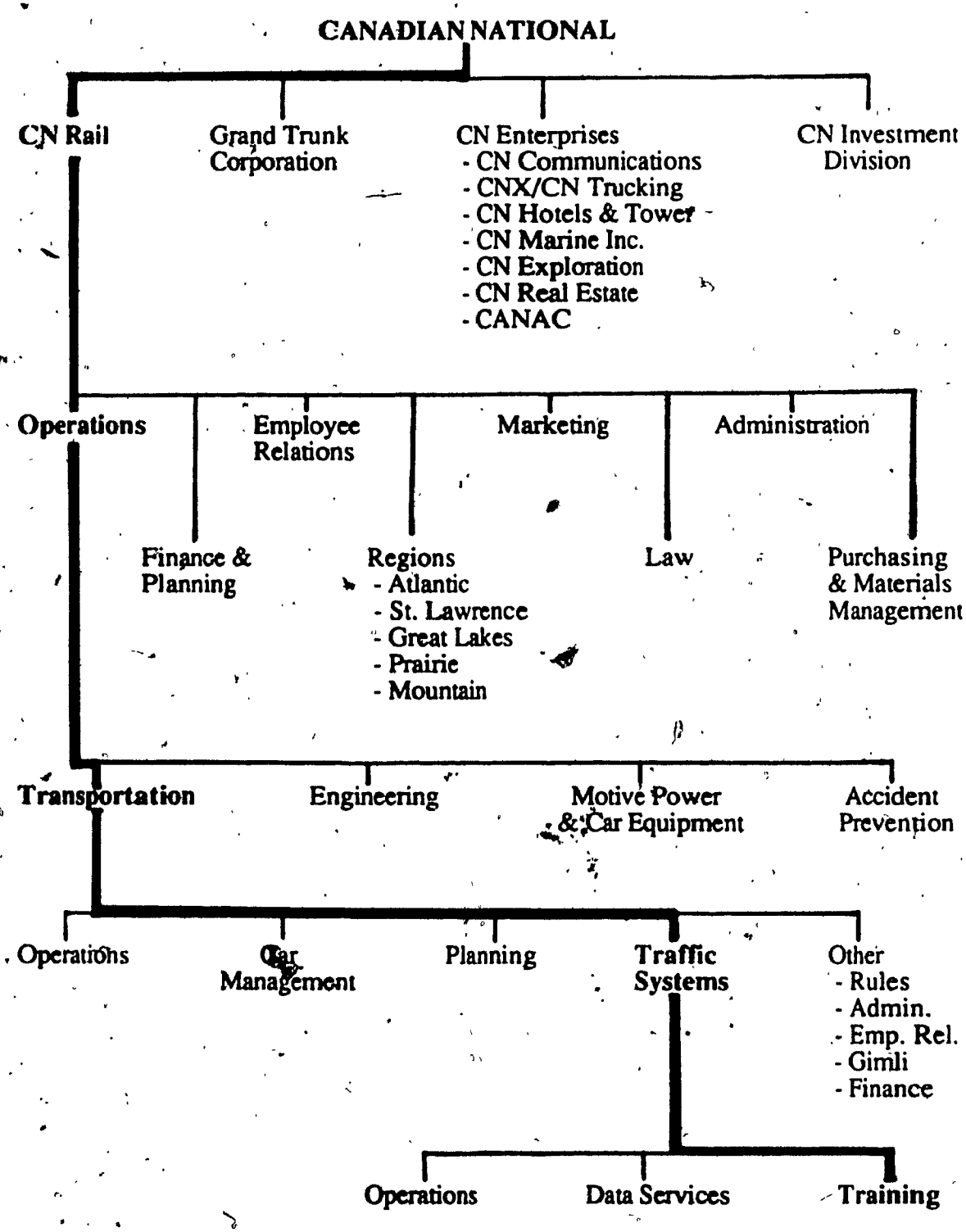

Figure 1. Partial organization chart, from 1981, showing Traffic Systems Training within Canadian National.

Transportation Training. In a similar manner, no mention has been made of the large implementation projects involving training, such as TRACS II or YIS.)

As well as the so-called *functional* divisions (e.g. Transportation, Engineering, etc.), and the so-called *subfunctional* divisions (e.g. Traffic Systems, Car Management, etc.), outlined in Figure 1, there are three layers of operation within CN Rail: System, region, and local. System's sphere of influence encompasses the whole country, with System Headquarters in Montréal, Québec. System is divided into five geographical regions, each headed by a Vice-President who reports to the President, CN Rail. In keeping with Canadian National's corporate policy of decentralized *profit centres*, the functions and subfunctions in one layer do not generally exercise direct control over the equivalent function or subfunction in a lower layer but, rather, act as a coordinative and policy setting body. See Figure 2 for the lines of control for Traffic Systems personnel within the three layers.

Carload Centres

The local operations of Traffic Systems are carried out in offices referred to as *carload centres*. These carload centres form a network of control points across Canada and in the north-eastern and north-central United States to service the operating arm of the railroad. The duties of carload centre employees are generally clerical in nature, insofar as a modern-day clerk does not so much use a pen as a computer terminal. The tasks performed by these clerks include, but are not restricted to: generating and updating records for the movement of trains, railcars, and shipments; interfacing with customers, other railway personnel, and other railroads; interpreting and applying various government and railway-industry tariffs, rules, and regulations; and assessing charges.

The responsibility for the training of the personnel who perform these tasks falls to

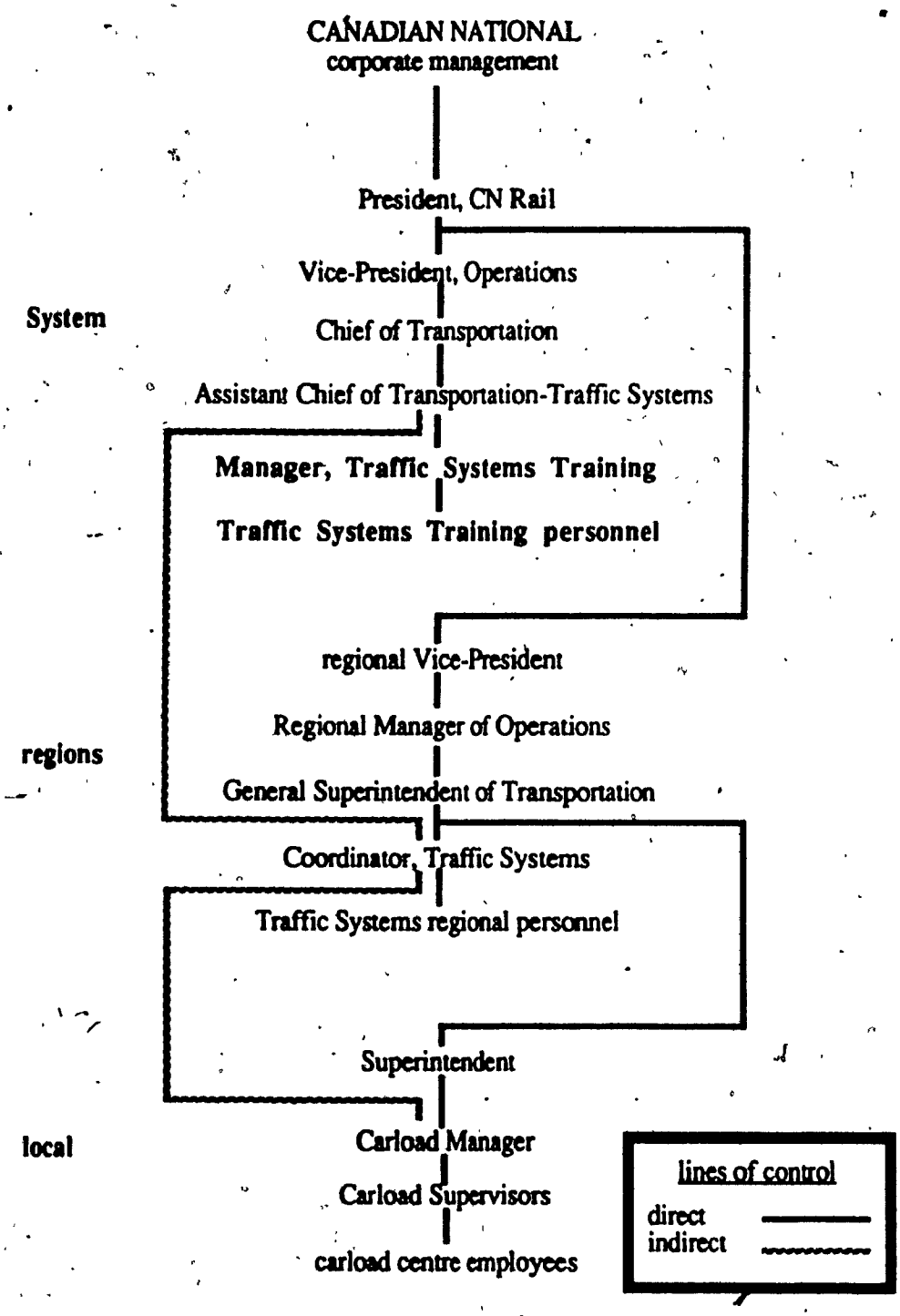

Figure 2. Lines of control for Traffic Systems personnel within the three layers of operation in CN Rail.

the individual managers at the carload centres (Carload Managers). Up until the mid-1970s, and reflecting the common attitude of the era, this training was a chance affair, and most new carload centre personnel learned their duties on-the-job by trial and error, or with minimal input from supervisory or senior personnel. Although no cost/benefit analysis was performed, this obviously was not an optimal situation, so in 1975 a new section was formed at the System level to coordinate all training efforts, and to develop training common to all carload centres.

Traffic Systems Training, with a client base at year-end 1975 of approximately 2,800 unionized employees and approximately 300 supervisory and management employees, began the development of training, and implemented a system for the dissemination and control of the training material. A brief description follows, outlining the training system implemented and the training development procedures used.

Training System Implemented

Training developed by Traffic Systems Training is predominantly in the form of modular, self-instructional packages. These self-instructional modules are standardized in format and administration procedures. All modules have clearly labelled objectives, most are accompanied by a criterion-referenced test, and are available in one or more of the following media:

1. filmstrip/audiocassette/workbook,
2. audiocassette/workbook,
3. programmed text, and
4. reading exercise.

In addition, Traffic Systems Training have created and distributed:

1. job performance aids, and,
2. lesson outlines, which are guides to instructors at the regions and carload

centres for preparing one-on-one or classroom instruction.

The training is administered at the carload centres by *advisors*, at least one of whom is established at each carload centre. The advisor is usually a Carload Supervisor, that is, a first-line supervisor reporting directly to the Carload Manager. The advisors are prepared for their role by studying a three day self-instructional course explaining the rationale behind self-instruction, and detailing the administrative, marking, and scoring procedures used in the training system.

In the function of advisor, the supervisor:

1. determines the need or responds to the request for a training session,
2. schedules the training session,
3. explains the objectives of the training module to the trainee,
4. administers a pretest to determine whether or not the module is required,
5. ensures that the trainee can operate any required audiovisual hardware, and remains available in case any problems arise,
6. on completion of the module by the trainee, marks the posttest, and gives the trainee immediate feedback on any wrong answers,
7. attempts to integrate the teaching points covered in the module into the daily work routine of the carload centre or, if not a master performer, assigns another employee to this task.

After administering a module to an employee, the advisor completes an *advisor's report*, which summarizes the reasons why the employee took the training, the times spent by both advisor and trainee, the costs, the pre and posttest scores, and any remarks. A copy of this advisor's report is then sent, along with the marked pre and posttests, to Traffic Systems Training at System Headquarters, where the relevant information is entered to a mainframe computer.

From the database that accumulates, the following management and control reports

are generated:

1. A time and cost summary is compiled monthly for distribution across the System. This report allows all levels of management to monitor the training administered at each location, the times spent, the costs, and how these compare to other locations, regions, and the System as a whole.

2. Concurrently with the time and cost summary, a statistical summary of all module administrations to date is compiled. An in-depth statistical analysis of each module is also generated regularly, after 30, 100, and 400 administrations, or by inquiry. These statistical analyses highlight any potential problems that were not eliminated during the formative evaluation of the modules, or that have occurred since the formative evaluation, and are used as a basis for module revision.

3. Further information, such as demographic data on the target population or individual employees' training records, can be accessed by inquiry from the database file.

In summary, the training system implemented provides the opportunity for standardized training to Traffic Systems personnel throughout the System. However, it remains sufficiently flexible to permit regional and local adaptation. For example, no Traffic Systems training module is mandatory; the need for training is generated at each carload centre. Also, the modules only cover the common elements of any subject, and leave it to the advisor to explain local procedures and actual application of the subject on the job. Furthermore, although all module tests are standard, and the pass mark set at 87-91%, an advisor can grant a qualified pass to a trainee with a score as low as 75%. This permits the advisor to pass a trainee who understands the concepts covered in the module but, for example, may have misinterpreted a test question or have been intimidated by the test situation. In other words, the training system in no way takes over the responsibility from the local carload centre management; the Carload Manager

remains, as before the establishment of Traffic Systems Training, solely responsible for the training and qualification of the carload centre personnel in his or her jurisdiction.

Training Development Procedures

From 1975 to 1980, the training modules from Traffic Systems Training were created, or adapted from outside sources, by *Training Project Developers*. These were railroad personnel at a middle management level, most of whom had formerly been Carload Supervisors. Their education was generally at the high school level. They were selected for the position by virtue of their broad knowledge of carload centre activities, and demonstration of an interest in the position. They were prepared for the training development job by undertaking a CN in-house course on the design of instruction, lasting approximately six weeks. This course, administered by a corporate training department, consisted mostly of a loosely grouped collection of self-instructional modules and texts garnered from various sources.

The subjects of the training modules developed by the Training Project Developers were chosen by the Manager, Traffic Systems Training. The developers worked individually to design, develop, and evaluate their training modules under the close supervision and direction of the Manager and an assistant. All development was done in English; one Training Project Developer would then handle its translation into French with the aid of CN's Linguistics Department. Production and duplication of the training materials were handled by CN corporate departments and by outside contractors.

By December 31, 1979, the training material from Traffic Systems Training, created by the above training development procedures, and available at the carload centres, was as outlined in Table 1.

In 1979, a new training development procedure was initiated. Termed *The SME Approach*, it entailed the establishment of temporary teams of subject matter experts

(SMEs), under the leadership of an Instructional Development Specialist, to develop courses of instruction in the SMEs' particular areas of expertise. The SMEs are regular carload centre employees, albeit master performers, who are transferred temporarily to Traffic Systems Training in Montréal. On completion of the project on their area of expertise they return to their regular jobs at their carload centres. The Instructional Development Specialist is a professional instructional technologist with formal education at the postgraduate level.

The SMEs act not only as subject matter experts; they also assume the role of instructional developers: Under the leadership of the Instructional Development Specialist, they perform a job analysis, write instructional objectives, create criterion test-items, determine a learning hierarchy, prepare the first drafts of the training modules, and carry out formative evaluation and revision. The SMEs are prepared for their developer role by studying self-instructional modules immediately prior to each step in the development process, and by coaching and guidance from the Instructional Development Specialist.

The duration of each SME team's stay in Montréal was initially proposed at two years. This was rejected for several reasons. First, a constraint in the collective bargaining agreement with the Canadian Brotherhood of Railway, Transport, and

Table 1

Traffic Systems training available on December 31, 1979.

	English	French
standard, self-instruction training modules	78	20
lesson outlines (i.e. guides to instructors for preparing local training)	3	0

General Workers (CBRT&GW), the labour union representing the majority of carload centre employees, protects the position of an employee on a temporary assignment for up to 90 days only. Second, the regional and carload centre management were concerned that any employee returning after a two year absence would be completely out of touch with daily operations, and hence prove difficult to place. Third, a lack of understanding of the training development process by the Traffic Systems Cabinet, the policy-setting body within Traffic Systems, made two years seem an unusually long period of time for such an assignment.

The draft work plan for the SME approach was thus specified as follows: Up to 90 days would be allowed for the analysis, design, and development of the training materials to the draft stage. At that time, the SMEs would return to their regular jobs at their carload centres, and the Instructional Development Specialist would move the material through production. When it was ready, some of the SMEs would return for 30 days to participate in formative evaluation and revision. The assumed workload, given a team consisting of four SMEs and one Instructional Development Specialist, was seven training units plus a prerequisite test. (Canadian National, 1980).

The subjects for training development by the SME teams are chosen by the Traffic Systems Cabinet. This policy-setting body is chaired by the Assistant Chief, Traffic Systems, and consists of the three Managers at the System level (one of whom is the Manager, Traffic Systems Training), and the five regional Coordinators. The cabinet meets several times per year, or as required.

The SME Approach

The subjects for the first two SME teams were designated as *waybilling* and *demurrage*. The waybilling project began in June, 1980, the demurrage project in September, 1980. In the draft work plan, the elapsed time from the beginning of

analysis to the distribution of modules to the field was estimated at eight months. This proved to be somewhat of an underestimation. The waybilling course was distributed 27 months after beginning analysis, the demurrage course was distributed 19 months after beginning analysis. At least one reason for the overrun was the size and scope of the courses. As mentioned above, the workload was assumed to be seven training units plus a prerequisite test. In fact, the waybilling course consists of 15 training units, 2 lesson outlines, a course outline, a prerequisite test, and a course test; the demurrage course consists of 10 training units, 3 lesson outlines, a course outline, a prerequisite test, and a course test.

The SME approach to training development has continued to be used by Traffic Systems Training.

Goal

The primary purpose of this thesis is to analyze the training development procedures used by Traffic Systems Training to determine their strengths and weaknesses. A secondary goal is to analyze the process of instructional development within a commercial environment.

The method of analysis will be a case study of the demurrage project, for which I was the Instructional Development Specialist on my first major assignment. Cohen and Manion (1980) provide a framework for the classification of case studies that compares the type of observation with the type of setting. Given their framework, this case study can be described as: structured, participant observation in a natural setting.

The use of alternative research methodologies has increased in frequency in the fields of psychology, education, and other social sciences. The legitimacy (i.e. validity and reliability) of the case study method is determined by the rigour with which the technique is employed and reported. The document that follows presents both the data

gathering and the analysis stages of a case study. Accompanying discussion of each stage in the project is a review of literature pertinent to the particular activity. It is maintained that the careful application of non-experimental approaches to research is an important skill that educational technologists must develop and utilize.

Defense of Case Study Methodology

This thesis clearly does not fall within the guidelines of the standard experimental or research thesis, which can be described as being "based on the *scientific* paradigm, [which] rests upon the creation of theoretical frameworks that can be tested by experimentation, replication and refinement" (Cohen & Manion, 1980, p. 99). Rather, it has used a case study approach. For the purposes of this thesis, a case study is defined as the examination of a system or event, and the documentation of the same, to determine the salient or typical features of the system or event.

The decision to do a case study rather than an experiment may seem imprudent, given that the arguments in the literature against case studies are numerous. Huck, Cormier, and Bounds (1974), for example, decry the absence of control in case studies:

> The design does not provide for a comparison of the results. . . . The only comparisons or inferences a researcher can make from this [case study] design are based upon hypothetical data or common knowledge expectations. . . . In other words, all the researcher or reader can do is make imagined conjectures. (pp. 227-228)

Tuckman (1972) concurs, and introduces his outline of case studies with the tone of a self-conscious cleric preaching on the dangers of social diseases: "There is value in knowing what you should not do as well as what you should do" (p. 104). Pitts (1971) comes to the point more succinctly: "Observers are prone to see what they want to see, that which fits their predispositions" (p. 17). "Science . . . goes out the window when it becomes so individualistic" (p. 32).

While the above battery of criticism contains some undeniably valid reasons for

avoiding case studies in favour of experiments "based on the *scientific* paradigm", they do not fully apply here. The subject of the thesis is instructional development and, although instructional development contains elements of the scientific process (Reigeluth, Van Patten, & Doughty, 1981), it is not a science, but can be more properly described as a craft (Medsker, 1981), or even an art (Davies, 1981). Therefore, does it really make sense to apply all the rigour of the scientific method to the study of it? There are two answers to this question by virtue of the dualistic nature of instructional development: as an academic discipline, and as a profession in the marketplace. Within academia, there are indeed gains to be made by applying the scientific method to research. It conforms to the wider university-community norms, especially those of the departments of psychology, from whence sprung a considerable number of the principles of instructional development. Within the marketplace, however, these gains become drawbacks. There would be insufficient return on investment in even attempting to isolate, replicate, and document most meaningful commercial applications of instructional development in laboratory experiments. Brethower (1983) best summarizes the problems inherent in this internecine conflict in his article calling for bridging of the gap between the academic and commercial worlds; he quotes Ben Franklin to demonstrate the practically inclined feelings of the business world: "Well done is better than well said!" (p. 11). In other words, the employers of professional instructional developers are demanding results, not proper form.

This is not to imply that the business and academic worlds are completely antithetical; the commerce and administration faculties of every major university offer a working model of the two worlds coming together with fruitful results. And, aptly, it is within these academic departments where we find the case study and case analysis are vital factors in the curricula.

Let us examine how Thompson and Strickland (1978) describe case studies in a

textbook on business policy:

> A *case* sets forth, in a factual manner, the conditions and circumstances surrounding a particular managerial situation or series of events in an organization. It may include descriptions of the industry and its competitive conditions, the organization's background, its products and markets, the attitudes and personalities of the key people involved, production facilities, the work climate, the organizational structure, marketing methods, and the external environment, together with whatever pertinent financial, production, accounting, sales, and market information upon which management had to depend. . . . It [the case] puts the readers at the scene of the action and familiarizes them with the situation as it prevailed. (p. 170)

This is a far cry from the quarantine conditions and laboratory standards called for by Huck, Cormier, and Bounds; Pitts; and Tuckman. Thompson and Strickland go on to point out that, as described above, the case study is an excellent instructional tool, in that it allows students to analyze a real problem within its environment, and then to ponder over what was done, and what should have been done.

Are we not in need of this type of teaching tool now in the study of instructional development as we try to advance the discipline and to bridge the gap between academia and commerce? If "pure" research is required to maintain the discipline in its academic environment, then case studies and other naturalistic enquiries that culminate in practical recommendations and workable solutions to real-world problems are required to establish it in its commercial environment. The verb "establish" is used purposely, given that the role of instructional development is still not fully accepted in the business world. Frankly, most current applications of instructional development in Canadian National have not proven to be either cost-effective, or to adequately meet the needs of the clients. In a complex open system such as a large corporation the entire blame for this inefficiency cannot be laid at the doorstep of instructional systems development, or professional instructional developers. In business terms, however, the emphasis is not so much on determining precisely what or exactly who is the problem but, rather, on taking immediate action to fix it before it costs more money and resources.

This is where the present thesis may aid in bridging one gap between academia and commerce. The instructional development methods used in the demurrage project by Traffic Systems Training (now Transportation Training) have never been closely studied. As it should be clear by now, no extensive time is allotted for such luxuries in a real-world setting. With projects following the demurrage project, changes and adjustments in method have been made; many of these changes, however, are stop-gap measures, or can be attributed to the maturation of the training personnel. This case study was the first in-depth look at what exactly happened, and has resulted in recommendations for changes in approach that will aid the training department in future projects and, hopefully, that will also aid other organizations undertaking similar projects. Although some of the criteria for the scientific process are conspicuously absent from the thesis, such is the nature of the real world. Indeed, it is with the real world that educational technologists will most often have to contend.

Case Study Method

The primary goal of the thesis was to analyze the instructional development method used in developing an industrial training course. Cohen and Manion (pp. 101-103) lay out a framework for classifying case studies that compares the type of observation with the type of setting. Given their framework, this case study may be described as: structured, participant observation in a natural setting.

This type of case study takes a global approach in that it attempts to deal, in some way, with all aspects of the project. In other words, it does not select one variable (e.g. instructional design model, selection of project team, training supplied, etc.) for in-depth analysis and ignore the other variables but, instead, deals with each component in the system as it occurs; as Thompson and Strickland point out above, the idea is to put the reader "at the scene of the action". The discussion then entertains what produced

acceptable results, what did not, the possible reasons why, and suggestions for future improvements in approach. The documentation from each of the developmental stages in the project exists in the form of copious notes that were kept throughout.

Analysis of Training Development Procedures

Introduction to Instructional Systems Development

Instructional development is not a modern concept, its birth is buried in prehistoric times (Steinmetz, 1976). However, as Hannum and Briggs (1982) point out, the so-called traditional approach to instructional development, distinguished by features such as preparation of course material based on what an individual instructor feels is important, has prior experience with, or by what was covered in earlier versions of the course, is unpredictable, the outcome dependent on the skill of each developer or instructor. Achieving quality instruction through traditional instructional development procedures, they go on to say, "is in large part an art" (p. 9).

Today, this traditional approach to instructional development is being slowly replaced by the systems approach. The systems approach is characterized by viewing each problem (or event, organization, etc.) as a whole (i.e. a system) and then analyzing and dealing with each component in that system, not in isolation, but as part of the system. Wileman and Gambill (1983) describe it this way:

> Systems analysis deals with the investigation of the component events of a task or process...and the relationship of these events to each other *and* to the environment in which they must operate. Systems analysis is a means by which the entire process in question may be holistically viewed, while allowing for explicit input/output and process analysis of each component event. (p. 25)

Furthermore, as systems are, for the most part, defined by the systems analyst (Beishon, 1971; Romiszowski, 1981), a problem can be viewed at different levels; for example, one can look at all railways as a system, or all railways in North America, or

Canadian National, or Traffic Systems, or Traffic Systems Training, and so forth. Each of the above can be defined as a system, depending on the subject under study and the needs of the systems analyst.

Traffic Systems Training uses a systems approach to instructional development.

Traffic Systems Training Model

The most basic tool of the systems approach to instructional development is an Instructional Systems Development (ISD) model. As Rosenberg (1982) states: "The ISD model provides a procedure for *systematically* identifying and manipulating significant components which make up the instructional process" (p. 44). Note, however, that an ISD model is not an algorithm, that is, it is not merely systematic, and cannot be applied to achieve a viable instructional outcome as a cookbook recipe is used to create a pie. Rather, an ISD model is an heuristic procedure that assists the instructional developer in attaining the instructional outcome (Beishon, 1971; Romiszowski, 1981). Therefore, although the graphic representation of the ISD model used by Traffic Systems Training (Figure 3) gives the impression of a rigid, linear process, this impression is false; the ISD process is a cybernetic process that feeds information back into itself. For example, new information uncovered during the design stage can cause further analysis, or a problem occurring during the development stage can cause further design, and so forth. As Kemp (1977) puts it: "There is an interdependence among the . . . elements; decisions relating to one may affect others. You can start with whichever element you are ready to start with and then move back and forth to the other steps." (p. 9)

The Traffic Systems Training (TST) model is based loosely on the *Interservice Procedures for Instructional Systems Development* (IPISD) model (Branson, Rayner, Cox, Furman, King, & Hannum, 1975). There were several existing ISD models that

1. **NEEDS DEFINITION**
   - statement of felt need for training
2. **PRE-ANALYSIS PREPARATION**
   - logistical and administrative preparation
     - statement of goals
     - timetable
     - budget
     - other administrative items
3. **TEAM SELECTION**
   - selection of project team
4. **ANALYSIS**
   - definition of activity
     - brainstorming session
     - task flowcharting
     - task descriptions
5. **DESIGN**
   - blueprint for training materials
     - select tasks for training development
     - objectives
     - test/exercise questions
     - learning hierarchy
     - media selection
6. **DEVELOPMENT**
   - drafts of proposed training materials
     - development strategy
     - storyboards/scripts/workbooks
7. **PRODUCTION**
   - prototype training materials
     - slides
     - recorded tapes
     - typed workbooks
8. **FORMATIVE EVALUATION & REVISION**
   - tryout and revision of prototypes
     - validated training materials
9. **DUPLICATION & DISTRIBUTION**
   - final version of training materials duplicated and distributed
10. **MONITORING & REVISION**
    - data on use of training collected, and revisions/corrections made as necessary

Figure 3. Traffic Systems Training (TST) model for Instructional Systems Development.

could have been chosen on which to base the TST model; Andrews and Goodson, in their comparitive analysis of models (1980), identify over 60 published models. The IPISD model was chosen as a starting point by Traffic Systems Training management on the recommendation of the corporate training department. Rather than just using an existing model, a new version was created by Traffic Systems Training personnel because, as Noel and Hewlett (1981) point out, without adaptation to fit the needs of a project or an environment an ISD model can become "a straight-jacket for those who are subjected to its use" (p. 15).

What follows is a description and analysis of each step in the TST model as applied to the demurrage project. To reiterate, the method of analysis is structured, participant observation in a natural setting. I am the Instructional Development Specialist and team leader of the project on my first major assignment; other participants will be introduced as they appear during the project. Detailed notes were made by me during each step in the process in anticipation of writing this thesis; the observations that follow have been taken from these notes and from the project documentation (e.g. analysis charts, objective statements, workbooks and scripts from formative evaluation, etc.). To put my role as project team leader into context, it should be understood that, as a novice, my authority and control were limited, and that all major decisions had to be cleared by management.

1. Needs Definition

The statement of need for training development within Traffic Systems is made by the Traffic Systems cabinet. The actual needs assessment, if any, that preceded the decision to choose waybilling and demurrage as the topics for development is unavailable to me; I was not present at the cabinet meeting.

It is known that the request for training on these subjects was expressed from the local level on at least one region: The Carload Managers on the Great Lakes Region collectively requested to their Coordinator that these subjects be made priorities for training development because they had noted the lack of qualified personnel in these areas during vacation periods when their regular personnel had to be relieved by temporary or less experienced personnel.

It is also known that no cost/benefit analysis was carried out.

Literature Review and Application of the TST Model

This literature review, and those of the following steps, contain the general knowledge base for the approach used in the TST Model.

That the statement of need for a training development project typically comes from an organization's management or policy-setting body is noted by Awotua-Efebo (1984), Branson et al. (1975), and Dick and Carey (1978); although, as Gagné and Briggs (1979) state, there is not complete agreement on what actually constitutes a need. The most common definition is shared by Branson et al. (1975), Burton and Merrill (1977), Kaufman (1983), and Kaufman and English (1979), who all agree that a need is a measurable discrepancy between the way things are and the way things ought to be. Kaufman (1983) goes on to define a needs assessment as "the process for identifying, documenting, and justifying the gaps between What Is and What Should Be for results . . . and placing the gaps (Needs) in priority order for closure" (p. 14).

The question that occurs is: Was a sufficient needs assessment made by the Traffic Systems Cabinet in making demurrage a priority for training development?

Kaufman (1977) proposes a taxonomy of six types of needs assessments. At one end of the taxonomy, what he terms an Alpha Needs Assessment, is one that makes absolutely no assumptions about anything related to the system under study, or its

environment. At the other end of the taxonomy, what he terms a Zeta Needs Assessment, is one that accepts all aspects of the system under study, and only seeks to find gaps in the expected behaviour of the system. The Beta, Gamma, Delta, and Epsilon Needs Assessments fall in between these extremes, each one accepting more assumptions about the system under study than the previous one. Given Kaufman's taxonomy, the needs assessment carried out by the Traffic Systems Cabinet can be classified as a Gamma Needs Assessment: The Cabinet accepted the stated problem and its solution at face value, their input was simply to determine the most appropriate method of achieving the solution, which in this case was a training development project by Traffic Systems Training. As Kaufman and English (1979) state, however, the further one goes into the taxonomy beyond the Alpha Needs Assessment, "the possibilities for non-cosmetic . . . change narrow and the probability of making errors due to faulty assumptions increases" (p. 61). Add to this Thomas' (1982) statement, that "most line managers and staff officers are not experienced performance technologists" (p. 6), and it is clear that a potential problem does exist, that the needs assessment made by the Traffic Systems Cabinet could be viewed as insufficient.

On the other hand, could we expect more from the cabinet than was done? Firstly, although Canadian National is a Crown Corporation, it is operated as a private corporation (i.e. with a profit motive). A complete and in-depth study of the problem would have caused delays and cost money, two events that no profit-conscious manager wishes to initiate. Secondly, at least one group of Carload Managers, the people directly responsible for daily operations, did express a need for the training. Even though Burton and Merrill (1977) would classify their request as only a "felt need" or a "want" (p. 22), it was nonetheless a request from an experienced group of first-line management personnel. Thirdly, in the dynamics of organizational culture, it is not considered wise to relinquish decision-making power to another party. Although Montemerlo (1979) and

Tosti and Carleton (1980) state boldly that professional instructional technologists, not management, must have the final word in an instructional development process, this is, given contemporary corporate conditions, not as simple to implement as they make it sound; the instructional technologists would have to gain and maintain a high degree of credibility for this to occur. As it is, all major decisions must be cleared by management.

Conclusion

Although I was not present at any cabinet meetings where the subject was discussed, given the prevailing corporate environment and management philosophy, the stated needs and the decision to proceed with the demurrage training development project must be accepted as reasonable. However, a proper needs assessment (i.e. an Alpha Needs Assessment), including a cost/benefit analysis, would probably have changed the decision.

2. Pre-Analysis Preparation

This stage in the ISD model covers the logistical and administrative preparation for the project. It includes diverse activities, from translating the needs expressed by the Traffic Systems cabinet into a clear statement of goals, to booking hotel accommodations for out-of-town personnel. A brief description of the major activities in the pre-analysis preparation follows:

Goal. The gross statement of needs from the Traffic Systems Cabinet, for a training project on demurrage, was refined to produce the following instructional goal:

To develop a training course that will get an employee started working at the demurrage activity in the carload centre.

The criteria for the goal were given as:

1. Aspects of the activity to be covered in the course are: from the time the JF Assessment Report is generated in the carload centre until the customer is billed.

2. Prerequisites will be specified and a prerequisite test developed, but any required prerequisite training material will not be developed by the project team.

3. All training materials must be brought to the completion of the draft stage by 90 days from the beginning of the analysis.

This goal and its criteria were composed by the Manager, Traffic Systems Training.

Detailed work plan. A detailed work plan had to be developed to plan and organize the substeps required to achieve the goal. As Carey and Briggs say: "written details of substeps provide both a guide for ongoing activities and a record for preparing interim and final reports of project procedures" (1977, p. 285).

On receiving approval to use the SME approach to training development, a generic, or general work plan had been drafted by the Manager, Traffic Systems Training (Canadian National, 1980), and the detailed plan for the demurrage project was created from this.

The following are several pertinent observations from the draft general work plan:

1. The 90 day period allowed for training development includes weekends, statutory holidays, training time, sick days, and other time for administrative matters. Thus, the actual number of days for training development is only approximately 48 days, which still does not take into account time for personal purposes and other routine delays.

2. The SMEs fall under the Canada Labour Code, which implies a 40 hour normal work week, with 48 hours being the maximum number of hours permitted in any week. This includes time for training.

3. The normal working period will be 10 days, followed by 4 days off. This is to accommodate employees who must travel long distances. Travelling will be done on an employee's own time.

4. Training and study will have to be done at night, after the regular working day.

5. With a four-person team, plus team leader, a course consisting of seven training units plus a prerequisite test should be completed to the draft stage.

The detailed work plan, which followed the above guidelines from the draft general work plan, scheduled the SME team to begin on September 29, 1980. This date was established by considering various factors, such as the expected workload from other sources on the support groups (i.e. typing services, audiovisual production, etc.), and getting the project team home for Christmas. The actual breakdown of expected work, for example, four days allowed for brainstorming session, three days to draft objectives, and so forth, will be discussed later.

Project team selection. Although project team selection is properly a part of pre-analysis preparation, because of the nature and importance of this activity it has been separated from the other pre-analysis activities and will be dealt with in its own stage of the ISD model.

Budget. The project had to be budgeted to fulfill normal corporate accounting procedures. The actual costs are Canadian National proprietary information, but the following items were considered:

1. salaries (including anticipated overtime) for one Instructional Development Specialist, four SMEs, and a sufficient number of employees for formative evaluation,

2. for employees away from their homes: transportation, accommodation, meals, and incidental daily expenses (e.g. laundry, telephone, etc.),

3. overhead for office space and conference rooms,
4. office supplies,
5. training material and training hardware required by the SMEs,
6. estimated costs for anticipated audiovisual production,
7. duplication and distribution costs.

SME training material. Training material on the ISD process required by the SMEs had to be assembled, and in some cases modified or even created. The design and development of this material was primarily the responsibility of a corporate training department.

Other administrative items. Various other administrative items had to be handled, for example, booking hotel accommodations, scheduling conference rooms, obtaining expense advances, fulfilling requirements by Employee Relations for temporary transfers, assigning office space, ordering office supplies, and creating or assembling orientation material.

3. Project Team Selection

This stage of the ISD process is where the actual personnel who will develop the training materials are selected. Each team consists of an Instructional Development Specialist as team leader, and four or five SMEs. The Instructional Development Specialist is a permanent employee of Traffic Systems Training and has formal education at the graduate level in educational technology. The SMEs are carload centre personnel on temporary assignment to System Headquarters for the training development project on their area of expertise.

Tools for the selection process for the SMEs were developed in the following manner:

In conjunction with industrial psychology professionals in a corporate personnel department, two standard forms were created (see Appendices A & B). The first form, to be completed by applicants to the team, requests information on education, personal background, work experience, and career plans; it ends with a request for a short autobiography. A 30 minute time limit is allowed for its completion. The second form, to be completed by each applicant's immediate supervisor, requests the supervisor's opinion on such subjects as the applicant's abilities, interest in work, dependability, relations with others, and so forth.

A short audiovisual presentation was also developed: its target population the applicants for the position of SME; its goal to briefly explain the ISD process and the role of the SME in that process. Further adjunct material was also prepared, outlining working conditions, salary adjustments, and so forth.

The SME project team selection followed these steps:

1. Traffic Systems Training sent a letter to each region stating the goal of the project and soliciting suitable candidates to fulfill that goal.

2. The regions, in turn, passed on the request to the Carload Managers in their jurisdictions.

3. At the carload centres, interested employees viewed the audiovisual presentation explaining the ISD process and read the material outlining the working conditions of the project. Any employee still interested in the project completed an application form. A Carload Supervisor, or the Carload Manager, then completed a Supervisor's Comments form, and forwarded the documentation to Montréal.

4. A spreadsheet on the applicants was compiled from the information on the completed forms, and a short list of potential SMEs selected. The key criteria used to

place a name on the short list were: depth and breadth of experience, writing ability, and an attempt to strike a regional balance.

5. The applicants on the short list were interviewed by the Instructional Development Supervisor from Traffic Systems Training, and a project team was chosen.

6. The regions were informed of the choices, and acceptance or rejection letters were mailed out to all applicants.

Literature Review and Application of the TST Model

The participation of an instructional technologist (IT) and SMEs as a team in the development of instructional materials is quite common, as can be seen by the amount of references in the literature (Berman & Gorski, 1984; Bollettino, 1980; Bratton, 1983; Carey & Briggs, 1977; Clark, Elam, & Merrill, 1983; Coldeway & Ramussen, 1984; DeWeaver, 1980; Gibbons, 1979; O'Neal, Faust, & O'Neal, 1979; Patton, 1980; Rosenberg, 1981). Disagreement exists, however, on exactly how the ITs and SMEs should participate. Bollettino, for example, favours the IT doing the bulk of the development work, with the SMEs acting merely as resource persons and validators of the IT's work. On the other hand, Clark et al. prefer to have the SMEs develop the materials, with the IT providing job aids and guidelines, and acting as consultant. Rosenberg strikes a middle ground, and suggests that SMEs must learn the basics of instructional technology and the IT become familiar with the basics of the content area being worked on, but that each maintain the major role in their respective area of expertise. The question posed by these different approaches is: Should ITs develop the training material because they know how to do it? or should SMEs design it because they know what should be in it? (Berman & Gorski).

The method used by Traffic Systems Training, where the SMEs act as instructional developers, albeit under the leadership of an IT, gets support from DeWeaver, who

notes that institutions following this method usually do so for reasons of cost and credibility. First, it would cost too much to thoroughly train the IT in every area requiring training development, especially when competent SMEs already exist, and second, as actual members of the target population, the SMEs can provide credible and realistic training materials. This is supported by Gibbons, who states:

> through the use of design guides and appropriate quality control, substantial amounts of the instructional development task may be carried out with minimum training by nondeveloper work force. (p. 9)

This approach of using SMEs as developers does have its detractors. Montemerlo (1979), for example, notes that SME/developers often suffer from information overload, and follow design rules blindly, as if they were algorithms rather than heuristics; he concludes that "one can become a competent training technologist only through a great deal of experience" (p. 11).

Problems encountered due to SMEs acting as developers will be discussed later. As to the actual SME project team selection for the demurrage project, at least three problems were encountered:

1. First, not all potential SMEs were made aware of the ISD project. As mentioned earlier, departments within Systems Headquarters do not generally exert a direct control over regional or local activities. Therefore, the manner in which the regional Traffic Systems personnel and the individual Carload Managers responded to the call for applications varied considerably: For example, at some locations the Carload Manager solicited volunteers in an open manner; at other locations applicants were delegated by management; at yet other locations the request for applicants was completely ignored. In some instances, the reason for a particular negative action could be explained by the fact that no relief was available, and no sane manager could be expected to part with the sole qualified employee in demurrage for 90 days. At other locations, however, the negative action was merely a reflection of management style, or

an indifference, even an hostility, to the affairs of System Headquarters, which is perceived in some quarters as being far removed from reality and dubbed *The Ivory Tower*. Whatever the motivations of the individual Carload Managers, the result was that some potential SMEs were denied a chance to participate in the demurrage project.

2. A second problem was that the actual pool of potential SMEs was small, perhaps only 40 individuals in the whole country. Compounding this problem, not all individuals approached by their managers wished to leave the relative comfort of their homes, families, social life, and the consoling routine of their daily jobs to participate in a training development project.

3. Finally, the audiovisual presentation and supporting documentation used to solicit potential SMEs gave neither a clear description of the ISD process nor a clear set of expectations regarding the SMEs' involvement. Consequently, when the SMEs arrived at headquarters, they did not know exactly what was about to happen. As it turned out, their reasons for applying for the position were not to participate in a training development project as much as a desire to get ahead in the company or to escape from the routine of a daily job.

Conclusion

In spite of the problems listed above, the SME project team selection process proved sufficient for the immediate needs of the demurrage project. From the information gathered from the approximately twenty employees who applied, the Manager, Traffic Systems Training, the Instructional Development Supervisor, and the Instructional Development Specialist selected the four individuals who seemed most capable of fulfilling the project goal.

4. Analysis

Analysis is the step in the ISD process where an activity is described in terms of its component parts, and of the relationships between them. The purpose of analysis is to provide a clear and comprehensive picture of the activity under study in order to create a solid base for the design of a solution to the defined problem, or need, related to that activity.

The analysis undertaken for the demurrage project had a three-step approach: It began with a brainstorming session to document the skills entailed in the demurrage activity, continued with flowcharting of the tasks involved, and concluded by the completion of worksheets to specify in detail the input, process, and output of the major tasks.

The SMEs were prepared for participation in the analysis stage by studying a series of self-instructional training units prior to arriving in Montréal. Shortly after being selected as SMEs, each employee had been administered the course, previously mentioned, to qualify as an advisor. From this point, they self-administered any required training units, including the marking of their own pre and posttests.

The analysis stage training consisted of three units:

1. a short reading exercise giving an overview of the brainstorming process to be used;

2. a reading exercise on task flowcharting. This unit contained background information on task analysis (e.g. why it is performed, etc.), explained the use of flowcharting symbols, and provided exercises on flowcharting simple tasks;

3. an audiotutorial on how to complete task description worksheets. These were worksheets used to record the input, process, and output data on specific tasks and subtasks.

These three training units were estimated to take eight hours study time, and were

to be completed prior to the SMEs' initial arrival in Montréal.

The work plan outlined the following schedule for the analysis session to take place (the numbers indicate the day of the project):

Day	*Assignment*
1	Orientation. Administrative items. Get-acquainted session.
2-6	DACUM session.
7-8	Set priorities. Select blocks for task flowcharting. Assign blocks to team members.
9-11	Task flowcharting.
12-16	Home. (Note: The extra day was for the Thanksgiving Holiday.)
17-19	Check and revise task flowcharts.
20-21	Prepare task description worksheets.

Literature Review

In reviewing the literature on analysis, articles from academic sources downplay somewhat the analysis phase of instructional development, treating it almost as an adjunct to writing objectives. For example, Kibler and Bassett (1977) describe the instructional development procedure as follows: Needs are defined, goals are established from the needs, and these goals are in turn broken into specific performance objectives. Only then do they concede that "this probably will require a number of levels of analysis before all of the short-term objectives are identified." (pp. 53-54).

Gagné (1977) agrees with the above procedure (needs → goals → objectives), but at least goes into some more detail on analysis. He states that after objectives are specified the next step is to do a "task analysis" (p. 115), which he subdivides into three steps: an information processing analysis, a task classification analysis, and a learning task analysis. The information processing analysis he describes is the documentation,

possibly by flowcharting, of each step in the activity under study, including any covert or mental operations that underly each step. The purpose of this information processing analysis is to "reduce a complex kind of behaviour to components which are simple" (p. 123). In the next step, the task classification analysis, he proposes the classification of tasks in terms of their encoding, memorial organization, and retrieval process, for example, into his own task classification hierarchy (i.e. verbal information, intellectual skills, cognitive strategy, attitudes, and motor skills). Finally, the learning task analysis he discusses is the creation of a learning hierarchy for the activity, that is, a detailed list of the tasks with their prerequisites.

Dick and Carey (1978) feel that a process similar to the last step in Gagné's task analysis is sufficient. This they call an *instructional analysis*, which consists of identifying all relevant procedures and subordinate skills inherent in the instructional goal. Unlike the other academic models, their instructional analysis precedes the creation of objectives.

In the military and industrial models, analysis is given a greater profile than in most of the academic models. In the military and industrial milieux, in agreement with Dick and Carey's approach, analysis is used as a basis for creating objectives, not a subsidiary activity to be performed after specifying objectives.

As Butler (1972) puts it:

> Task description is the foundation upon which the entire [training] system is built. A thorough and accurate job/task description is absolutely essential to the entire structure . . . . [It] suggests the sequencing and form of training, and also serves as a statement of the performance criterion which will be used in evaluating both the training and the students. *Task description is virtually the fundamental source of training objectives.* (p. 73)

The most comprehensive approach to analysis is found in the IPISD model. Branson et al. propose a five-step analysis for this military model:

1. Analyze Job.

2. Select Tasks/Functions.

3. Construct Job Performance Measures.

4. Analyze Existing Courses.

5. Select Instructional Setting.

Their approach, however, is far from being rigid:

> The ISD process does not restrict you to a specific job analysis approach or to a specific sequence of steps in carrying out the requirements of the first three blocks in the model. The only requirement is that your approach be well-planned, logical, and consistent with the needs and resources of your command. (*1*, p. 6)

Application of the TST Model

The Traffic Systems Training model has a three-step approach to analysis: The first step is a brainstorming session using the *DACUM* approach.

DACUM is the acronym for "Designing a Curriculum". This is an analysis process for occupational training development created by the Nova Scotia NewStart Programme, funded by the Department of Regional Economic Expansion, a branch of the Canadian federal government (Adams, 1975).

During a DACUM brainstorming session, the SMEs are prompted by the Instructional Development Specialist to list all of the skills involved in their daily jobs, classified into a few logical groupings called *General Areas of Competence* (GACs). As each skill is specified by the SMEs, it is written on a 5" x 7" card by the Instructional Development Specialist, and the card is attached to a large, plain wall. The skill statements are then ordered from left to right in bands of GACs, according to whether they are skills that could be handled by a new employee or require the experience of a master performer. The skill statements are then typed on labels and transferred to a chart for reduction and duplication.

The outcome of a DACUM session is a chart that can be used as a basis for

designing a comprehensive course of instruction. At least two other less tangible but very important benefits accrue from the use of this DACUM process:

First, it reduces anxiety in the SMEs. It sets them at ease by not requiring any greater skill from them than merely being able to talk about their jobs with people from other parts of the country who do the same or a similar job. The ISD process, although explained generally in the training provided and in opening day presentations, is, at this stage, still a mystery to the SMEs. Furthermore, a unionized carload centre employee, temporarily posted to System headquarters and surrounded by management personnel wearing jackets and ties, is very far from a familiar environment. By beginning with the relatively easy DACUM process, the SMEs are reassured that they are not completely out of their depth.

Secondly, the DACUM session generates a team-building atmosphere. An ISD project of this nature involves a group of complete strangers working closely together for a common purpose within a limited time frame. Isolation in a closed room for a few days at the beginning of the project provides the perfect environment for the Instructional Development Specialist team leader to begin developing a team mentality and a team spirit.

The creation of the DACUM chart for the demurrage activity, including a review by management, took three and a half days.

Several minor problems were encountered:

1. Bolletino (1980) states that the team leader need not be an SME. However, as the SMEs' discussions on the intricacies of demurrage were somewhat abstruse, the Instructional Development Specialist's lack of knowledge caused him more anxiety than anticipated. This also made it difficult for him to determine when to terminate debate, and when to encourage it.

2. The team lacked the participation of a *generalist*, that is, an individual with a

System and a managerial overview of the demurrage activity. The addition of a generalist could have reduced discussion on needless or minute details, and have helped resolve differences on local exception situations.

3. The SMEs initially volunteered *tasks* or even *subtasks* instead of *skills* for the DACUM chart, for example, "fill in the date, station number, . . . on the Customs Manifest", instead of "apply information to customs documents". This was soon corrected by coaching from the Instructional Development Specialist.

While the DACUM chart was being printed, work began on charting the workflows using the standard IBM flowcharting method (IBM, *Data processing techniques*, C20-8152). See Appendix C for an example. After developing the major workflows in a group session, the SMEs worked independently in creating the flowcharts of the subtasks. On completion of a chart, it would be photocopied and circulated to the other team members for revision or approval.

The creation of flowcharts for the entire demurrage activity took eight days.

Several problems surfaced during this phase:

1. The SMEs had trouble acquiring flowcharting skills. None of them had previously entertained the idea of analyzing their job into discrete steps, and found the concept completely alien. This was compounded by the fact that the self-instructional training in flowcharting was found to be inadequate for a target population at the level of the SMEs: The functions of the flowcharting symbols were completely misunderstood by the SMEs, for example, *decisions* were at first charted as *actions*, creating long, linear charts with no branches.

2. The SMEs still confused the concept *skill*, as used in the DACUM brainstorming session, with the concept *task*, required in the flowcharting process, and applied them indiscriminately. This resulted in attempts to create flowcharts for skills such as "maintain filing system", or "operate YIS computer terminal". As with the

flowcharting, this lack of understanding was not their fault; inadequate training and coaching on the subject was given to them.

3. The SMEs were hesitant to challenge the others' work. The flowcharts circulated for revision or approval were usually approved without changes, no matter what they indicated.

4. The first flowcharts produced were not as thorough as those done later, after the SMEs had gained some experience in creating them. Time constraints did not permit the earlier efforts to be redone.

The ramifications of these problems will be discussed later.

Using the completed flowcharts as a guide, task descriptions were prepared on the workflows. This entailed the detailed specification of the input, process, output, and any other pertinent information on the tasks on preprinted worksheets. See Appendix D for an example.

As with the flowcharting phase, after working through one or two examples together, the SMEs worked independently to create the task descriptions. Each completed task description sheet would then be photocopied and circulated to the other team members for revision or approval.

The creation of the task description sheets took five days.

Again, several problems were encountered:

1. The SMEs had still not grasped the necessity for carrying out a detailed analysis. They later confessed that they were doing the analysis merely because they were told to do so; they were just following orders. This lack of understanding, of course, was not their fault, no one had yet come up with a good explanation for them.

2. The training on completing task description worksheets did not work any better than the training on flowcharting. The SMEs were simply not competent in this activity, which was really no more than expanding on the logic flow detailed in the just-completed

flowcharts. To illustrate the magnitude of the problem, it was discovered at this point that one particular SME had not created a single flowchart or task description worksheet by himself. The team-building activity had worked, however, the other three SMEs had quickly realized his incompetence and lack of productivity, but were covering up for him by doing his assigned tasks as well as their own.

3. The Instructional Development Specialist did not help much in remedying the problems. He was inundated with the paper that was being created, and spent most of his time trying to establish a logic flow in the flowcharts and task description worksheets. He lacked the time to provide remedial training and coaching to the SMEs, and the experience to attempt other strategies or deviate from the work plan. Furthermore, no other support was available.

4. As with the flowcharts, the first task description worksheets produced were not as thorough as those done later, after the SMEs had gained some experience in creating them. And again, time constraints did not permit the earlier efforts to be redone.

Conclusion

In spite of these rather serious problems that were encountered, the analysis stage of the demurrage project can be considered a success. The analysis proved to be functional and of satisfactory quality. The work plan had allowed 21 out of the 90 days for this stage, and it was completed on schedule.

Furthermore, the project team was compatible, worked well together, and the individual SMEs helped and supported each other. They did not even lose their enthusiasm when it was later announced that the one individual was being returned early to his carload centre. The individual was actually quite relieved to return home, given that he had been under a fair amount of stress not being able to fulfill his assigned tasks by himself. The administrative details of his return were orchestrated to make it seem

that his duties were finished ahead of schedule so that he would not lose face with his fellow-workers or supervisors at his home terminal, and he parted with positive feelings. He even agreed to return later in the project to participate as a technical validator in the formative evaluation phase. In hindsight, he was not to blame for his inability to participate in the ISD process; he had been, after all, a competent Demurrage Clerk for over 20 years. It was the training material that had failed him, and the coaching by the Instructional Development Specialist had not been sufficient to overcome its deficiencies. Furthermore, the selection process had not warned of the potential problems. The training material and selection tools will be discussed in more detail later.

5. Design

The design stage of an ISD project can be compared to the drawing of blueprints in a construction project. Blueprints are detailed plans from which a structure will be built; design stage materials are detailed plans from which training will be created.

The design for the demurrage project consisted of a five-step approach: selecting tasks for training development, writing objectives, developing test-items, specifying learning hierarchies, and selecting media.

The three remaining SMEs were prepared for participation in the design stage by studying a series of eight self-instructional training units, divided into four blocks to coincide with four of the steps in the stage:

Block 1: Writing objectives

1. the book, *Preparing Instructional Objectives*, by Robert Mager, (1975); this short and easy-to-read text introduces the concept of behavioural objectives;

2. an audiovisual (filmstrip/tape) unit on recognizing well-written instructional objectives; this unit also provided practice in rewriting poorly written objectives.

Block 2: Developing test-items

3. an audiovisual unit presenting the concept of criterion tests, relating them to the task analysis, and introducing the SMEs to various forms of tests;

4. a programmed instruction text leading the SMEs to consider the important aspects of test-item construction, presenting the purposes and methods of a testing programme, and outlining the characteristics of a good test;

5. a reading exercise consisting of an indexed set of notes on the testing process to be used as a reference during test construction;

6. the book *Measuring Instructional Intent*, by Robert Mager, (1973); this short text actively involves the SMEs by requiring them to check for a proper match between stated instructional objectives and criterion test-items.

Block 3: Instructional sequence and structure

7. an audiovisual unit involving the SMEs in recognizing the dependent and independent structures of task and subtask relationships.

Block 4: Media selection

8. an audiovisual unit presenting the SMEs with various decision considerations regarding the selection of an instructional strategy and the subsequent selection of appropriate instructional media and materials.

The eight design stage training units were estimated to take approximately 22 hours study time, and were to be completed by the SMEs on overtime, after their regular workday.

The work plan outlined the following schedule for the design stage:

Day	*Assignment*
22	Select tasks for training development. Review design stage training. Assign areas to SMEs.
23-25	Develop objectives.

26-29	Home.
30	Review completed work.
31-36	Develop prerequisite and terminal test-item pools.
37-39	Specify learning hierarchies.
40-43	Home.
44	Determine media.

Literature Review

> Objectives identify the end products or terminal performances of instruction in terms of observable, measurable behavior. (Kibler & Bassett, 1977, p. 55)

From the amount of literature on the subject, it appears that the creation of behaviouraly stated objectives is one of the cornerstones of instructional technology. Several writers do, however, also provide opposing points of view to this tenet. For example, by communicating objectives to students, it may prevent them from trying to meet other objectives that they may formulate by themselves (Briggs, 1977; Gagné & Briggs, 1979); using objectives is dehumanizing, and makes education mechanistic and impersonal (Kemp, 1977). These negative comments, however, seem to be more of an attempt to provide a balanced approach to the subject than to seriously challenge the concept. Objectives (also referred to as behavioural objectives, instructional objectives, and performance objectives) are, rather, held by most writers to be absolutely necessary to the ISD process. Although Mager's (1975) justification for creating objectives is the most delightful: "if you're not sure where you're going, you're liable to end up someplace else" (Preface), Gagné and Briggs (1979) are more comprehensive in their reasoning: precisely stated objectives meet the requirements of two needs, communicating the purpose of the instruction, and evaluating the instruction (p. 118).

There are several formulae for the construction of objectives. Gagné and Briggs

(1979) go into the most detail by demanding five components for the operational description of an objective: action, object, situation, tools and other constraints, and capability to be learned (p. 120). A similar but simpler formula is proposed by Branson et al., (1975); Dick and Carey (1978); Kemp (1977); and Mager (1975): Objectives must specify an action, conditions, and criteria or standards.

Branson et al. (1975); Briggs (1977); Gagné (1977); Gagné and Briggs (1979); and Kemp (1977) also require that the objectives be classified by the type of learning required. This concept is also referred to as learning category, or learning domain. For example, Branson et al. propose four learning categories: information, mental skills, physical skills, and attitudes, which they classify into the following subcategories (2, pp. 19-30):

I Mental Skills
  1. Rule learning and using
  2. Classifying - recognizing patterns
  3. Identifying symbols
  4. Detecting
  5. Making decisions

II Information
  6. Recalling bodies of knowledge

III Physical Skills
  7. Performing gross motor skills
  8. Steering and guiding - continuous movement
  9. Positioning movement and recalling procedures
  10. Voice communicating

IV Attitudes
  11. Attitudes

Kemp recommends that objectives be classified by Bloom's (1956) taxonomy for the cognitive domain: knowledge, comprehension, application, analysis, synthesis, and evaluation (cited in Kemp, p. 25); Kibler's (1970) classification for the psychomotor domain: gross bodily movements, finely coordinated movements, nonverbal communication, and speech behaviour (cited in Kemp, p. 26); and Krathwohl's (1964) taxonomy for the affective domain: receiving, responding, valuing, organizing, and characterizing by a value complex (cited in Kemp, p. 27). Gagné and Briggs propose

that objectives be classified into the following categories: intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes (pp. 49-51).

Branson justifies the need for classifying objectives into their learning categories by claiming that each learning category is analyzed differently. Gagné (1977) echoes this idea, and adds the further reason of efficiency, especially when dealing with hundreds of objectives: "While instructional planning is possible for each single objective, great economy of thought is achieved by classifying a total set into five categories." (p. 129).

The creation of test-items to measure achievement of the behavioural objectives is yet another article of faith in ISD. Roid (1979) goes as far to say that "a radical but plausible argument could be made that tests and the items that compose them are the most important elements in an instructional system." (p. 67). Branson et al. (1975) are of the opinion that "the key to any successful instructional program is the precision with what is taught is tested" (Executive Summary, p. 52).

In an industrial environment, it is important to achieve mastery of the skills being taught. This skill mastery requirement calls for criterion-referenced testing. In other words, an employee's performance of a skill is compared to a criterion, or standard, and an observation made of the employee's performance of the skill (can perform skill to the criterion, or, cannot perform skill to the criterion). This information, when part of a terminal test, is then used to permit entry of the employee to a specified job, to indicate the need for more training prior to awarding the job or, in certain cases, to deny entry to the job.

Butler (1972) sets the following high standards on test-item development by stating categorically that "to be a true measure of the student's learned capabilities, *the criterion test must be criterion-referenced, comprehensive, valid, reliable, objective, standardized, and economical.*" (pp. 97-98).

Criteria for performance, and their criterion-referenced test-items, are derived from

objectives (Branson et al., 1975; Briggs, 1977; Butler, 1972; Dick & Carey, 1978; Gagné & Briggs, 1979; Kemp, 1977; and Mager, 1973). Test-items linked to objectives have the following advantages:

1. They refer back to the earlier stages in the project (objectives, goals, and needs).

2. They are useful for monitoring trainee progress.

3. They have diagnostic value, directing attention to where remedial training may be required.

4. They help make a *yes* or *no* decision on whether the desired performance criterion has been met by a trainee (Briggs, 1977, pp: 171-172).

Briggs, Butler, and many others also point out that these test-items fulfill another need: that of playing an important role in evaluating and improving the instruction.

> The criterion tests serve as quality control instruments by comparing the performance demands placed on the student during training with those of the actual job for which it is preparing him. To do this, the *criterion tests are used to evaluate the training objectives, to evaluate individual lessons, to evaluate the complete system, and to continuously evaluate the system after it has been implemented in the classroom.* (Butler, 1972, p. 97)

More will be said about this aspect of testing during discussion of the formative evaluation and revision, and monitoring and revision steps of the model.

Another concept closely linked to objectives is that of learning hierarchies. A learning hierarchy is the output of a process to identify and organize dependent and supportive knowledge and skills in a project. The learning hierarchy aids in determining the most logical and efficient sequence for the training interventions that follow (Branson et al., 1975; Briggs, 1977; Butler, 1972; Dick & Carey, 1978; Gagné, 1977; Gagné & Briggs, 1979).

The most straightforward approach to developing a learning hierarchy is suggested by Gagné. Learning task analysis, as he refers to it, is accomplished by asking of each skill: "What simpler skill(s) would a learner have to possess in order to learn skill X, the

absence of which would make it impossible for him to learn skill X?" (pp. 132; 134).

Dick and Carey make reference to Gagné, but their approach is somewhat more involved, in that they combine development of the learning hierarchy with task analysis to produce what they refer to as an *instructional analysis*. In their model, this instructional analysis is then used to generate objectives.

Unlike the creation of behavioural objectives, criterion-referenced tests, and to some extent learning hierarchies, the approach to instructional media selection does not generate a united front in the educational technology establishment.

> Very little of the vast published research on audio-visual media is of any help at all in deciding which media to use. Research into 'older' media, let alone combinations of old and new, is even less productive of insights. (Rowntree, 1974, p. 123)

> Media and delivery systems are usually selected on the basis of equipment availability, local past experience, and available production facilities. (Branson et al., 1975, Executive Summary, p. 72)

> The traditional approach to selecting media for instruction has often been based on a search for applications for a new item of equipment which has come on the market. (Romiszowski, 1981, p. 339)

> Media decisions often are mostly educated guesses. (Butler, 1972, p. 127)

Carey and Briggs (1977) and Gagné and Briggs (1979) do propose a nine-step approach to media selection that links the media choice directly to a project's objectives and their learning classification:

1. state the objective of the lesson
2. classify the objective
3. select the instructional events
4. determine the type of stimuli for each event
5. list the candidate media for each event
6. list the theoretically best media for the events
7. make final media choices

8. write a rationale for the decisions made

9. write a prescription for each event (Gagné & Briggs, p. 195).

If Clark and Clark (1984) are correct, however, this may all be somewhat wasted effort: "Media *do not under any circumstances influence performance.*" (p. 1). Given this, the simplest and most direct approach to instructional media selection may be achieved by following Butler's suggestion, that the best choice is the least costly medium that adequately meets the objective.

Application of the TST Model

The first step in the design stage of the TST model is to select tasks for training. In a meeting for this purpose, the team was joined by the Manager, Traffic Systems Training, and the Instructional Development Supervisor.

Using the output from the analysis stage, which provided a clear picture of the entire demurrage activity, a preliminary course outline was drafted. The outcome was that the original goal (see **2. Pre-Analysis Preparation**) was expanded. Criterion 1. had restricted the aspects of the training to be developed as: from the time the JF Assessment Report was generated until the customer was billed. This was expanded to include training development for the entire demurrage activity, practically doubling the scope of the project. This decision was made jointly by management and the team because, after viewing the analysis, it was clear that by keeping the training centred only on the JF Assessment Report the resulting training package would be incomplete.

Selection of the tasks for training development and drafting of the preliminary course outline took approximately three hours.

The decision to expand the scope of the course, which at the time seemed logical, was one of the major causes of the project missing its deadline. With hindsight, a preferable approach would have been to keep the original goal, but reserve the right to

recall the team at a later date to complete any outstanding training requirements. In the heat of a project, however, rash decisions are easily made.

The only other problem encountered at this step was that the team perceived management as interfering unnecessarily with one of their decisions. The team had identified the skill "interpret the demurrage tariff" as one of the key training requirements. This skill was arbitrarily and without proper explanation classified by management as a prerequisite skill and, therefore, according to criterion 2. of the goal, not to be developed by the project team.

The criterion that a project team not develop prerequisite material is a sensible one. Otherwise, the team could spend all its time developing background material that could be more efficiently developed by others. However, the difference between a component skill and a prerequisite skill is not always clear. The management decision to arbitrarily take one direction, and to ignore the team's reasoning to go the other direction, caused repercussions beyond the importance of the decision. The project was thus demonstrated to the team to be management's project and, therefore, less of their own project.

Although this was only a minor incident, and management does have the right to make decisions such as these, it was handled poorly, and the resulting bad feelings had negative effects on the team and on the team process. It does highlight, however, the importance of good interpersonal and communications skills for management personnel, and how easy it is to offend subordinate employees.

The next step in the design stage of the TST model is the writing of behavioural objectives. Using the DACUM chart and the task flowcharts, on which the skill statements and tasks were already in behavioural terms, the team created lists of objectives for each of the subjects in the preliminary course outline. The SMEs worked individually, following the Mager (1975) model of the three-part objective, and then

collectively reviewed and revised their lists. The group approach to reviewing and revising the material worked much better than had the passing around of the drafts in the analysis stage. The reasons for this were that the SMEs were more comfortable with verbal criticism than with written criticism, and that the Instructional Development Specialist could provoke discussion when he sensed that all members were not in agreement on any point.

Writing and revising the objectives took three days.

One problem was encountered at this step: The SMEs had difficulty getting started writing the objectives, and this in spite of this task entailing, for the most part, transcription of the DACUM chart skill statements and flowchart tasks behind the standard phrase: *On completion of this training unit, the trainee will be able to...* . Once again, the SME training had failed to meet its objectives, this time, ironically, on objective writing.

Two other points, although not causing a problem at this stage, are worthy of note:

1. The TST model treats in one step what the IPISD model treats in two steps.

Step I.3 of the IPISD model is: Construct Job Performance Measures (JPMs).

> A JPM measures one or more complete tasks. Job Performance Measures are used to:
>
> 1. Separate people into two groups: those who can satisfactorily do the task and those who cannot
> 2. Serve as the fundamental basis for development and control of training
> 3. Control the quality of the output (graduates) of training
> 4. Form the basis for skill qualification tests, tests for promotion, tests to ensure that units are in appropriate state of readiness, and any other measures of DOS [Defense Occupational Specialities] proficiency. (*1*, p. 157)

Step II.1 of the IPISD model is: Develop Objectives.

> Learning objectives describe precisely what is to be learned in terms of the expected student performance under specified conditions to accepted standards. (2, p. 1)

As Branson et al. state in the Executive Summary of their model, it is at the

Develop Objectives stage that "the break occurs between the job world and the training world" (p. 46).

In order to save time, the TST model eliminates the step of creating JPMs. The resulting objectives are somewhat of a hybrid between IPISD's JPMs and objectives and, therefore, there is no clean break "between the job world and the training world".

2. In the TST model the objectives are not classified into learning categories, also for the reason of saving time.

The next step in the design stage of the TST model is the development of test-items. Criterion test-items were developed for each objective; prerequisite test-items were also developed or, where possible, selected from existing training units. The SMEs worked individually or in pairs at this task, and then collectively reviewed and revised the items. An attempt was made to create a sufficient number of items from each objective to provide for embedded tests, module pre and posttests, and a course terminal test.

Developing the criterion test-item pool and the prerequisite test-item pool took nine days.

Again, problems were encountered at this activity:

1. At first, the SMEs could not produce anything more complicated than true/false items, or completion items with an inappropriate word or phrase missing. And, once again, the SME training material had failed.

Luckily, by this stage of the project the Instructional Development Specialist had started to gain a basic understanding of the subject, and so designed written simulation items on the key area (processing the JF Assessment Report), and arbitrarily set the SMEs to create several examples of these.

2. A second problem, however, arose out of this. Sufficient examples of source documents (e.g. switch lists, customs papers, car orders, etc.) were not available for the simulations. Permission was obtained from management to allow for overtime for the

SMEs to collect source materials at their carload centres during their next time home.

3. Creating test-items, even badly, took longer than anticipated, and so, in order to keep to the work plan schedule, a scheduled tryout of the test-item pool was cancelled. The SMEs did check on each other's work, but, given that they were all immersed in the project, this cannot be considered a completely valid check. The tryout of the test-items that had been planned, however, was not as extensive as that proposed by Butler (1972), who recommends that test-items be tried out on two sample populations: (a) *untrained-unskilled*, and (b) *trained-skilled*. Briefly, the untrained-unskilled group should fail the test, the skilled-trained group should pass the test. The purpose of this type of tryout is to rectify administration and procedural details, and check for validity and reliability (pp. 105-112).

4. With the exception of the written simulation items on processing the JF Assessment Report, many of the test-items were ultimately discarded by the Instructional Development Specialist as being too simplistic or unclear, and new items were created after the units had been developed. This runs contrary to Briggs' (1977) warning that creating test-items after development risks the items being too "content oriented", and thus possibly missing the main point of the objectives (pp. 183-184).

The third step in the design stage of the TST model is the specification of learning hierarchies. Using the objectives and following Gagné's guidelines (quoted above), learning hierarchies were developed for the major skill areas identified in the preliminary course outline.

The hierarchies took one and a half days to develop.

The usual problem of inappropriate SME training was encountered. The training unit on developing hierarchies had provided extremely easy exercise examples; consequently, when confronted with a complex task, the SMEs were not prepared to handle it. Furthermore, they could not initially grasp the difference between a work flow

and a learning hierarchy.

The final step in the design stage of the TST model is the instructional media selection. This task was performed by the Instructional Development Specialist because it was considered too difficult for the SMEs, although they were consulted on the media choices.

Media selection, and the discussion with the SMEs on the reasons for the selection, took less than one hour.

The only problem encountered at this step was that it was clearly stated in the department's Training Manual (Canadian National, 1977, 01B01), and implicitly understood by Traffic Systems Training employees, that the media selected had to be one of the self-instructional audiovisual media normally used by the department (i.e. filmstrip/audiocassette/workbook, audiocassette/workbook, etc. See the first chapter of this thesis for a complete list). Group or classroom instruction was completely out of the question; lesson outlines for one-on-one instruction were tolerated, but not in any quantity.

There is nothing inherently wrong with self-instructional training. Forman (1982) recommends its use in large corporations and justifies it both economically (cuts down travel expenses, overhead for classrooms, etc.) and educationally (systematic design and evaluation principles can be embedded in materials; all learners receive the same training, etc.). However, as the media were more or less predetermined, the whole subject of selection was not given due consideration.

The final outcome of the media selection was: four audiovisual modules (filmstrip/audiocassette/workbook), six audiotutorial modules (audiocassette/workbook/panel), one job aid, and three lesson outlines.

Conclusion

In summary, the design stage of the demurrage project went one and a half days over schedule (the work plan had allowed from day 22 to day 44), and cannot be viewed as successful as the analysis stage.

First, in selecting tasks for training, the expansion of the original goal was the first major step in putting the project behind schedule, and the heavy-handedness of management in communicating a decision to the team caused a minor motivational problem.

Second, the development of criterion test-items proved to be a problem. Only the written simulation items on the processing of the JF Assessment Report, designed by the Instructional Development Specialist, were ultimately useful, and an insufficient number of these existed. More questions of this type had to be created during the development, and formative evaluation and revision stages; most of the other test-items also had to be redone during these stages.

Third, the instructional media selection was not given proper consideration. The type of media selected also added to the time required to complete the project, not to mention the cost.

In spite of these problems, the behavioural objectives and most of the learning hierarchies were functional and of a sufficient quality to permit progress to the next stage in the project: development.

6. Development

Development is the stage in ISD where drafts, on paper, are made of the components of the individual training modules. For example, storyboards are created for audiovisual modules, scripts for audiotutorial modules, and workbooks, panels, and

instructor's guides are assembled for all modules.

The development stage in the TST model has two steps: determine development strategy, and develop instructional and support materials.

As with the previous stages, the SMEs studied a series of self-instructional training units to prepare them to participate in the course:

1. a reading exercise on the fundamentals of programmed instruction, actually, excerpts from Bell and Abedor's *Developing Audio-Visual Instructional Modules for Vocational and Technical Training* (1977).

The following training units, which deal with production in different media, were to be taken only as needed by the SMEs.

2. an audiovisual unit on the development of audiovisual training modules;
3. two audiotutorial units on the development of audiotutorial training modules;
4. a programmed text on the development of programmed text;
5. an audiotutorial unit on the development of lesson outlines;
6. an audiotutorial unit on the procedures and requirements for submitting a storyboard for production.

The seven development stage training units were estimated to take a total of approximately 13 hours study time, although it was not expected for the SMEs to take more than six hours of training each, depending on the media required for the modules assigned to them.

The work plan anticipated that each SME would work on two modules, and outlined the following schedule:

Day	*Assignment*
45	Review development stage training.
46-48	Determine development strategy.
49-53	Begin draft of first assigned module.

54-57 Home.

58-63 Complete draft of first module.

64-67 Begin draft of second assigned module.

68-71 Home.

72 Revise draft of first module as a result of technical review.

73-81 Complete draft of second module.

82-85 Home.

86-90 Cleanup.

Literature Review

> In a well-designed instructional module, the module itself must contain many of the strategies or procedures that a teacher might normally use with a group of students. Therefore, it is necessary to develop an instructional strategy that employs, to the degree possible, that knowledge which we have about facilitating the learning process. (Dick & Carey, 1978, p. 105)

In her book *Good Frames and Bad* (1969), Susan Meyer Markle claims that in order to produce successful training a developer must follow the three Skinnerian principles of (a) active responding, (b) minimal errors (i.e. the trainee should not be lead to respond in a way that the developer does not want), and (c) trainee knowledge of results. Even though Markle is discussing the writing of programmed instruction text, a rare item in the late 1980s, these basic principles are as valid for the development of any type of instruction today as they were when first formulated by Skinner in the 1950s.

Kemp (1977) also quotes the above-mentioned Skinnerian principles, and adds a few more learning principles that require equal consideration when developing training modules: (a) ensure prelearning preparation (i.e. that trainees possess all prerequisites before beginning training), (b) motivate trainees to participate in the learning process, (c) consider individual differences (e.g. rates of learning), (d) arrange instructional conditions to enhance learning, and (e) provide opportunities to practice new skills (pp.

58-60).

Gagné and Briggs (1979) propose a systematic and comprehensive approach to module development by providing a model for the organization of instructional events that takes into account these learning principles:

1. gain attention,
2. inform the trainee of the objective,
3. stimulate recall of prerequisite learning,
4. present the stimulus material,
5. provide "learning guidance",
6. elicit the performance,
7. provide feedback,
8. assess the performance,
9. enhance retention and transfer (p. 157).

Hamilton (1983) brings up several points that all other sources tend to overlook. He states that every training module should contain:

1. a cover page,
2. an introduction,
3. directions,
4. learning activities, and,
5. a performance assessment.

He goes on to say that, depending on the needs, there may also be items such as preassessments, prerequisites, equipment and materials lists, safety precautions, and optional activities (p. 11). Although making mention of such mundane items as cover pages and directions in the same sentence as "learning activities" may seem perverse, it does draw attention to the type of detailed considerations that are required during the development stage of a training project. The finished product, after all, does have to be

functional in the hands of the target population.

Cover pages and other commonplace mechanical components are, however, swept aside by Davies (1981) when he grandiloquently states:

> Instructional developers don't *make* products, they *create* experiences likely to lead to worthy performance. (p. 6)

Although, as Hamilton has pointed out, Davies may not be absolutely correct, he is fundamentally correct: A well-written training module can transcend a poorly designed cover page; a poorly written training module is not saved by being beautifully packaged and presented. Beginning the writing of training modules confronts a developer with a blank page, and module creation requires the same basic skills used by journalists, novelists, and screenwriters, with the added demand that the finished product fulfill a training need.

Application of the TST Model

The first step in the development stage of the TST model is to determine a development strategy.

Using the objectives, the learning hierarchy, and following the Kemp (1968) model, a treatment was written for each module to be developed. A treatment is a detailed prose statement of approximately one page in length explaining the overall strategy that the module will take, including the content, setting, characters (if any), story line, and tone; in other words, the angle or approach the developer will take on the topic (Association for Educational Communications and Technology, 1977, p. 228). A treatment facilitates the transition from design to development by presenting a synopsis of the module to be developed and, therefore, functions as an outline or guide for the developer to follow when writing.

Development strategies for all of the modules took two days to complete.

No apparent problems were encountered during this step. However, it later became clear that the treatments were not done to sufficient detail, or that a more detailed approach was necessary; the treatments produced did not ultimately aid the SMEs in the writing.

The major step in the development phase is the writing of the instructional and support materials. This is where all of the team's previous work, from the task analysis to the development strategy, comes together on paper in the creation of the training modules.

By using the treatment from the development strategy and following the Traffic Systems Training universal training unit model (Figure 4), the individual SMEs drafted the scripts or storyboards for their assigned modules. The universal training unit model calls for the instruction to be broken into learning blocks: Each learning block consists of the presentation of a limited number of teaching points, followed by a brief review to reinforce the teaching points, followed by an exercise to provide practice on what has just been learned, and concludes with feedback to confirm that learning has occurred or to counsel for more review before continuing. The learning blocks in an individual module are preceded by an overview, which provides an orientation for the trainee to the module and presents the module's objectives and the reason for their importance. The module ends with an overall review, which summarizes the objectives, perhaps gives references for future study, and provides motivation for continuing study.

The drafts of the scripts and storyboards were submitted to the Instructional Development Specialist for review, and then returned to the SMEs for revision. Most modules went through at least five or six drafts in this manner.

The drafts of all the modules were completed by the team in 28 1/2 days. That is to say, a final draft from the SMEs on each module was presented to the Instructional Development Specialist within the 90-day time limit specified in the work plan.

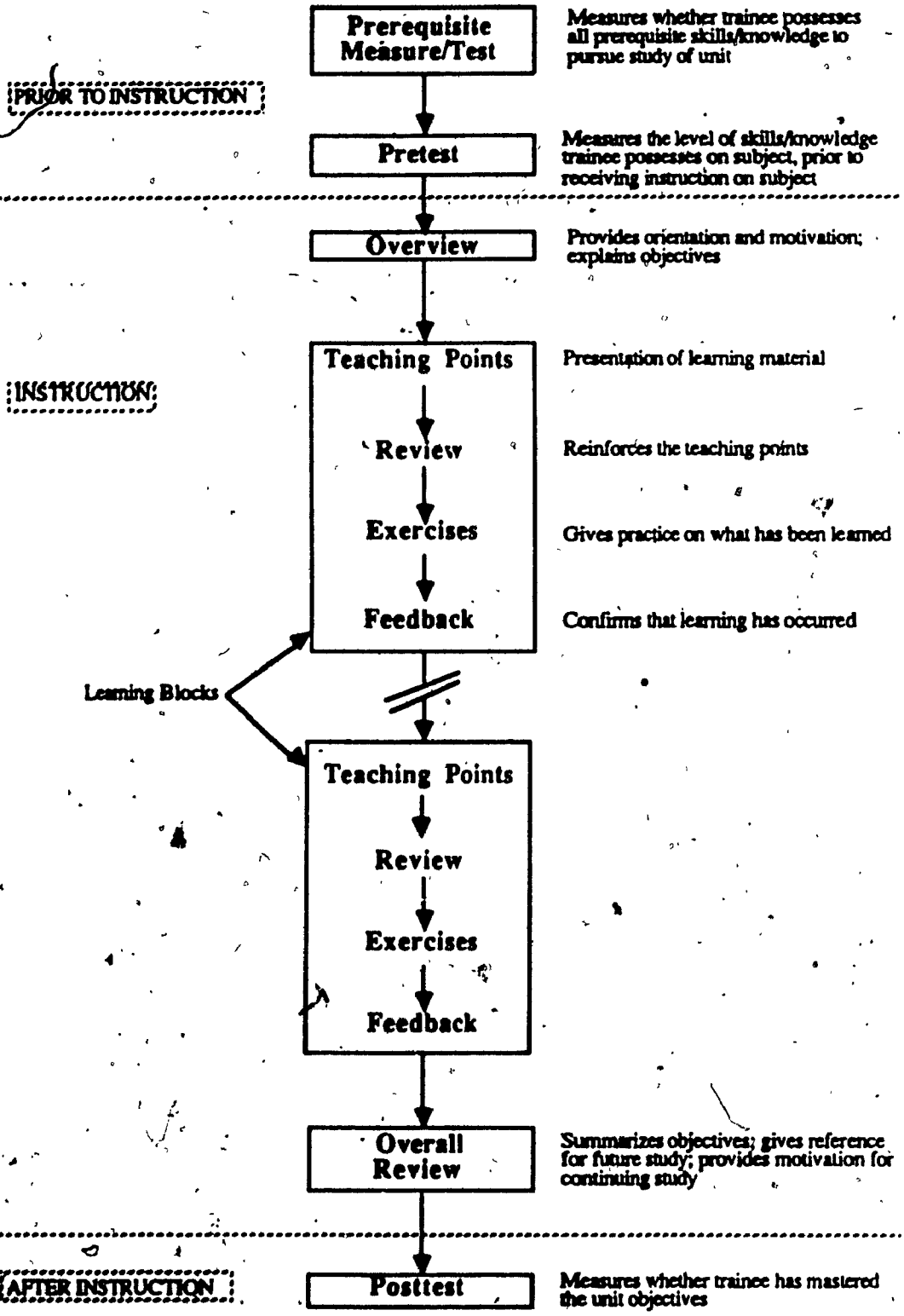

Figure 4. Traffic Systems Training, universal training unit model.

It was at this stage, however, that the SME approach to instructional development finally broke down. Try as they might, the SMEs simply lacked the ability to create logical, cohesive, and grammatically correct training modules, and this in spite of having just gone through a lengthy and intensive analysis and design.

The major problems encountered were:

1. The SMEs lacked writing skills. This problem was incipient from the beginning of the project but, due to the nature of the tasks in the earlier stages and in the approach taken, it was contained by the Instructional Development Specialist. At this stage, which centres on the skill of creative writing, it could be contained no more. Perhaps this lack of writing ability should not have been surprising. The three SMEs' ages ranged from the mid-30s to early-40s, and none had progressed beyond the high school level in formal education (although one had completed a quite rigourous correspondence course on transportation from the Canadian Institute of Traffic and Transportation). Furthermore, their jobs did not require them to write more than the occasional terse memorandum. Their lack of writing skill manifested itself not only in an inability to write grammatically correct text, which could have been corrected relatively easily, but also in an inability to create a logical flow of sentences, or to group these sentences into paragraphs. As Aristotle said so eloquently over 2,300 years ago, a plot must have a beginning, a middle, and an end (p. 634); the SMEs' scripts and storyboards had, in most cases, an endless flow of unstructured text.

2. Part of the reason for the lack of structure was that, at the previous step in the model, the treatments were not sufficiently detailed. As Kemp says: "Writing the treatment . . . causes you to think through your presentation, putting it in a sequential, organized form that you . . . can follow easily" (1968, p. 40). In most cases there was not enough to follow. However, as the definition of a treatment restricts it to approximately one page in length, perhaps the added step of a more detailed lesson

outline should have followed the writing of the treatments.

3. When the SMEs did create something, they had great difficulty in expressing their teaching points so that they could be understood from the perspective of an inexperienced trainee. In spite of the learning hierarchies, the SMEs wrote their modules as if they were intended for themselves: There was insufficient explanation of quite complex procedures, and reading them required too great an understanding of the subject.

4. The SMEs had to be pressured into handing over their scripts and storyboards for review. For the most part, they recognized their limitations in writing, but were still trying to revise them by themselves in order to turn out a viable product.

The three SMEs returned to their home terminals in late December, 1980. In spite of the difficulties they had encountered, all three expressed satisfaction with their participation in the project. They stated that they had learned more about their own jobs than they had imagined possible, and this in spite of being the best available subject matter experts in the country. They had also gained a System perspective on the railroad.

One of the SMEs was recalled to Montréal for a second 90-day period, starting in January, 1981, to aid the Instructional Development Specialist in rewriting the scripts and storyboards. As each module was completed, it would be given to a technical expert in Traffic Systems Operations for technical review.

Conclusion

In summary, the development stage of the demurrage project was a qualified disaster. The Instructional Development Specialist, with the assistance of one SME to validate the content, had to rewrite most of the modules. This caused its own problems because, even though the Instructional Development Specialist had by this time fully

grasped the procedures of the demurrage activity, even the intricacies of it, he had never actually experienced working at the job, and so lacked an internal perspective of it. This ultimately displayed itself in the final product, which would have been greatly improved had he shared this perspective.

The schedule was, from this point on, completely disrupted. Development continued through April and May when, according to the draft general work plan, the completed modules should have been released to the field.

What in the earlier stages of the project had only been sensed, and perhaps puposely overlooked, was now all too clear: Too much had been expected of the SMEs; they were not capable of functioning at the level that had been expected of them. In hindsight, again, this is not surprising: It takes a minimum of two years of graduate study to provide a student instructional technologist with a basic understanding of the theoretical underpinnings of the profession. Even then, there is no guarantee that the graduate will be capable of practical application of the technology, and certainly not without a long and properly supervised internship. To take unsuspecting industrial employees and try to turn them into course developers in less than three months is ludicrous, even under the tutelage of an instructional technologist. Storyboard development by itself is an art that can take years to master, requiring an acute visual sensibility to form, colour, layout, and movement, in addition to the writing and organizing skills mentioned above. This is not to say that SMEs could never do any instructional development in an ISD project. They can, but the appropriate tools, training, and coaching are required. These were missing in the demurrage project.

7. Production

While development was still underway, production began on the prototype

modules.

Note that no literature review is included for this stage of the TST model, given that practically all of the production work is transferred to specialists. Guidelines (for appropriate media formats, etc.) may be obtained from Heinich, Molenda, and Russell (1982), and Kemp (1968).

Application of the TST Model

This stage of the TST model entailed the Instructional Development Specialist meeting with production personnel in CN and in outside production houses to present the scripts and storyboards, and to ensure that the modules being produced by them met Traffic Systems Training standards.

The procedure for slide production is as follows:

1. A storyboard is delivered to the audiovisual shop for preview by the audiovisual staff.

2. A preliminary production meeting is held between the developer, producer, and illustrator to communicate the goal of the module and to clarify any special requests from the developer. Negotiations for changes begin (i.e. the audiovisual staff, based on their experience, may foresee problems, or determine a different way of doing something, and suggest that the developer make changes before production begins). The developer must decide whether the suggested changes fit within the overall instructional design.

3. A follow-up meeting is held where the illustrator presents his or her detailed storyboard. Negotiations for changes continue.

4. The completed slides are presented to the developer who checks them against the storyboard and, where necessary, returns them to the producer for revisions.

While the slides are being produced, the scripts are typed, and the workbooks, panels, and instructor's guides are typed and layed out.

When the slides are ready, the Instructional Development Specialist records the script and pulses the tape.

During this stage, contact is made by the Instructional Development Specialist with producers, photographers, copy stand technicians, illustrators, sound technicians, typesetters, and typists.

The production stage for the demurrage project was completed in early September, 1981, practically six months after it began; the draft work plan had anticipated ten weeks for completion of this stage.

The training course produced, titled *The Demurrage Function*, consisted of:

1. a course outline (i.e. a trainee guide for the course),
2. a two-part prerequisite test,
3. eleven self-instructional training modules (each with pre, post, and embedded tests),
4. two lesson outlines,
5. one job aid,
6. a course test, and,
7. detailed advisor's notes and marking guides for all material.

The major problems encountered were:

1. There is considerable difference in look and effect between a storyboard sheet and a slide. It takes experience to see through the storyboard sheet into the potential slide, experience that the Instructional Development Specialist did not have. The Instructional Development Specialist was disappointed in the outcome of some of the slides and, therefore, requested several changes and improvements after viewing them. Making these changes caused delays. Except for the correcting of obvious errors, it would have been preferable to merely make note of any potential changes and save them for the formative evaluation stage.

2. As the CN audiovisual shop was fully occupied with the production of the waybill course, the artwork and slides for the demurrage course had to be contracted out to a private company. This caused several problems: First, the contracted audiovisual shop was in a suburb, and the Instructional Development Specialist had to waste time in travelling to production meetings. Second, the shop had not previously done work for the railway and, therefore, their illustrators made many small but important contextual errors that required close inspection of and revisions to the slides. Third, this last problem caused many long and sometimes heated meetings over whether a change was caused by a CN request and, therefore, chargeable, or whether it was caused by the illustrator or copy stand technician not following the storyboard and, therefore, not chargeable unless the producer could find a loophole in the contract to make it so.

Conclusion

Although the product was of a high quality, the time taken to bring it to this stage (approximately six months) and the production costs involved must be considered as serious problems.

8. Formative Evaluation and Revision

Formative evaluation is the tryout of prototype training modules on a sample group from the target population before the modules are released to the field. The main purpose of this is to obtain feedback on the modules' effectiveness, but it also serves to catch any procedural or administrative problems, typographical errors, and so forth. The SMEs were recalled for 35 days to aid in this stage of the project.

The formative evaluation and revision for the demurrage project consisted of three steps: technical validation by the SMEs, tryout on a sample group from the target

population, and final revision.

The SME training for this stage consisted of the following self-instructional units:

1. an audiovisual unit with supplementary reading exercise providing an introduction to and a general overview of the evaluation process;

2. an audiotutorial unit detailing the specific steps to be followed during formative evaluation.

The two units were estimated to take up to two and a half hours study time, and were taken by the SMEs at their home terminals, prior to their return to Montréal on September 21, 1981.

The work plan outlined the following schedule:

Day	*Assignment*
1 - 5	Technical validation of course material by team.
6 - 7	Review formative evaluation stage training. Ship equipment and materials to first site (Moncton, New Brunswick).
8	Travel to Moncton. Set-up.
9 - 11	Formative evaluation on first group of three candidates.
12 - 14	Formative evaluation on second group of three candidates.
15	Clean up. Ship equipment and materials to second site (Toronto, Ontario). Travel home.
16 - 21	Home.
22	Travel to Toronto. Set up.
23 - 25	Formative evaluation on third group of three candidates.
26 - 28	Formative evaluation on fourth group of three candidates.
29	Clean up. Ship equipment to Montréal. Travel to Montréal.
30 - 31	Analyze results. Make recommendations for revision.
32 - 35	Home.

Literature Review

> How much time and money are people prepared to spend collecting information that may demand they spend yet more on major overhauls of the learning system? (Rowntree, 1974, p. 136)

This is the dilemma of the formative evaluation and revision stage of an ISD project. Formative evaluation, also referred to as: learning validation, and developmental testing, is the systematic collection and analysis of data on prototype training materials to obtain information on their effectiveness. This information is then used to revise the training materials until they meet their objectives. When they meet their objectives, the materials can be released to the field (Bell & Abedor, 1977; Butler, 1972; Dick, 1977; Dick & Carey, 1978; Gagné & Briggs, 1979; Kemp, 1977).

Whether the objectives are met is not the only aspect of the training being verified during formative evaluation: learning methods, materials, roles of personnel, use of facilities and equipment, schedules, and all other factors that may affect the achievement of the objectives are examined and, if necessary, revised (Kemp, p. 98).

Rowntree justifies the iterative test-revise-retest cycle of formative evaluation by stating that learning is not a science and, therefore, in spite of having gone through a costly and time-consuming analysis, design, and development, there is still no guarantee to the developer that by following the instructional technology methods prescribed in these stages that the training will actually work. Dick agrees with Rowntree's reasoning, but holds out hope that the future may be different: that we may one day design perfect objectives and tests, and use perfect instructional strategies to develop perfect instruction. When, if ever, that day arrives, he goes on to say, "there will be no need for formative evaluation" (p. 313).

Dick, and Dick and Carey, propose a three-step approach to formative evaluation: one-to-one evaluation, small-group evaluation, and field evaluation. One-to-one evaluation entails trying out a rough form of the training materials with one member of

the target population at a time. Basically: (a) the developer sits down with a trainee and observes the trainee work through a module, (b) the developer and trainee discuss any problems, and (c) revisions are then made to obvious problems before administering the module to the next trainee. Dick suggests that one to three trainees be used for one-to-one evaluation, Dick and Carey suggest a minimum of two trainees be used. Both suggest that one-to-one evaluation should also be carried out with SMEs, to aid in technical validation of the product. Next, small-group evaluation entails trying out the module, since revised and improved after the one-to-one evaluations, under conditions similar to that in which the training will be administered in the field. During this step, the developer does not generally intervene if a trainee is observed having difficulty, but leaves the trainee to work out the problem, if any, by him or herself. Analysis of the pre and posttest scores, completed attitude questionnaires, and debriefing sessions with the trainees help the developer pinpoint any problem areas in the instruction. Dick recommends using eight to two dozen trainees representative of the target population for small-group evaluation, Dick and Carey ten to twenty. Finally, after revision of the training based on data from the small-group evaluation, field evaluation entails, if possible, a tryout of the materials in the actual implementation setting or, if not possible, in an environment that closely resembles it. Approximately thirty trainees are recommended for this step.

Branson et al., whose formative evaluation approach is similar to that of Dick, and Dick and Carey, seem to have unlimited resources:

> You may conduct several small group trials or none. Several small groups may be a substitute for a large group and you may do one or several large group trials. (Branson et al. *3*, p. 312)

However, Bastian, Edward, Medsker, and Schimmel (1983) raise the issue of the economic feasibility of performing formative evaluation and point out the occasional necessity, in industrial settings, of making compromises. Lowe, Thurston, and Brown

(1983) provide an example in the development of a vocational training programme where they used only the one-to-one evaluation, and conclude: "After the second verification, few if any changes were found to be necessary in the training sequence. At this point, further evaluation was not deemed to be cost- or time-effective." (p. 9). Wager (1983) supports their slimmed-down approach with research evidence that training material revised after one-to-one evaluation is as effective as training material revised after one-to-one and small-group evaluation, as long as the trainees used in the one-to-one evaluations are of mixed aptitude (i.e. at least one trainee of high aptitude and one of low aptitude).

One item that all agree must be made clear to the trainees during formative evaluation is that it is the training material being tested, not the trainees. This principle, however, is not always easy to communicate to trainees, given that the key focus while evaluating is on the criterion test, and that the trainees are closely observed taking the training. But the effort is worth it, for, as Butler (1972) states: "The concept of using a criterion test to measure the effectiveness of the instruction rather than to measure student proficiency is truly a breakthrough in education and training methodology." (p. 97).

Application of the TST Model

The first step in the formative evaluation and revision stage of the TST model is a technical validation of the material by the SMEs.

All four original SMEs were recalled to participate in this step. They began by writing the pretest of the first module, then, as the Instructional Development Specialist corrected their pretests, individually worked through the module. The team would then meet and collectively go through the module, discussing problems and making recommendations for changes and adjustments. This process was used to technically validate the entire course.

This step was completed on schedule, and uncovered some minor technical problems. One SME returned to his home terminal, as arranged, after this step was completed. No major problems occurred, and the SMEs were pleased with the outcome of their earlier labours. No mention was made by anyone that the prototype modules tended not to resemble the draft storyboards created by the SMEs.

The only minor problem encountered was that insufficient time was allowed to make the revisions and, therefore, the workbooks used in the formative evaluation were not in pristine condition, but had words written in or crossed out, or large corrections pasted in.

Before travelling to Moncton, the first evaluation site, the three remaining SMEs reviewed the formative evaluation and revision stage training: Under the guidance of the Instructional Development Specialist, each took turns being validator and trainee, the former to practise the skills they would need, the latter to develop empathy with the trainees who would soon be under their close observation.

All the administrative arrangements had been made with the regional representatives prior to the beginning of the formative evaluation and revision stage, and twelve trainees in total, volunteers from the target population, were to be ready in Moncton and Toronto on the established dates.

Traffic Systems Training's formative evaluation procedures are as follows:

1. The trainees, referred to as validation candidates, are briefed by the Instructional Development Specialist. The purpose of the briefing is to put the candidates at ease and to make them feel part of the development team. Topics covered in the group discussion include a short history of the training project, why training materials are evaluated, our benefits from their *mistakes*, the confidentiality of any scores, and the actual details of the formative evaluation process (e.g. that the SMEs would be observing each candidate work through the material, but not intervene or answer questions, etc.). The main theme

of the briefing is that it is the materials being tested, not the candidates.

2. Each candidate is then assigned an SME, and the two retire to a semiprivate location. The candidate completes a background information form indicating name, age, service date, position, mother tongue, education, training, and employment history. At this point, the candidate is issued a number, and it is this number only that is used as an identifier on the materials.

3. The candidate then works through the course, following the course outline.

4. The candidate begins by writing the pretest of a module. The completed pretest is given to the Instructional Development Specialist for correction. Without knowing his or her pretest score, the candidate works through the module. Each candidate is given a blue and a green pen, the blue to complete exercises, make notes, and so forth, the green to make corrections, when and if required, to the embedded tests; this to facilitate later analysis. The SME closely observes the candidate work through the module, following along on his or her own copy of the material. The SME is told to record anything of interest or out of the ordinary that occurs (e.g. miscues, hesitations, etc.), but not to intervene unless the candidate is totally incapable of continuing, and only then as a last resort.

5. On completion of the module, the candidate writes the posttest and completes an attitude questionnaire. The candidate then takes a five to ten minute break while the Instructional Development Specialist and SME correct the posttest, review the candidate's workbook, and discuss any problems that were encountered.

6. A short debriefing interview takes place between the Instructional Development Specialist, SME, and candidate. In the initial interviews, great pains are taken to emphasize that any errors made by the candidate are actually of more use than the correct answers, and to re-emphasize that it is the material being tested, not the candidate.

7. The SME and candidate take a short break before moving on to the next module,

where the pattern repeats itself. The Instructional Development Specialist tabulates the results, further analyzes the data, and makes plans for revisions.

8. In the evening, after the candidates are gone, the team meets to discuss the day's events, to analyze the results, and to make any changes to the modules in preparation for their next administration.

This process was used to evaluate the entire course with twelve candidates: six in Moncton and six in Toronto. The tabulated results are recorded in the following chapter.

The team returned briefly to Montréal to analyze the results and make final recommendations for changes. After the SMEs returned to their home terminals, the Instructional Development Specialist made the final revisions to the course materials, and processed these through production.

The final course (*TC-B40, The Demurrage Function*) consisted of the following self-instructional modules, lesson outlines, and tests:

1. *TC-B40P-(1&2) The Demurrage Function - Prerequisite Test (Parts 1 & 2).* This is a two-part prerequisite test to determine whether a trainee has sufficient background knowledge and skills to begin study of the course. Blocks of questions in the tests are linked to specific subject areas, and the advisor's notes provide a suggested passing score for each block and, if necessary, a list of modules for remedial study.

2. *AV-T-B40A01 Introduction to the Demurrage Function.* This is an audiovisual module that provides an overview of the demurrage function (e.g. the responsibilities, the computer reports used, etc.). It ends with a typical day-in-the-life of someone working at the function.

3. *AV-TC-B40C02-(1&2) Introduction to the JF Assessment Report (Parts 1 & 2).* Two audiovisual modules that analyze the form, content, and function of the key report in the demurrage function: the JF Assessment Report. A job aid, *JA-TC-B40C03-6, Job Aid for Processing the JF Assessment Report*, is also

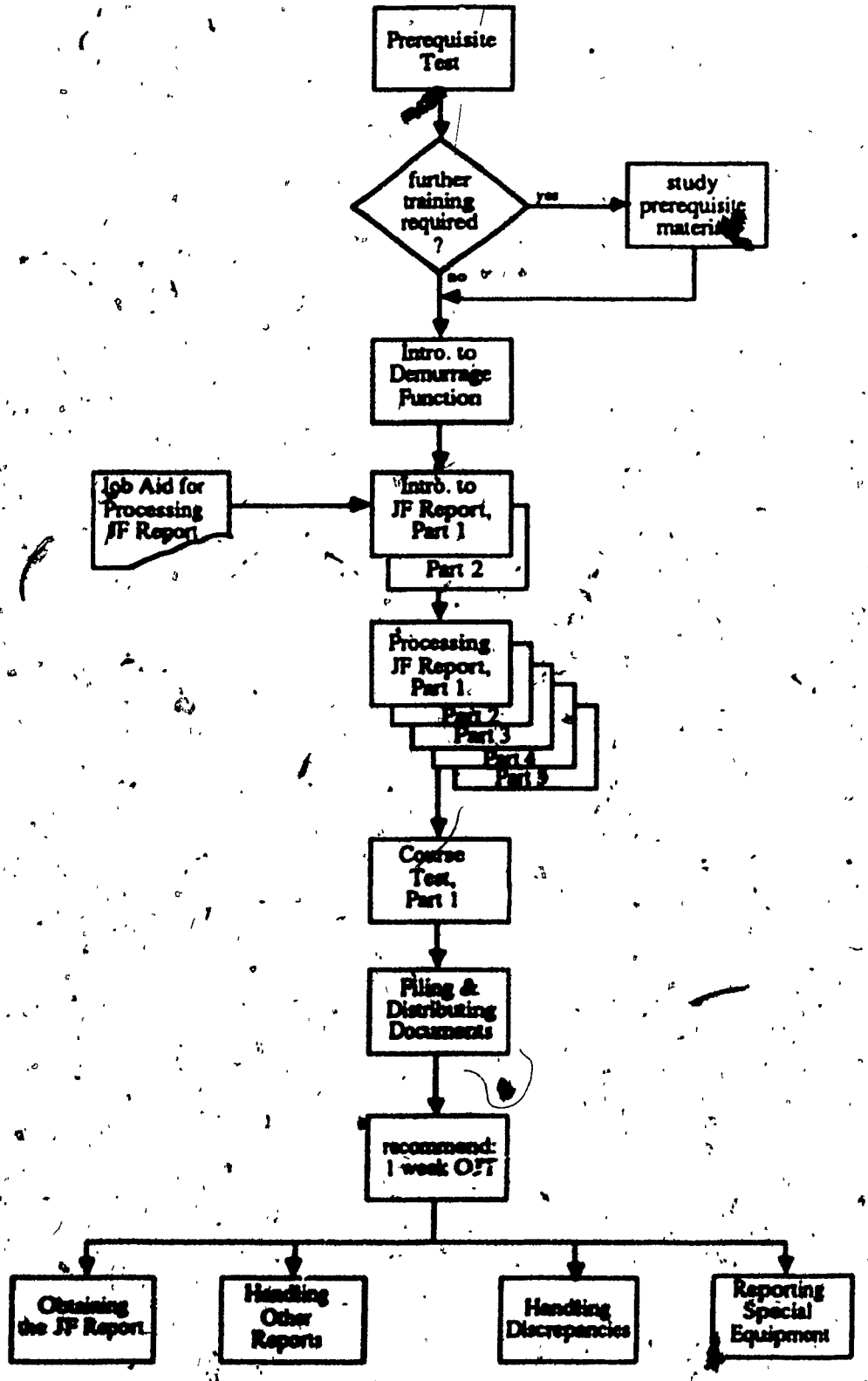

Figure 5. Course TC-B40, *The Demurrage Function*.

introduced.

4. *AT-TC-B40C03-(1-5) Processing the JF Assessment Report (Parts 1 - 5).* These are five audiotutorial modules that lead the trainee through the steps involved in processing the JF Assessment Report.

5. *TC-B40-T1 The Demurrage Function, Part 1 Course Test.* This is a test consisting of an unchecked JF Assessment Report that the trainee must check and verify, update, and then use to assess charges. In other words, this is a test on everything that has been covered in the course up to this point.

6. *LD-TC-B40C03-7 Filing and Distributing Documents.* This is a lesson outline to aid the advisor in preparing training on local filing and document distribution procedures.

At this point, to promote transfer of learning, the course outline recommends that the trainee work for approximately one week on the job to gain experience in the major activity in the demurrage function: the assessing of demurrage, detention, and switching charges from the JF Assessment Report.

For the remaining modules in the course, there is no set administration order, and the trainees are invited to study them based on local needs or personal preference:

7. *LD-TC-B40C01 Obtaining the JF Assessment Report.* As the JF Assessment Report is quite long, it is usually run by employees on the night shift at the carload centres. If they forget to do this, or if the computers were down, the demurrage clerk must obtain a copy by him or herself. This lesson outline aids the advisor in preparing instruction on how to request a transmission or a retransmission of this report.

8. *AV-TC-B40D-1 Handling Demurrage-Related Activities - Reports.* This audiovisual module covers the handling of two other important computer reports used by the demurrage clerk: The Report for Notification of Cars Pending/On Demurrage, and the 15 Days No Activity Report.

9. *AT-TC-B40D-2 Handling Demurrage-Related Activities - Discrepancies.* This audiotutorial module leads the trainee through the steps required to investigate and deal with the most common discrepancies and customer claims arising from the processing of the JF Assessment Report.

10. *LD-TC-B40D-3 Handling Demurrage-Related Activities - Reporting Special Equipment.* This lesson outline aids the advisor in preparing instruction on how to handle the local procedures for the reporting of special equipment, such as mechanical refrigerator or depressed-flat cars.

See Figure 5 for a graphical outline of the course.

Various problems were encountered, both with the prototype training materials and with the Traffic Systems Training approach to formative evaluation and revision. The problems with the prototype of *The Demurrage Function* will be discussed in the next chapter, the problems with the application of the TST model were as follows:

1. Insufficient time had been scheduled for the evaluation: In order to maintain the work plan schedule, the validation candidates were crammed through the course in three days. The candidates were fatigued by this pace and, undoubtedly, suffered from information overload. The development team was even more fatigued: for the first nine administrations of the course the workdays averaged between 12 - 16 hours. At least twice the allotted time would have been preferable to carry out this step.

2. There had been a communication breakdown between System and the two regions where the evaluation was held. In spite of the Instructional Development Specialist visiting the two regional centres in August, meeting personally with the two regional training supervisors to explain the process and make the arrangements, and following-up the meetings with memoranda, the validation candidates at both locations were unprepared. All candidates were under the impression that they were there to be

trained as Demurrage Clerks, not that they were to participate in a formative evaluation process on a course on demurrage. Furthermore, volunteers had been requested; all of the candidates had been ordered by their supervisors to appear at the training room at the given times. Finally, it had been requested that all candidates possess the required prerequisites, a list of these had been provided, and Traffic Systems Training had even offered to absorb any required training costs; no attempt had been made to even determine the candidates' prerequisite knowledge, and some had to be given crash courses by the SMEs during the formative evaluation when it was determined that they were deficient in certain areas.

3. A third major problem, somewhat related to the previous problem, was that some candidates were totally unfamiliar with the conventions of the self-instructional training produced by Traffic Systems Training. Before participating in the evaluation, these particular individuals had never in their careers taken a Traffic Systems' self-instructional module. This caused delays as the process was explained to them and, even after taking two or three modules, some were still unclear on some details, such as the difference between a *workbook* (containing instructions, exercises, and tests) and a *panel* (containing reference materials), even after the words "Workbook" and "Panel" had been pointed out several times as being clearly printed on these documents.

Conclusion

Apart from the time constraints (35 days), and the problems caused by a lack of communication with the regions involved, the formative evaluation and revision stage of the demurrage project went very well. The SMEs were, for once, well prepared for the work, and were highly motivated to the task (how else can you get someone to work 16 hours a day?). Unlike the creation of new materials, which was beyond their capabilities, the review and revision of the prototype materials was well within their

skills.

9. Duplication and Distribution

As soon as final revisions are completed on a module, the module is prepared for duplication. When the entire course has been duplicated, it is distributed to the field.

Note that no literature review is included for this stage of the TST model, given that practically all of the duplication and distribution work is transferred to specialists.

Application of the TST Model

The following procedures are carried out:

1. Workbooks and panels are submitted for typesetting.
2. Slides are submitted for filmstripping.
3. Scripts are submitted for professional voicing and the creation of master tapes. The master tapes are then submitted for pulsing.
4. Advisor's notes and marking guides are submitted for retyping.

The paper copy and the tapes are duplicated by CN corporate departments, the filmstrips by an outside company.

This work is coordinated by the administrative section of Traffic System Training. The Instructional Development Specialist's role is to supervise the voicing of the scripts, and to proofread and approve all final versions of the product.

One final task is to establish a computer file for each module, and for the course as a whole, to permit computer reporting and analysis. This demands the creation of a *Valid Response Masterfile* (VRM), a file that identifies the module, provides the correct and alternative responses for each test-item, and so forth.

No major problems were encountered at this stage, although several delays due to

workload at various shops pushed back the release date.

The final version of the course was distributed to the field in March, 1982, practically 19 months after beginning analysis.

10. Monitoring and Revision

Use of the course in the field is monitored, and revisions are carried out as necessary.

Literature Review

> *A training system is never a finished product; rather it is a continuing process for meeting the differing and changing needs of the individual student.* Butler, 1972, p. 162.

This stage in an ISD project is referred to as summative evaluation (Dick, 1977b; Dick & Carey, 1978; Gagné & Briggs, 1979; Kemp, 1977), macro-evaluation (Rowntree, 1974), internal evaluation and external evaluation (Branson et al., 1975), and field testing (Butler, 1972). Briefly stated, it is the analysis of the test results and other outcomes of a course after the course has been implemented. These data are collected, primarily, to compare the effectiveness of the course with another course or another strategy.

The monitoring of course results can also be used to determine whether the course needs revision or improvement; in this way, the purpose of field testing is very similar to that of formative evaluation, and is pursued for the same reasons: As Butler says, no one should expect to implement a new instructional system without encountering problems that will call for revisions of the system; local conditions, he goes on to say, always affect the training implementation to some extent.

Towards these ends (obtaining data for comparison and obtaining feedback for

revision), Dick and Carey demand that a summative evaluation study must answer the following questions:

1. What are the comparitive costs of the two sets of materials?
2. How much time do students spend studying the materials?
3. Is any special teacher training required for either set of materials?
4. What are the side effects of using any of the materials (e.g., development of new student interests, increased reading scores)?
5. What are the long term effects of using the materials?
6. Will the materials be quickly out-of-date or has a system been established for updating them? (p. 203)

Branson et al. and Rowntree very judiciously question the perspective of an instructional developer working on the evaluation of a personal project:

> To compensate for our human tendency to see what we expect to see and ignore the unexpected, it may be wise when evaluating outcomes also to enlist the participation of an "uninvolved" evaluator who can afford to be more sceptical than those who have invested a great deal of emotional capital in the venture. (Rowntree, p. 143)

The underlying message here is that the more independent the evaluator, the more likely the data will be accurate.

Kemp suggests that reviewing posttest scores is not the only method of summative evaluation, but that following-up on trainees to see how they are actually applying the knowledge and skills may be required. Rowntree takes this concept one step further in what he refers to as *supra-evaluation*, that is, questioning not the efficiency of the course but the aim of the course, and determining if it was actually worth doing at all. Branson (1980) echoes this sentiment by noting that ISD is a neutral method, and can be used to teach appropriate and inappropriate content, right methods and wrong methods, sense and nonsense, all equally well. He states: "In my view, the major problem facing instructional developers today is the failure to stress *content validity* to the same extent they stress *instructional processes*." (p. 38). Spitzer (1982) takes it even one step further:

> Instructional development in industry and government is far more than simply developing materials. It involves the development of *coordinated systems* that

> fit well into the work environment and the employees' performance systems. (p. 38)

This brings us back, or rather sends us back, to step one in the ISD model, the needs assessment. A well-done needs assessment may save a lot of time, effort, and money.

Application of the TST Model

Monitoring the effectiveness of training produced by Traffic Systems Training is the responsibility of the Instructional Development Analyst. This individual uses the computer reports, described in the first chapter of the thesis, to aid in the analysis of the test scores of the modules and courses. These computer reports are, again, a monthly statistical summary of all the module administrations to date, called the *Basic Course Analysis* (BCA), and an in-depth statistical analysis of each module, generated after 30, 100, and 400 administrations, or by inquiry.

The BCA lists: (a) the number of trainees who have taken the module, (b) the maximum score, (c) the average raw score, (d) the average percentage score, (e) the standard deviation, (f) the standard error, (g) the average gain, (h) the average percentage gain, (i) the average modified gain, (j) the number of trainees who took the pretest only, and (k) the number of instances of negative gain. All statistical analyses on the BCA are classified by trainee category (e.g. carload centre unionized employee, Traffic Systems management employee, etc.). An example of a BCA output is presented in the next chapter (Table 13).

The in-depth statistical analysis lists: (a) a raw score analysis (i.e. the number of trainees, number of questions, maximum score, average score obtained, pass score, median, mode, minimum raw score in sample, maximum raw score in sample, standard deviation, skewness, kurtosis, and raw score distribution); (b) a question analysis (i.e. a graphical display of the trainees, identified by their employee identification number, and

the questions, with an indication of the questions missed by each trainee); (c) an item analysis (i.e. a breakdown of each test-item indicating the proportion of trainees scoring correctly, incorrectly, or leaving the item blank, and the test scores of those trainees); and (d) an item analysis summary (i.e. the difficulty index, discrimination index, confidence in discrimination index, and standard deviation for each question, and, the Kuder Richardson 8).

The Instructional Development Analyst also compiles any data from returned *trainee's comments* forms, which are survey forms attached to each module to permit confidential feedback from each trainee on the training they have taken.

When the Instructional Development Analyst perceives any problems with a module, a report is presented to the Instructional Development Supervisor and the Manager, Traffic Systems Training. These management personnel must then decide if any action is to be taken on the problem. This could be as simple as a one-page memorandum to all advisors to pay special attention to a particular question, or it could mean withdrawing a module from distribution.

If a module is to be revised, a Training Projects Developer is assigned to the task. The Instructional Development Specialist does not generally participate in revisions, but is informed of the problem, and possibly consulted on the instructional strategy for the revision.

No attempt is made within Traffic Systems Training at supra-evaluation, that is, at questioning whether the course is needed at all, or determining whether it meets the actual needs of the carload centre employees.

In the case of *The Demurrage Function*, the indications for change came not from the Instructional Development Analyst, nor from the advisors in the field, but in the form of a memorandum from Traffic Systems Operations. In 1983, the JF Assessment Report, the heart of the demurrage activity, would undergo a complete change in format.

As examples of this report were spread throughout the course, a revision of practically the entire course would be required.

A Training Projects Developer was assigned to this project, one of the original SMEs recalled, and a work plan was developed for the revision. In June, 1983, a second version of *TC-B40, The Demurrage Function* was issued.

In the period from March, 1982, when it was issued, to June, 1983, when it was withdrawn from distribution and replaced with another version, approximately 15 CN employees made use of the first version of the course. Summative evaluation data on this first version, from the BCA, is presented in the following chapter (Table 13).

Conclusion

After approximately 15 administrations in the 16 months it was available, the course *The Demurrage Function* underwent a complete revision to bring it into line with the changes in format to the JF Assessment Report made by Traffic Systems Operations.

Results

Formative Evaluation

As reported in the previous chapter, the formative evaluation of TC-B40, *The Demurrage Function*, took place in late September and early October, 1981. The course was tried-out on a total of twelve validation candidates drawn from the target population, in four groups of three, in Moncton and Toronto (see Table 2 for background information on the validation candidates). After administration to a group of three, a prompt analysis of each module was undertaken (usually the same evening, or within one or two days). Such modifications as permitted by the constraints of time and resources were made before administration to the next group of three. Other problems were noted during these analysis sessions but, due to the aforementioned restrictions, corrective actions were postponed until later. A more in-depth analysis of the results after the tryouts dictated further revision before the course was released to the field in March, 1982.

The following is a brief discussion of the problems encountered with each self-instructional module during the formative evaluation process, the types of changes made to each module, and the reasons for making them.

AV-T-B40A01. ***Introduction to the Demurrage Function*** is an audiovisual module that provides an overview of the demurrage function (e.g. the responsibilities, the computer reports used, etc.). It ends with a typical day-in-the-life of someone working at the function.

location	Moncton, New Brunswick						Toronto, Ontario					
candidate	1	2	3	4	5	6	7	8	9	10	11	12
age	29	31	49	30	57	28	45	37	35	26	33	55
years of education	12	12	10	12	9	12	14	10	11	12	10	9
years of CN service	10	6	32	10	21	10	14	16	14	6	15	33
mother tongue	English	French	English	English	English	English	Korean	Italian	English	English	English	English
other languages	nil	English	nil	French	nil	nil	English	English	nil	nil	Ukranian	nil

Table 2. Background information on validation candidates.

Table 3 details the posttest results of this module. As can be seen from the widely scattered distribution of errors, blanks, and even four instances of negative gain, this module does not appear to be a shining example of the application of ISD to a training problem. Debriefing of the candidates, however, provided the following underlying reasons for this particular distribution of scores:

1. The validation candidates felt that the pacing was too fast, and thus they did not have sufficient time to absorb the concepts presented in the module. This problem was easily corrected for the final issue of the module.

2. As mentioned earlier, most candidates were unfamiliar with the conventions of self-instructional training. In fact, for 11 out of the 12, this was their first introduction to Traffic Systems' self-instructional training (only candidate number 3 had previous experience with it). Undoubtedly, this lack of experience with the approach and the media influenced their ability to properly interact with the material. To overcome such problems as the disorientation felt by this inexperienced type of trainee, the redundancy of instructions was increased for the final release of all the modules in the course (e.g. an instruction to turn to a certain page in the workbook would be shown on the filmstrip and spoken on the tape where before it may have only appeared on one of the two).

3. Problems were also encountered due to a lack of prerequisite knowledge by the validation candidates. For example, the candidates were supposed to know the concepts of demurrage, detention, free time, and so forth; some had only a vague idea of most of these definitions. Rather than assume that ideal conditions would prevail for future administrations in the field, a brief review of key terms was added to the final issue of the module. The argument that this was adding unnecessary detail to the module was rejected in favour of ensuring that all future trainees would understand the topics being discussed.

4. Even though only one validation candidate had problems with question 1., it

question	candidate max score	1	2	3	4	5	6	7	8	9	10	11	12	tot
1.(a)	1				-	-	-	-	-	-	-	-	-	-
1.(b)	1	x			-	-	-	-	-	-	-	-	-	-
1.(c)	1	b			-	-	-	-	-	-	-	-	-	-
1.(d)	1	x			-	-	-	-	-	-	-	-	-	-
2.	1							x		x		x		3
3.	2													
4.	1							N	x					2
5.	1					x		x			x			3
6.(a)	1			N							b			2
6.(b)	1	x												1
6.(c)	1	x				x				b	b	x		5
6.(d)	1	x				N				x	b	x		5
6.(e)	1	x												1
6.(f)	1					x						x		2
7.	1	x										x		2
8.(a)	1							x						1
8.(b)	1							x						1
8.(c)	1					x		x						2
9.(a)	1													
9.(b)	1													
9.(c)	1													
10.	1							N						1
11.	1				x									1
12.	1	x							x					2
13.	1													
14.	1					x								1
15.	1													
16.(a)	1					x								1
16.(b)	1					x								1
raw														
pre		06	22	23	10	08	19	16	08	14	09	03	14	
post		21	30	29	25	18	26	19	24	23	22	21	26	
%														
post		70	100	97	96	69	100	73	92	88	85	81	100	

x wrong answer on posttest
b blank on posttest
N wrong answer on posttest. Negative gain.
- test item removed.

Table 3. Formative evaluation data for AV-T-B40A01 *Introduction to the Demurrage Function.*

was removed after the first group of three candidates completed the module. This question presented an example of the type of problem discussed by Briggs (1977) when he warned that test-items created after a module has been developed may be too "content oriented". This particular test-item (a free form list) was seen by the SMEs as falling into that category. Interestingly, this only became clear to them by watching the validation candidates work through the module; they had not noticed it when they themselves had gone through the module.

5. The problems with questions 2. (a multiple choice item), 5. (a multiple choice item), and 6. (a multiple response item) were deemed to be caused by insufficient instruction, and additions were made to the script and workbook exercises on the teaching points linked to these items.

In summary, the majority of problems apparent in the posttest results shown on Table 3 were due to reasons exterior to the module. Overall, the module seemed to perform as it should, and only minor revisions were made for its final release. (It should be noted that Traffic Systems Training's policy of 90/90, i.e. that at least 90% of the trainees score 90% or better on the posttest, does not apply to formative evaluation.)

AV-TC-B40C02-1. *Introduction to the JF Assessment Report - Part 1* analyzes the form, content, and function of the JF Assessment Report, the key report used in the demurrage function. It also introduces a job aid, JA-TC-B40C03-6, *Job Aid for Processing the JF Assessment Report.*

Table 4 details the posttest results of this module. Two major problems are evident immediately: question 10., and validation candidate number 5. Observations by the SMEs uncovered other problems not obvious from the posttest scores. Debriefing the validation candidates raised another minor problem, but also a solution to a greater problem:

question	candidate max score	1	2	3	4	5	6	7	8	9	10	11	12	tot
1.(a)	1													
1.(b)	1													
1.(c)	1													
2.	1													
3.	1					x								1
4.	1													
5.	1													
6.(a)	0													
6.(b)	1													
6.(c)	1											b		1
6.(d)	1													
6.(e)	0													
6.(f)	0													
6.(g)	0									N				1
7.(a)	1													
7.(b)	1													
8.	1													
9.	1				x		x							2
10.	1	x	x		x	x	x		x		x	x	x	9
11.	1					x								1
12.(a)	1													
12.(b)	1													
12.(c)	1					x		-	-	-	-	-	-	-
12.(d)	1							-	-	-	-	-	-	-
12.(e)	1							-	-	-	-	-	-	-
13.(a)	1													
13.(b)	1													
13.(c)	1													
14.	1					N								1
15.	1					x			x					2
16.	1					x	N							2
17.(a)	1					x	x					x		3
17.(b)	1													
17.(c)	1													
raw														
pre		18	23	28	16	13	21	20	18	19	13	17	19	
post		29	29	30	28	22	26	27	25	26	26	24	26	
%														
post		97	97	100	93	73	87	100	93	96	96	89	96	

x wrong answer on posttest
b blank on posttest
N wrong answer on posttest. Negative gain.
- test item removed.

Table 4. Formative evaluation data for AV-TC-B40C02-1 *Introduction to the JF Assessment Report - Part 1.*

1. The problem with question 10. (a multiple choice item) seemed quite innocuous, but it continued to cause problems throughout the entire formative evaluation: It initially broke the oft-repeated rule counseling against the use of the term *always* in a test-item. After removing this offending word it was, apparently, still awkwardly constructed, and continued to confuse the validation candidates. It was revised again for final release of the module.

2. Validation candidate number 5 displayed problems in adapting to self-instructional training. His background information form showed that he was 57 years old and had a grade 9 education (see Table 2).

Candidate number 5 is a good example of the type of individual for whom self-instruction is probably not a viable training option, in that it places too much responsibility for learning on the individual. This, of course, raises the question of how exactly one approaches the segment of the population that he represents. Modern selection tools now eliminate most job applicants who do not possess the required skills to exist in the contemporary railroad environment; however, the majority of that segment of the population who secured their jobs before the introduction of these selection tools remain in the workforce.

A decision was made by the team, primarily at the urging of the SME assigned to observe him, to not send candidate number 5 back to his job but, rather, to bend the formative evaluation rules. Although he insisted that number 5 write the tests by himself, the SME occasionally aided him as he worked through the modules. This, of course, means that the posttest data for candidate number 5 are not completely valid. The experience, though, was not a total loss; the process used by the SME was similar to Dick and Carey's one-to-one evaluation and provided another perspective on the modules. The SME assigned to candidate number 5 dealt with him in an extremely sensitive manner, and displayed great empathy in doing so. Candidate number 5, a very

proud individual, was aware that he was not being treated as the other validation candidates but, given that the team was supportive and discrete about the matter, seemed to appreciate the experience and displayed a determination to learn from the modules.

3. After observing six administrations of the module, the SMEs deemed that question 12. (a matching item) was too detailed, and that counting for five points out of a total of thirty gave the objective to which the item was linked too heavy a weighting for its worth. It was thus reduced from a five-part question to a two-part question for the final release of the module.

4. Three validation candidates had a problem with question 17.(a), which was a written simulation item requiring them to look-up several codes on sample pages from the primary reference source in the carload centre, the *Integrated Procedures Manual*. The problem with question 17.(a) was not a training problem, but arose from the poor format of the pages in this manual. As changing the format of the manual was considered beyond the mandate and ability of the team, no action was taken on this problem.

5. A further problem encountered was that the validation candidates tended not to refer to the job aid that was provided with the module, relying instead on their memory to answer the exercise and test questions. As the job aid contained many relevant points to check while processing the report, it was felt by the team that the habit of using it should be developed in new trainees. Therefore, in the final issue of the module, statements such as *you may use the Job Aid to answer the following questions* were changed to ***USE THE JOB AID TO ANSWER THE FOLLOWING QUESTIONS***.

6. One validation candidate questioned why certain items in the job aid referred only to the province of New Brunswick (e.g. "N.B. no arrival advice needed for empties"). In the final release of the job aid, all N.B.s were changed to a star-like

symbol with a key explaining that it alerted the trainee to be aware of special situations.

7. The same validation candidate who did not know that N.B. stood for *Nota Bene* made an excellent suggestion to make this and several of the following modules easier to use. By having the trainees remove the workbook page containing the sample JF Assessment Report a considerable amount of time was saved in flipping back and forth to refer to it.

Overall, this module worked well, and the debriefing provided useful information for its revision before final release.

AV-TC-B40C02-2. ***Introduction to the JF Assessment Report - Part 2*** continues where Part 1 leaves off and describes the contents of the subsections of the JF Assessment Report.

Table 5 details the posttest results of this module, with questions 5. and 9. being the only obvious problems:

1. The problem with question 5. (an objective short answer item) was a lack of prerequisite knowledge by the candidates. The question dealt with the *Received in Open Interchange* subsection of the report. Open interchange is a relatively complex area and its mere mention caused confusion in some candidates. Further explanation of the concept of open interchange was added to the final release of the module.

2. Question 9. was a poorly worded multiple choice item that confused some candidates. It was revised for final release of the module.

3. A problem that is not apparent from Table 5 is that all candidates got question 8. correct on the pretest. This is a matching item, worth nine points, that requires the trainees to match the titles of the JF Assessment Report subsections with the type of traffic that each subsection contains. It was decided to not change this item, even though it is solvable by the application of common sense, seeing that it at least gets the trainees

question	candidate / max score	1	2	3	4	5	6	7	8	9	10	11	12	tot
1.	1													
2.	1													
3.(a)	1													
3.(b)	1	x				b								2
4.	1													
5.	1	b				x		x		x		b		5
6.(a)	1				x					x				2
6.(b)	1				x							b		2
6.(c)	1													
7.	1													
8.(a)	1													
8.(b)	1													
8.(c)	1													
8.(d)	1											N		1
8.(e)	1													
8.(f)	1													
8.(g)	1													
8.(h)	1													
8.(j)	1													
9.	1	x			x			x				x		4
raw														
pre		13	14	18	13	13	13	14	14	12	11	13	16	
post		17	20	20	17	18	20	18	20	18	20	16	20	
%														
post		85	100	100	85	90	100	90	100	90	100	80	100	

x wrong answer on posttest
b blank on posttest
N wrong answer on posttest. Negative gain.
- test item removed.

Table 5. Formative evaluation data for AV-TC-B40C02-2 *Introduction to the JF Assessment Report - Part 2.*

to think about the subject. (The negative gain by candidate number 11 was claimed by him to be caused by an oversight at the end of a long day.)

Overall, no major problems were discovered with this module, and only minor revisions were required for its final release.

AT-TC-B40C03-1. *Processing the JF Assessment Report - Part 1* is the first in a series of five audiotutorial modules that lead the trainee through the steps involved in processing the JF Assessment Report.

Table 6 details the posttest results of this module. Five problems are immediately evident: questions 1.(c) and 4. are scoring poorly, validation candidates numbers 4 and 11 are having difficulty, and validation candidate number 12 is gone:

1. Validation candidate number 12 decided that one day of formative evaluation was all he could handle and called in sick for the rest of the week.

His background information form shows demographic data similar to that of candidate number 5: age 55 with a grade 9 education (see Table 2). Unlike candidate number 5, however, he seemed to respond very well to self-instructional training: His scores on the first three modules were excellent, and the only difference between his performance and those of the other candidates was that he tended to take longer to work through the modules. On further checking with his supervisor, it was established that he had previously reacted in a similar manner to another training course. After 33 years of service to the company he held the lowest-rated job in the carload centre, and apparently was content with it.

It was too late to obtain a replacement for him, and so the formative evaluation continued with one less validation candidate.

2. The problem with questions 1.(c) (a completion item) and 4. (an objective short answer item) was in their wording. Both questions were unclear on what they required

question	candidate max score	1	2	3	4	5	6	7	8	9	10	11	tot
1.(a)	1									x			1
1.(b)	1												
1.(c)	1		x			x			x			x	4
2.(a)	3												
2.(b)	3												
2.(c)	3												
2.(d)	3												
3.(a)	2										x	x	2
3.(b)	2											x	1
3.(c)	2											x	1
3.(d)	2									N			1
4.	4				x		N	x		x	x	x	6
5.(a)	2										x		1
5.(b)	2												
5.(c)	2				N							b	2
5.(d)	2									x		b	2
6.(a)	2				N								1
6.(b)	2	x		x									2
6.(c)	2				N								1
6.(d)	2				N								1
raw													
pre		26	40	01	34	00	22	35	31	26	12	21	
post		41	42	41	31	42	39	39	42	34	35	28	
%													
post		95	98	95	72	98	91	91	98	79	81	65	

x wrong answer on posttest
b blank on posttest
N wrong answer on posttest. Negative gain.
- test item removed.

Table 6. Formative evaluation data for AT-TC-B40C03-1 *Processing the JF Assessment Report - Part 1.*

from the candidates. Both items were revised for the final issue of the module.

3. Candidate number 4 explained that his four negative gains were caused by not paying attention during the posttest. This is a plausible reason given that he was, generally, a good candidate.

4. Candidate number 11, on the other hand, had real problems with the module. As it was felt that he was typical of a large group of the target population: age 33; grade 9 education; 15 years service, predominantly in jobs with low skill requirements (see Table 2), the team closely analyzed the areas where he encountered the most difficulty and took the necessary corrective actions.

5. A major problem observed by the SMEs was the difficulty of the validation candidates in getting started at this module. Its format and procedures for study were different than those of the previous modules in that it required them to use a variety of reference materials to verify data on a sample JF Assessment Report. To ease the transition to the new procedures, additional instructions were added to the workbook and advisor's notes for the final issue of the module.

Overall, this module worked well, and only required minor revisions to the script and workbook, and clarification of the administration procedures.

AT-TC-B40C03-2. *Processing the JF Assessment Report - Part 2* takes up where Part 1 leaves off in leading the trainee through the steps involved in processing the JF Assessment Report.

Table 7 details the posttest results for this module. Two problems are evident: questions 2.(c) and 8:

1. In question 2.(c) (a written simulation item), the validation candidates were confusing the actual origin of the railcar in the question with the junction where it came on CN lines. A short addition was made to the script to highlight the difference

question	candidate / max score	1	2	3	4	5	6	7	8	9	10	11	tot
1.(a)	2	N											1
1.(b)	2				x							x	2
1.(c)	2	N											1
1.(d)	2												
2.(a)	2												
2.(b)	2						x			x			2
2.(c)	2		x				x			x		x	4
2.(d)	2									x		x	2
3.(a)	1												
3.(b)	1												
3.(c)	1												
3.(d)	1												
4.(a)	1												
4.(b)	1												
4.(c)	1												
4.(d)	1												
5.	2									N		x	2
6.(a)	2												
6.(b)	2												
6.(c)	2			x									1
6.(d)	2												
7.(a)	1	x											1
7.(b)	1												
7.(c)	1					x							1
7.(d)	1	x										N	2
8.	4	x		x		x	x					N	5
9.	1					x							1
raw													
pre		16	33	29	38	20	14	43	34	14	25	33	
post		33	41	37	41	37	35	43	43	35	43	30	
%													
post		77	95	86	95	86	81	100	100	81	100	70	

x wrong answer on posttest--
b blank on posttest
N wrong answer on posttest. Negative gain.
- test item removed.

Table 7. Formative evaluation data for AT-TC-B40C03-2 *Processing the JF Assessment Report - Part 2.*

between these two types of locations for the final issue of the module.

2. The validation candidates indicated that the problems with question 8. (an objective short answer item) were actually caused by the wording of question 7. (a written simulation item). The two questions went together, and the validation candidates were unclear on what they required. Both questions were reworded for the final issue of the module.

Overall, this module worked well, and only required minor revisions for final release.

AV-TC-B40C03-3. *Introduction to the JF Assessment Report - Part 3* takes up where Part 2 leaves off in leading the trainee through the steps involved in processing the JF Assessment Report.

Table 8 details the posttest results for this module. As can be clearly seen on this, table, the version of this module used in Moncton required some revision before being tried-out again in Toronto:

1. Some problems encountered in the Moncton administrations were a compounding of the problems from earlier modules, for example, not using the job aid to help answer the questions and thus overlooking certain key procedures for checking the data on the JF Assessment Report.

2. Another problem was that the validation candidates were not marking-up their copies of the JF Assessment Report when they discovered incorrect data, as they were supposed to. This caused a further compounding of errors. Both of these problems were dealt with by rewriting the script and actually talking the trainees through each step in the checking and verifying process.

3. A third problem was that some of the source material used in the written simulations was not clear. This was improved for the final release of the module.

question	candidate max score	1	2	3	4	6	7	8	9	10	11	tot
1.(a)	1		N	N								2
1.(b)	1		N									1
1.(c)	1	N										1
1.(d)	1	N										1
2.	1	-	-	-	-	-	-	-	-	-	-	-
3.(a)	2				x							1
3.(b)	2			x	x							2
3.(c)	2	N										1
3.(d)	2	N		N								2
4.(a)	2	x	x	b	x	x					x	6
4.(b)	2	b	x	b		N				x		5
4.(c)	2	x	x	b	x	x				x		6
5.(a)	2		x	x	x	x						4
5.(b)	2	b	x	b		N						4
6.	2		x	x	x	x			x			5
7.	2	b	x	x		x				x	x	6
8.(a)	2	N		x								2
8.(b)	2	N		x								2
8.(c)	2			b								1
9.	2		x		x							2
10.	2											
11.	2	N		x		N						3
12.(a)	2			x					x			2
12.(b)	2					x						1
13.	2	x	x	x								3
14.	1			b								1
15.(a)	1											
15.(b)	1				b				b		b	3
15.(c)	1		b		b						b	3
16.(a)	1											
16.(b)	1				b			b	b		b	4
17.(a)	1						x					1
17.(b)	1				x		x					2
18.(a)	1											
18.(b)	1											
18.(c)	1											
19.	1						x	x				2
raw												
pre		29	12	14	10	23				04	24	
post		32	35	24	38	38	52	54	50	50	49	
%												
post		57	63	43	68	68	93	96	89	89	88	

x wrong answer on posttest
b blank on posttest
N wrong answer on posttest. Negative gain.
- test item removed.

Table 8. Formative evaluation data for AT-TC-B40C03-3 *Processing the JF Assessment Report - Part 3.*

In summary, this module totally failed to achieve its objectives when it was first tried out, although some of the problems encountered were actually a compounding of other problems from previous modules. This notwithstanding, the difficulties came together with a vengeance; and the validation candidates in Moncton were not shy to express their opinions to the much-chagrined team. It was practically rewritten for the tryout in Toronto and Table 8 shows that it fared much better there (validation candidates 7 - 11). Minor changes were still needed for its final release.

AT-TC-B40C03-4. *Processing the JF Assessment Report - Part 4* takes up where Part 3 leaves off in leading the trainee through the steps involved in processing the JF Assessment Report. Part 4 deals specifically with the calculation and assessment of demurrage, switching, detention, and other ancillary charges.

Table 9 details the posttest results for this module. Questions 2.(d) and 5.(d), and validation candidates numbers 3 and 10 display problems with this module:

1. Validation candidate number 3 had twelve negative gains on his posttest. In debriefing, he explained that he had simply overdosed on training (especially after having just suffered through Part 3). This is a perfect example of what can happen to trainees, even very good ones, when too much information is pushed at them at the same time. Luckily for candidate number 3, and for the formative evaluation process, this was the last module of the day and he was able to go home and rest.

2. In debriefing, it was discovered that validation candidate number 10 lacked many of the prerequisites to study this module. No changes were made to the module because of this. The SME assigned to observe him gave him a brief lesson on the demurrage tariff in preparation for the next module.

3. The problem with question 2. (a multiple choice item) was caused by the candidates still not marking-up their copies of the JF Assessment Report with changes to

question	candidate max score	1	2	3	4	5	6	7	8	9	10	11	tot
1.(a)	3												
1.(b)	3										N		1
1.(c)	3					x							1
1.(d)	3											N	1
2.(a)	3										x		1
2.(b)	3										x		1
2.(c)	3					N				x			2
2.(d)	3	N		x						x		N	4
3.(a)	2					x							1
3.(b)	2										x		1
3.(c)	2												
3.(d)	2											N	1
4.(a)	3												
4.(b)	3										N		1
4.(c)	3												
4.(d)	3												
5.(a)	2												
5.(b)	2										x		1
5.(c)	2												
5.(d)	2	x				x				x			3
6.(a)	1			N									1
6.(b)	1			N	N								2
6.(c)	1			N									1
6.(d)	1			N		x							2
6.(e)	1			N									1
6.(f)	1			N									1
6.(g)	1			N									1
6.(h)	1			N									1
6.(j)	1			N									1
6.(k)	1			N		x							2
6.(l)	1			N									1
6.(m)	1			N									1
7.(a)	1												
7.(b)	1												
raw pre		59	47	61	57	38	47	66	55	55	46	53	
post		61	66	51	65	54	66	66	66	58	50	58	
% post		92	100	77	98	82	100	100	100	88	76	88	

x wrong answer on posttest
b blank on posttest
N wrong answer on posttest. Negative gain.
- test item removed.

Table 9. Formative evaluation data for AT-TC-B40C03-4 *Processing the JF Assessment Report - Part 4.*

the data on the report (see point 2 of the discussion on AT-TC-B40C03-3). This procedure was, therefore, stressed even more in the final release of the module.

4. Question 5 (a written simulation item) just turned out to be a difficult question dealing with a difficult subject: *mechanical detention*. To aid trainees in assessing mechanical detention and other charges, procedural checklists were added to the final release of the module.

Overall, this module did well, and it was released with minor revisions. The reaction of validation candidate number 3 is a reminder that our subjects are human beings, who need appropriate treatment if we expect them to learn anything from our training.

AT-TC-B40C03-5. *Processing the JF Assessment Report - Part 5* combines all the teaching points covered in the first four parts and requires the trainee to process a JF Assessment Report in its entirety.

Table 10 details the posttest results for this module. Questions 3.(d) and 10.(d), plus validation candidates numbers 3 and 10 indicate problems with this module:

1. The problems with the validation candidates remained the same as for the previous module. Candidate number 3 was burned out, although not as badly as on the previous day, and candidate number 10 lacked the prerequisite knowledge and skills to perform any better than he did.

2. The problem with questions 3.(d) and 10.(d) (both written simulation items) was oversight on the part of the validation candidates in transcribing information to the report. Transcription of data was further stressed in the script for the final release of the module.

Overall, this module worked very well, and all validation candidates who completed it expressed that they felt pleased with themselves, and that they had

question	candidate max score	1	2	3	4	6	7	8	9	10	11	tot
1.(a)	2									x		1
1.(b)	2											
2.(a)	1	-	-	-	-	-	-	-	-	-	-	-
2.(b)	3	x										1
2.(c)	3											
2.(d)	1											
2.(e)	1											
2.(f)	1											
3.(a)	1			b								1
3.(b)	1	-	-	-	-	-	-	-	-	-	-	-
3.(c)	2											
3.(d)	1			b	x			x		x		4
3.(e)	3			b						x		2
3.(f)	1			b								1
3.(g)	1			b								1
4.(a)	1	-	-	-	-	-	-	-	-	-	-	-
4.(b)	2		x									1
4.(c)	3											
4.(d)	3											
4.(e)	1			x								1
4.(f)	1			b								1
5.(a)	1	-	-	-	-	-	-	-	-	-	-	-
5.(b)	3											
5.(c)	2								x		b	2
6.(a)	1								x			1
6.(b)	2		x									1
6.(c)	3			b		x				x		3
6.(d)	1					b						1
6.(e)	1					b						1
7.(a)	1											
7.(b)	2	-	-	-	-	-	-	-	-	-	-	-
7.(c)	1							x				1
7.(d)	3	x			x					x		3
8.	4											
9.(a)	1										b	1
9.(b)	2	-	-	-	-	-	-	-	-	-	-	-
9.(c)	3				x					x		2
9.(d)	3									x		1
9.(e)	1									x		1
9.(f)	1						x					1
9.(g)	1			b								1
10.(a)	1							b			b	2
10.(b)	2	-	-	-	-	-	-	-	-	-	-	-
10.(c)	2											
10.(d)	1			b	x			x		x	b	5
10.(e)	3			b							b	2
post raw		67	68	53	62	65	69	66	67	50	62	
%		96	90	76	89	93	99	94	96	71	89	

x wrong answer on posttest
b blank on posttest
- test item removed.

Table 10. Formative evaluation data for AT-TC-B40C03-5 *Processing the JF Assessment Report - Part 5.*

accomplished "something special".

The team, however, found that the test was too long for a module test, and so it was made, with minor modifications, into the course test. A much shorter pre and posttest, but in the same vein as this one, was developed for the final release of the module.

AV-TC-B40D-1. *Handling Demurrage-Related Activities - Reports* is an audiovisual module that covers the handling of two important computer reports used by the demurrage clerk: The Report for Notification of Cars Pending/On Demurrage, and the 15 Days No Activity Report.

Table 11 details the posttest results of this module. Only two problems are evident: questions 2.(c) and 6.(c):

1. Question 2.(c) was a multiple choice item that was poorly worded. As it was felt by the team that question 2.(c)'s objective was adequately covered by questions 2.(a) and 2.(b), it was deleted from the final issue of the module.

2. Question 6.(c) was a true/false item on the types of railcars found in one of the reports. The relevant teaching point was strengthened for the final release of the module.

Overall, no real problems existed with this module, and only very minor revision was required for its final release.

AT-TC-B40D-2. *Handling Demurrage-Related Activities - Discrepancies* is an audiotutorial module that leads the trainee through the steps required to investigate and deal with the most common discrepancies and customer claims arising from the processing of the JF Assessment Report.

Table 12 details the posttest results of this module. Due to time constraints, only seven validation candidates were able to get to this final module. Problems are evident

question	max score	candidate 1	2	3	4	6	7	8	9	10	tot
1.(a)	1										
1.(b)	1										
1.(c)	1										
2.(a)	1										
2.(b)	1										
2.(c)	1	N							N		2
3.	2										
4.	1										
5.	1										
6.(a)	1										
6.(b)	1										
6.(c)	1	N						N			2
6.(d)	1										
6.(e)	1										
6.(f)	1										
7.	1										
8.(a)	1										
8.(b)	1										
8.(c)	1										
8.(d)	1										
9.	1										
10.	1										
11.	1										
12.(a)	1										
12.(b)	1										
12.(c)	1										
13.(a)	1										
13.(b)	1										
13.(c)	1										
13.(d)	1										
13.(e)	1										
13.(f)	1										
raw											
pre		20	22	31	20	26	27	16	22	22	
post		31	33	33	33	33	33	32	32	33	
%											
post		94	100	100	100	100	100	97	97	100	

x wrong answer on posttest
b blank on posttest
N wrong answer on posttest. Negative gain.
\- test item removed.

Table 11. Formative evaluation data for AV-TC-B40D-1 *Handling Demurrage-Related Activities - Reports.*

from this select group with three questions: 3.(d), 9., and 12.:

1. Question 3.(d) was a rank order list item requiring the validation candidates to indicate the flow of information in a customer-initiated claim against a demurrage bill. The format and the wording of the question seemed to be causing the difficulty and so these were revised for the final issue of the module.

2. Questions 9. and 12. were objective short answer items. Debriefing showed that poor wording was causing confusion among the validation candidates on what exactly was required from both of the questions. Both items were reworded for the final issue of the module, and question 12. was made into a multiple choice item.

3. This module introduced *Zimdex*, which is an audio indexing system developed at the American College, Bryn Mawr, Pennsylvania. Zimdex works like a table of contents and page numbers in a book. On one side of the audiocassette the narration is recorded as usual; on the other side is recorded a series of numbers with a five second pause between each number. A *contents page* links sections of narrative with specific numbers on the Zimdex side. These numbers are then used to locate particular passages on the tape for review. The only supposed confusing part about the system is that to move forward on the narration side you must reverse on the Zimdex side (because the tape is turned over). Unfortunately, no one told the validation candidates that this was the only confusing part and it caused them no end of problems. Zimdex had been added to this module because it was felt that the subject matter lent itself to being reviewed in this manner. It turned out to be more trouble than it was worth. With regrets (as a great idea with inefficient application), Zimdex was removed from the final issue of the module.

Overall, with the exception of the Zimdex debacle, no major problems were encountered in the module, and it was released with minor revisions.

question	candidate max score	1	2	3	7	8	9	10	tot
1.(a)	1								
1.(b)	1								
1.(c)	1								
2.(a)	1								
2.(b)	1	N							1
2.(c)	1								
3.(a)	1								
3.(b)	1								
3.(c)	1		x	x					2
3.(d)	1	x	x	x					3
3.(e)	1					x			1
3.(f)	1								
4.(a)	1	N							1
4.(b)	1	x							1
4.(c)	1	x							1
4.(d)	1					x			1
4.(e)	1								
5.(a)	1								
5.(b)	1								
5.(c)	1								
5.(d)	1								
6.(a)	1								
6.(b)	1								
6.(c)	1							N	1
6.(d)	1								
7.(a)	1								
7.(b)	1								
7.(c)	1								
7.(d)	1								
7.(e)	1								
7.(f)	1								
7.(g)	1								
7.(h)	1								
8.	1								
9.	1		x		N	x			3
10.	3	x							
11.	5								
12.	2	x	x		N	x	x		5
raw									
pre		22		26	37	10	21	21	
post		35	40	43	42	40	43	44	
%									
post		78	89	96	93	89	96	98	

x wrong answer on posttest
b blank on posttest
N wrong answer on posttest. Negative gain.
- test item removed.

Table 12. Formative evaluation data for AT-TC-B40D-2 *Handling Demurrage-Related Activities - Discrepancies.*

Conclusion

In summary, the formative evaluation and revision procedures for TC-B40, *The Demurrage Function*, worked very well. The team was able to observe and correct the administrative and procedural problems inherent in the materials and, by analyzing the test results and debriefing the validation candidates, were able to determine and correct any learning problems.

To fulfill Traffic Systems Training procedures, summary statistics of the posttest scores from the formative evaluation were compiled (expected range of the mean, standard deviation, standard error, worst case, average case, best case). As the modules had all been modified to varying degrees between each group of three validation candidates, these statistics were meaningless. Furthermore, as Rowntree states: "If a relationship is not obvious without high-level statistical computation it is probably not worth bothering about" (1974, p. 152). The simple tabulation of the posttest scores was sufficient to meet the needs of the team in detecting any problems in the modules.

The formative evaluation had one other aspect that is not initially evident from the tables of neatly arranged data. It confronted the team, and particularly the Instructional Development Specialist, with live members of the target population. It is altogether too easy to lose sight of this very important group of people during instructional development. It is even easier to resent them for intruding with their petty problems on your perfectly conceived training system (e.g. candidate number 3's burnout, number 5's learning deficiencies and false pride, number 12's disappearance, number 4's oversights, etc.). The bottom line is, however, that if the training is to work, it had better be *their* system and meet *their* needs, not *your* system to meet *your* needs.

All in all, formative evaluation is an exhilarating but, above all, a humbling experience.

Summative Evaluation

Approximately 15 employees took the course during the 16 months it was in the field.

Table 13 lists their summary results. This shows that the revisions made after formative evaluation had apparently worked. Looking only at the unionized employees, who are the primary target population, the lowest average percentage score is 92. The standard deviations are generally low, with the exception of those of AT-TC-B40C03-4 and AT-TC-B40C03-5, *Processing the JF Assessment Report Parts 4 & 5*, which could bear closer analysis by the Instructional Development Analyst. The gains are relatively high.

Although this is a small sample, the results still demonstrate that the ISD process was able to produce a workable training course on demurrage.

module	employee category	no. of trainees	max. score	average score raw	average score %	std. dev.	std. error	ave. gain	ave.% gain	av. mod gain	pre only	neg gain
AV-T-B40A01	union	13	27	26.38	97.72	1.121	.324	10.54	39.03	94.54	1	
	management	2	27	27.00	100.00	.000	.000	5.00	18.52	100.00	1	
	total	15		26.47	98.02	1.060	.283	10.14	37.57	94.93	2	
AV-TC-B40C02-1	union	12	28	27.50	98.21	.674	.203	6.73	24.03	93.18	1	
	management	2	28	27.50	98.21	.707	.707				1	
	total	14		27.50	98.21	.650	.180	6.73	24.03	93.18	2	
AV-TC-B40C02-2	union	12	21	20.83	99.21	.389	.117	6.25	29.76	96.50	2	
	management	3	21	20.67	98.41	.577	.408	5.50	26.19	90.00		
	total	15		20.80	99.05	.414	.111	6.14	29.25	95.57	2	
AT-TC-B40C03-1	union	12	37	35.50	95.95	1.624	.490	11.55	31 20	83.45	1	
	management	3	37	37.00	100.00	.000	.000	19.50	52.70	100.00		
	total	15		35.80	96.76	1.567	.419	12.77	34.51	86.00	1	
AT-TC-B40C03-2	union	10	42	41.60	99.05	.843	.281	11.00	26.19	97.44	3	
	management	2	42	42.00	100.00	.000	.000	9.00	21.43	100.00	1	
	total	12		41.67	99.21	.778	.235	10.80	25.71	97.70	4	
AT-TC-B40C03-3	union	13	54	50.92	94.30	2.465	.712	13.75	25.46	79.33		
	management	3	54	52.67	97.53	2.309	1.633	12.00	22.22	89.67		
	total	16		51.25	94.91	2.463	.636	13.40	24.81	81.40		
AT-TC-B40C03-4	union	8	66	60.75	92.05	4.621	1.747	11.67	17.68	62.33	5	
	management	3	66	64.33	97.47	2.887	2.043	12.00	18.18	83.33		
	total	11		61.73	93.53	4.406	1.393	11.78	17.85	69.33	5	
AT-TC-B40C03-5	union	10	55	50.60	92.00	3.950	1.317	13.10	23.82	77.70	1	
	management	3	55	52.67	95.76	2.517	1.779	15.67	28.48	87.00		
	total	13		51.08	92.87	3.684	1.064	13.69	24.90	79.85	1	
TC-B40-T1	union	11	100	94.45	94.45	2.911	.920					
	management	2	100	95.50	95.50	6.364	6.364					
	total	13		94.62	94.62	3.254	.939					
AV-TC-B40D-1	union	8	32	31.88	99.61	.354	.134	5.83	18.23	98.50	3	
	management	3	32	32.00	100.00	.000	.000	4.67	14.58	100.00		
	total	11		31.91	99.72	.301	.095	5.44	17.01	99.00	3	
AT-TC-B40D-2	union	9	45	44.33	98.52	1.000	.354	11.14	24.76	94.63	2	
	management	3	45	44.33	98.52	1.155	.816	10 67	23.70	95.00		
	total	12		44.33	98.52	.984	.297	11.00	24.44	94.60	2	

Table 13. Summative evaluation data of TC-B40, *The Demurrage Function*.
From Canadian National, Servocentre Training System, Basic Course Analysis, November 01, 1984.

Conclusions and Recommendations

Summary of the Background to the Project

A new approach to training development was established in 1979 by CN's Traffic Systems Training. Temporary teams of subject matter experts under the leadership of an Instructional Development Specialist would be formed to develop courses of instruction in the SMEs' particular areas of expertise.

Following a statement of felt needs from Carload Managers in the Great Lakes Region, the Traffic Systems Cabinet requested that a training course be developed on demurrage. An Instructional Development Specialist was assigned to lead the project and, using newly developed selection tools, a team of four SMEs was chosen.

The analysis stage of the demurrage training development project began in September, 1980, and was completed relatively successfully and on schedule. The design stage, on the other hand, ran into several obstacles, the most serious being the SMEs' lack of knowledge of and skills in instructional systems development procedures (e.g. criterion test-item development). The development stage of the project, however, produced the most serious problem: the SMEs' lack of ability to create scripts and storyboards. Practically every script and storyboard had to be rewritten by the Instructional Development Specialist, with the aid of one SME, after the expiration of the 90 days time limit allowed in the draft work plan. When the development was finally completed, the artwork and subsequent slide production were contracted out to an audiovisual shop. Formative evaluation of the prototype training material was then carried out at Moncton and Toronto on 12 members of the target population, providing

useful data to aid the project team with revision. The finished course was released to the field in March, 1982.

Due to a revision to the format of the JF Assessment Report, this first version of the course was withdrawn from use in June, 1983. It had been administered to approximately 15 employees in the 16 months it was available in the field.

I was the Instructional Development Specialist on this project. I kept detailed notes on the events as they occurred, and the discussion in the preceding chapters has been taken from these notes and from the project documentation (e.g. analysis charts, etc.). The following conclusions, and the consequent recommendations for future direction, are discussed under the appropriate subheadings.

The SME Approach to Training Development

The demurrage clerks who participated in the training development project as subject matter experts had limited formal education, and had spent their entire careers at CN in clerical duties: duties that did not require in-depth analytical thought or creative writing skills, duties that definately did not require knowledge of instructional systems development and learning theory. And yet when they were asked to write behavioural objectives, draft criterion test-items, and create storyboards, they were given short, self-instructional modules on each of these subjects, and a limited amount of coaching from a novice Instructional Development Specialist.

It can therefore be concluded:

Given the training and support available to them, subject matter experts from carload centres should not be expected to function as competent instructional developers.

This is not to say that SMEs cannot function as developers. However, training a

carload centre employee to be a competent instructional developer cannot be anticipated to be a cost-effective approach to training development, especially when the assignment to that function is temporary.

The human factor must also be considered. Most people know when they are out of their depth, but social pressures do not always allow them to be open and honest about it, or to request the appropriate aid. Think of how the SME who could not create flowcharts felt as he came to work each morning, or how the three remaining SMEs felt as they struggled with their storyboards. To avoid a recurrance of these types of pressures on employees, it is clear that the approach to instructional development used by Traffic Systems Training must be changed, and that the available personnel must be assigned to the tasks for which they are most properly suited.

The following recommendation is therefore proposed:

Employees on loan to Traffic Systems Training should function primarily as subject matter experts, and only minimally as instructional developers.

Some instructional development work by the SMEs is still possible: The demurrage project SMEs thrived at formative evaluation, performed well in analysis, and were able to participate adequately in some phases of design. They were totally inadequate, however, at script and storyboard development, and at designing criterion test-items. In other words, they were capable of working at group tasks led by an Instructional Development Specialist and at tasks that centred very specifically on their regular jobs (e.g. brainstorming, formative evaluation, etc.), but were incapable of working at tasks requiring individual creative thought, complex problem solving, or in-depth knowledge of instructional technology.

This suggests that the following steps in the ISD process are still viable for future SME involvement:

1. analysis (i.e. DACUM or other group brainstorming techniques, task flowcharting, completing task description worksheets, etc.),

2. objective writing,

3. developing course outlines (i.e. course syllabi),

4. listing teaching points for modules,

5. technical review at any stage of the instructional development process, and

6. formative evaluation.

To lessen even more the individual pressure to perform unfamiliar tasks, it would be preferable that the SMEs work in pairs at those steps where they currently work individually (e.g. task flowcharting, objective writing, etc.). Group reviews of all work should also be held more frequently to ensure that all team members are in concurrence with approaches taken, and are up-to-date on the latest developments.

Participation by SMEs in the more complex steps of the ISD process (e.g. test-item development) should be undertaken only under the following circumstances:

1. if close personal coaching and supervision is available to the individual SMEs and the work is delegated to them in extremely small amounts, or

2. if an SME with exceptional abilities and high motivation is a member of the project team and demonstrates a facility with the tasks assigned.

This recommendation to use employees on loan to Traffic Systems Training primarily as subject matter experts and only minimally as instructional developers entails a fundamental change to the *SME approach to training development* that was originally presented to the Cabinet, where the SMEs were expected to be full-fledged instructional developers. At first look, it also seems much more costly and time-consuming than the original approach, due to the doubling-up of the SMEs on certain tasks, the increase of group reviews, and more of the workload being apportioned to the Instructional Development Specialist. However, the anticipated economy of the original approach is

lost when it is considered that, by following the original approach, the Instructional Development Specialist had to redo most of the SMEs' development work. Some savings can even be foreseen with the recommended changes when it is considered that four or five SMEs need not be resident at System headquarters for 90 days, but can return to their regular jobs after 40 days or less (i.e. after objective writing). With this new approach, one SME would remain at headquarters as primary subject matter expert, the others would have any new material mailed to them at their carload centres on a regular basis. They would then be recalled as required, probably for brief periods of group review before the production and formative evaluation stages.

By assigning personnel to the tasks for which they are best suited, a less costly product, both in monetary and human terms, will be obtained.

Project Team Composition

Participation of generalist. It is Traffic Systems' policy that the training distributed across the System should cover only skills and knowledge common to all (or most) carload centres; training on local and exception situations is the responsibility of local management. Time was lost by the team during the analysis stage on arguing whether certain tasks were common practice, or local and exception situations. This is not surprising, given that most carload centre personnel are familiar only with the procedures in their home terminals. It actually came as a shock to some SMEs that tasks they carried out every day were "local and exception situations".

It can be concluded:

Subject matter experts from carload centres should not be expected to possess a System perspective.

This creates the following recommendation:

Each training development project must include the participation of at least one generalist.

The generalists attached to each project team would be individuals possessing a System overview of the subjects under study. These individuals need not be current master performers, as is required of the SMEs. However, in order to fully participate in the process, sufficient knowledge of the day-to-day activities would be required of them, and so they would have to be operations officers. On the other hand, a staff officer or administrator may also have useful input to a project (e.g. a staff officer may have had forewarning of the changes to the JF Assessment Report). An enlarged team would thus consist of a diagonal slice of the organization, and be more capable of anticipating potential problems and pitfalls.

As the generalists would be System or regional management employees, their current positions and duties would be less easily covered during temporary absences than those of unionized employees, and they would probably not be available for participation in training development projects for long periods, as could unionized employees. This anticipated constraint may require judicious planning of the generalists' time. However, minimum involvement by the generalists should include participation in the analysis stage brainstorming sessions, and in the group reviews before the production and formative evaluation stages. They should also be available to the teams for consultation on an as-needed basis.

Even though the generalists will be senior to the SMEs, and possibly even senior to the Instructional Development Specialists, it is extremely important that they be perceived as equals, not as superordinates; it would serve no good to have the SMEs or the Instructional Development Specialists always defer to the opinions of the generalists. After all, it is the SMEs who actually work at the activity, and it is their on-the-job

experience that the ISD process is attempting to capture, synthesize, and recreate in the training material for the benefit of the trainees. The generalists' role in the process will be to provide a wider perspective on the activity than the SMEs', to explain how the activity fits into the company's overall goals and strategy, and to help ensure that local and exception situations do not get included in the common training.

Regional participation. The SMEs for the demurrage project consisted of four demurrage clerks, one from the Atlantic Region, two from the Great Lakes Region, and one from the Mountain Region; there was no representation from either the St. Lawrence or the Prairie Regions. The team members were chosen from the pool of applicants because they seemed to be the individuals best capable of fulfilling the project goal.

It was noted that the three SMEs from the east tended to follow similar procedures in the execution of their jobs, and that all three differed somewhat more from the procedures used by the SME from the west (e.g. in handling discrepancies, the easterners use a form CCDB 12, the westerners a form CCDB 106).

There are not enough data to draw any new conclusions from these observations (e.g. that the east and west always follow separate procedures). However, in order to be safe, the following recommendation is made:

When selecting project teams, an attempt should be made to include representation from all regions. If this is not possible, representation should at least be present from both the western regions (Mountain and Prairie) and the eastern regions (Great Lakes, St. Lawrence, and Atlantic).

This recommendation also makes good political sense. By having an employee participate in a training development project, a region is more likely to be committed to the outcome of the project than if it has no representation.

Career Development for SMEs

Twice during their 90-day assignment to Traffic Systems Training for the demurrage project, the SMEs' attitudes and performances were assessed by the Instructional Development Specialist using the Traffic Systems Training *standard personnel evaluation worksheet*. The first time was at approximately Day 45, when the SMEs were given verbal feedback on such factors as their ability to learn new concepts, their communications skills, and their tenacity at completing assigned tasks; the second time was at the end of their tenure, when they were given verbal feedback and letters for inclusion on their personnel records. The three SMEs improved in many of the areas measured from the first to the second assessment.

It was later reported to Traffic Systems Training by local and regional management that, on returning to their home terminals and regular assignments, most of the SMEs displayed an improved understanding of their jobs and a more positive attitude towards the company.

From the above, from observations made by other System management personnel, and from comments made by the SMEs themselves, it can be concluded that:

For many carload centre employees, participation as a subject matter expert in a Traffic Systems Training project will tend to improve the employee's attitude and performance on the employee's regular job.

In addition to undergoing the rigours of the ISD process, the following events may have also had an influence on and contributed to the personal growth of the SMEs during the demurrage project.

It had been noted earlier that unionized carload centre employees, temporarily posted to System headquarters and surrounded by management personnel wearing jackets and ties, are very far from a familiar environment. Activities on Day 1 of the project were therefore designed to help overcome any anxieties due to culture shock.

After a morning of introductions, presentations, and a tour of CN facilities, the SMEs were taken on a walking tour of downtown Montréal, and ended up in a local bar for an informal closing to the day. Several SMEs expressed that by meeting and getting acquainted with management personnel in this way made them feel more at ease while dealing with them later in the project.

During their stay, a tour of the Canadian Car Demurrage Bureau (CCDB) was arranged for the SMEs. (The CCDB is a government body that monitors the application of the demurrage rules.) The SMEs expressed that meeting and seeing in action the individuals to whom they usually only talk on the telephone was greatly appreciated, in that it increased their understanding of and empathy with the CCDB personnel and their role in policing the demurrage rules.

On conclusion of the project, the Traffic Systems Training management took the team to a downtown restaurant for a closing dinner. All SMEs expressed that sharing conversation and dinner with management personnel in an elegant restaurant made them feel important. Some even expressed how surprised they were that management personnel could be so "normal" in an informal setting.

To return to the conclusion that participation in a training development project tends to make the SMEs more visible and more valuable to their local management, then it makes sense to capitalize on this, and to make the personal growth and career development aspects of the SMEs' time at headquarters more formal.

It is not enough to merely make the SMEs "feel important", although this is undoubtedly a significant and essential factor. It is therefore recommended that:

Opportunity for personal growth and career development for carload centre personnel should be made an integral part of their participation in a training development project.

Towards this end, more tours of relevant departments and organizations should be

arranged; and meetings with senior company officers, on a formal and informal basis, should be encouraged. By investing development time and effort in the human resource from the carload centres in this way, both CN as a whole and Traffic Systems in particular will benefit. For example, if local management come to realize that releasing employees to participate in Traffic Systems Training projects will tend to have a markedly positive effect on the employees' attitude and performance, they will be less reluctant to nominate their best employees for future projects. This, in turn, will cause Traffic Systems Training to gain access to a wider and deeper pool of potential SMEs, and perhaps a better reputation for their training.

Instructional Development Specialist

It was noted in earlier chapters that the Instructional Development Specialist on the demurrage project was on his first major assignment. It was also noted that he was reluctant to deviate from the work plan when confronted with problem situations, even though, in hindsight, other strategies may have produced better results.

To draw an analogy: it is not expected that a carload centre employee immediately become a master performer on successful conclusion of a Traffic Systems Training course. Rather, it is expected that the employee will possess enough knowledge and skills to begin working at the job under the guidance of a supervisor or other senior employee. As instructional technology is more complex than any of the jobs in the carload centres, it is unclear why instant expertise should be expected from a novice Instructional Development Specialist any more than from a novice carload centre employee, especially when it is considered that the Instructional Development Specialist must also supervise SMEs and perform a host of other administrative duties.

It can be concluded that:

Instructional Development Specialists with limited practical experience will tend to have a limited repertory of strategies for dealing with unforeseen or problem situations encountered during an instructional development project.

Montemerlo's conclusion that "one can become a competent training technologist only through a great deal of experience" (1979, p. 11) rings true. Too many problems are caused by inexperience, and these are compounded when one considers that the Instructional Development Specialist must play a leadership role with a team of SMEs.

It is therefore recommended:

All major projects must be led by, or under the responsibility of, an experienced Instructional Development Specialist.

This recommendation can be implemented in several ways:

1. New or inexperienced Instructional Development Specialists can be assigned relatively small or simple projects until they gain confidence in themselves, and experience in the practice of instructional technology.

2. A senior Instructional Development Specialist can be appointed as mentor to new or inexperienced Instructional Development Specialists. The senior would be expected to spend some time each day with the neophytes, coaching and guiding them through their projects.

3. New or inexperienced Instructional Development Specialists can be attached to a major project as aides to a senior Instructional Development Specialist. The senior would then be responsible for the overall strategy and meeting the project deadlines, while the junior could be assigned responsibility for smaller tasks within the project.

A combination of the above three strategies is possibly the ideal approach to the training and development of Instructional Development Specialists within Traffic Systems Training. In addition, management should be expected to spend more time with

the new employees, primarily to encourage them, but also to be prepared to aid and counsel them in overcoming any personal problems. In the event that no experienced Instructional Development Specialists are available to act as mentors or to lead projects, it would be preferable that two new or inexperienced Instructional Development Specialists be assigned joint responsibility for a project.

One final point needs attention on this subject: As *supervision* is not generally included in the curricula of graduate programmes in educational technology, supervisory training, and where unionized employees are involved, labour relations training, should also be provided to new or inexperienced Instructional Development Specialists.

SME Training

Traffic Systems Training received approval in 1979 to use temporary teams of carload centre employees to develop instruction. A request was made at that time to CN's corporate training department to produce training for the SME/developers to impart to them the knowledge and skills they would require for analysis, design, and development. (The mandate of Traffic Systems Training was to produce technical training for carload centre personnel, the mandate of the corporate training department to support other CN training departments.)

The criteria given to the corporate training department were that their training be self-instructional, modular, and follow Traffic Systems Training formats. It was further conveyed to them that the intended target population had no background in instructional development, and that the training would be self-administered after the regular working day during the training development projects.

If these criteria seem laughably naïve and optimistic today, it is with the benefit of hindsight. Traffic Systems Training management felt that they had a viable approach,

and the corporate training department, whose Training Coordinator held a graduate degree in educational technology, did nothing to dissuade them from the path they were following.

The lack of success of the SME training prepared by the corporate training department has been outlined in previous chapters. The conclusion is clear:

The training currently available to the SMEs does not prepare them for participation as training developers in an instructional development project.

It would serve no useful purpose to dwell in detail over how pitifully inadequate was most of the SME training. However, when it is remembered that the training on writing objectives was Robert Mager's excellent text, *Preparing Instructional Objectives* (1975), and that the SMEs still had difficulty getting started at this activity, then it is possible that, even if most of the training had been better prepared, the outcome may not have been any different.

It has already been established that SMEs should not be expected to function as full-fledged developers and, therefore, there is no point in recommending that the entire SME training course be redone to meet its original goal. In this light, the criteria given to the corporate training department in 1979 are examined below:

1. *self-instructional.* Self-instructional materials are appropriate when the target population is large, spread over a wide geographic area, or when competent instructors are not available. The population of SMEs is small (approximately eight per year) and concentrated in Montréal. Instructional Development Specialists should be capable of presenting instruction in a competent manner.

2. *modular.* Modular course design is a useful criterion, given that not all trainees may have to study all aspects of a subject.

3. *following Traffic Systems Training formats.* This is a rather unclear criterion.

If it means that all modules must have clearly stated objectives, pre and posttests linked to the objectives, and instruction that follows the recognized principles of instructional technology, then it is an excellent criterion. If, on the other hand, it only means that the training media must be filmstrip/cassette, and so forth, then it is a poor criterion (N.B. filmstrips are only cost-effective when there is a large distribution, or the subject-matter is relatively stable).

4. *target population with no background in instructional development.* This parameter is unlikely to change.

5. *self-administered.* As has been stated earlier, ISD is not a systematic process that can be followed as a cookbook recipe. It is a very complex field that can be understood only after much practical experience. To ask carload centre employees to self-administer anything but the most simple modules on ISD is unrealistic.

6. *after the regular working day during the project.* Most SMEs stated that their 90 day tenure with Traffic Systems Training was one of the most difficult and stimulating assignments in their careers at CN. They all also admitted to being generally exhausted at the end of each working day. To ask them, after eating supper, to return to work to study subjects barely comprehensible to them is a waste of both the SMEs' time and the company's money.

Given the above, the following is recommended:

The training on instructional systems development procedures for Traffic Systems Training should be revised as follows:

1. A series of job aids and easy-to-use reference material must be developed for each step in the ISD process (e.g. a checklist for the analysis brainstorming session, a worksheet for instructional objectives, etc.).

2. Training in any instructional development skills required by

carload centre employees must be in lecture/demonstration format. Each lecture must be followed by guided practice sessions led by the Instructional Development Specialist.

3. Short, self-instructional modules may be developed as overviews, introductions, links, and for the presentation of simple background knowledge. If audiovisual modules are used, they should be in slide or video format.

4. All SME training must be done during regular working hours.

The above recommendations, if fully implemented, should alleviate any SME training problems.

TST Model and Work Plan

By following the TST model, albeit not to the work plan schedule, the goal of producing a training package to get employees working at the demurrage activity in the carload centre was reached.

It can be concluded:

The Traffic Systems Training model for instructional systems development can be used to produce effective training.

This is not to say that it cannot or should not be improved. Therefore, each step in the model will be examined to determine any changes or adjustments that could be made to improve its efficiency:

1. Needs definition. As explained in a previous chapter, this step in the model is not carried out by Traffic Systems Training. The Traffic Systems Cabinet, of which the Manager, Traffic Systems Training is a member, is responsible for the

direction taken on all training within Traffic Systems. It is the sole client of Traffic Systems Training.

Given that the course produced on demurrage only had approximately 15 administrations in the 16 months it was available in the field (and at least two of these administrations were to management personnel who are not permitted to actually work at the job), it cannot be clearly demonstrated that a need existed for a training development project of this scale. The needs definition stage, given that it contains the process that initiates the projects, is a stage in the model that requires close attention.

It can be argued that few other options were available to the Cabinet. It was, after all, reacting to a request for training from the field. However, if it had been taking a longer-term view, it could at least have anticipated the format changes to the JF Assessment Report and combined the two projects. A possible reason for the short-sightedness in the decision to authorize the demurrage training development project is that training per se may just not be given a high enough priority by the Cabinet. To be frank, discussion on training does seem to pale somewhat when compared to decisions required on, say, meeting special requests from large and important customers such as General Motors, on labour unrest, or on computer purchases worth millions of dollars. One solution to this problem is to change training from a mere support function, and to tie it closer to bottom-line operational concerns; to direct the Cabinet's discussions not at training needs but at performance deficiencies and, moreover, to consider not only training development as a solution to the deficiencies but, rather, to consider a whole range of performance improvement interventions (e.g. job aids, reordering of job duties, adjustments to the environment, etc.). This process falls within the consultative role of the instructional technologist.

It is therefore recommended:

A needs assessment process must be adopted to provide the Traffic

Systems Cabinet with the information required to make appropriate and cost-effective decisions on interventions required to correct performance deficiencies.

This recommendation will entail the establishment of a needs assessment working group within Traffic Systems Training. This group will have to develop or adapt a practical needs analysis model to aid in the determination of employee performance deficiencies, and in the setting of priorities for subsequent performance improvement interventions. To ensure maximum efficiency, and acceptance by the field, the actual needs assessment studies will have to be undertaken as joint efforts by local management and System training personnel. The outcome will be a report, submitted to Cabinet, listing performance deficiencies and alternative solutions to correct them (e.g. training, revision of job duties, adjustment to environment, etc.) in order of priority, and with cost/benefit analyses attached.

In this way, expensive training development projects would only be undertaken when actually required. Furthermore, the Cabinet would not be relinquishing its decision-making prerogative; however, its decisions would be based on hard data, validated by both instructional technologists and field management, not merely on felt needs.

The beauty of this approach, if accepted, is that there will be many beneficial side effects. For example, Traffic Systems Training will expand its mandate beyond that of a mere support function and be tied closer to the daily operations of the company. Increased contact between System training and field personnel (both management and unionized) will reduce the alienation of the training group from the target population, increase the training group's expertise in field operations, and cut back on the perception of System as the *Ivory Tower*. In addition to this, it raises the possibility of quick fixes for minor problems. For example, if during a needs assessment study a minor problem

is uncovered and an intervention is diagnosed that can be implemented for, say, less than $5,000, it could be implemented without waiting for Cabinet approval. In this way, minor problems that in the past may have gone undetected or unheeded could be dealt with quickly and efficiently.

This is a recommendation requiring a major shift in approach by Traffic Systems Training, and could not be implemented without Cabinet approval. A proposal will therefore have to be made to Cabinet outlining the needs assessment model, and with a cost/benefit analysis attached. However, it is anticipated that the company can only gain by this proactive approach to detecting and correcting performance deficiencies.

2. Pre-analysis preparation. During pre-analysis preparation, Traffic Systems Training personnel are getting ready for the upcoming project, and for the arrival of the project team. Many of the duties in this stage require dealing with CN's bureaucracy, sometimes for good reason (e.g. expense account advances must be controlled). This can be very frustrating and time-consuming for someone who does not know the standard procedures and approaches required in this esoteric world.

It is therefore recommended:

As many administrative duties as possible (e.g. booking hotels, arranging advances, etc.) should be handled by Traffic Systems Training's administrative personnel.

In most cases when a bureaucratic obstacle is encountered, it is to these individuals whom the Instructional Development Specialist goes for aid and rescue anyway. Implementation of this recommendation will eliminate the possibility of the Instructional Development Specialist violating any standard procedures, and thus slowing down the administrative processes. Of course, the Instructional Development Specialist, as team leader, must be kept aware of the preparations, in case of events that can adversely affect

the project (e.g. if no suitable hotel rooms can be found). The Instructional Development Specialist should, therefore, be sent copies of all correspondence, and kept apprised of all relevant events. However, having the qualified administrative personnel directly responsible for all of the administrative activities will provide the Instructional Development Specialist with more time to prepare for and deal with instructional problems.

3. Team selection. One problem encountered at the team selection stage of the demurrage project was that the audiovisual presentation and supporting documentation used to solicit applicants neither gave a clear description of the ISD process nor of what type of work was expected from the individuals chosen as SMEs.

It is therefore recommended:

The material used to solicit applicants to be SMEs in training development projects, and to inform them of the duties and working conditions therein, must be revised.

Another more serious problem related to this stage was the selection of an SME for the demurrage project team who, although a master performer and very knowledgable of the subject, was incapable of applying his knowledge and skills to the requirements of the ISD process (e.g. by converting knowledge of actual work flows into flowcharts). It is anticipated that the doubling-up on tasks by SMEs and transfer of all creative writing to the Instructional Development Specialist, as outlined in a previous recommendation, will eliminate a recurrance of this type of problem.

A third problem encountered at this stage of the demurrage project was that the Instructional Development Specialist did not meet the team members in person until they arrived on Day 1 of the project. The interviews had been carried out by the Instructional Development Supervisor.

It is recommended:

Team selection interviews must be carried out jointly by the Instructional Development Supervisor and Instructional Development Specialist.

Although the Instructional Development Specialist for the demurrage project was inexperienced, his opinions during the interview process would have been beneficial to the outcome. The intensity of the work and the close relationship demanded of team members make team selection one of the most critical stages in a project. The cost of involving the Instructional Development Specialist in future interviews will be well justified.

4. Analysis. Many of the types of problems encountered during the analysis stage of the demurrage project should be corrected by implementation of the previous recommendations. Nonetheless, some adjustments can be made to this stage of the TST model to streamline the approach.

The following is therefore recommended:

Creation of a DACUM chart should be replaced by creation of instructional analysis diagrams.

The DACUM chart created in the demurrage project was not put to full use. DACUM charts are intended to be used to track the progress of individual apprentices through the acquisition of skills in their trades. Their observable performance of each of the skills listed on the chart is rated against a 7-point scale (e.g. 0 - *cannot* perform this task satisfactorily for participation in a work environment; 3 - can perform this task satisfactorily *without* assistance or supervision; 6 - can perform this task with more than acceptable speed and quality, with initiative and adaptability, and *can lead others* in performing this task) (Adams, 1975). Thus, the chart is used to track individuals'

progress on the job until they become master performers. The Manager, Traffic Systems Training, decided that this use of DACUM charts would not be accepted in the unionized carload centre environment and, therefore, restricted the chart's use to the instructional development project. Without DACUM charts for all classifications of unionized carload centre employees, his hypothesis was probably correct.

However, the group brainstorming session used to generate the DACUM chart was excellent; as reported earlier, it provided a simple introduction to ISD for the SMEs, and an ideal team-building environment for the Instructional Development Specialist. A more useful product of this brainstorming session, however, would be *instructional analysis diagrams* in the format proposed by Dick and Carey (1978). By using their "combination approach" to instructional analysis, the possibility can even be foreseen, in some instances, of eliminating the *task flowcharting* and *prepare task description worksheets* steps from the analysis stage, and the *specify learning hierarchies* step from the design stage. It is possible that sufficient information, previously obtained from these three steps, could be conveyed by the instructional analysis diagrams. Elimination of the three steps could possibly save up to 11 days of development time.

Another problem encountered by the Instructional Development Specialist during the demurrage project's brainstorming session was that he lacked knowledge of the carload centre environment, and of how the demurrage activity was practised in that environment. It is understood that instructional technologists will sometimes find themselves developing instruction in areas where they are not qualified to work or, as Bolletino (1980) states, a team leader need not be an SME. However, some acquaintance with the activity is not necessarily a bad thing.

It is therefore recommended:

Instructional Development Specialists should become acquainted with an activity in its environment prior to participating in a training

development project on that activity.

The point of this recommendation is not to make the Instructional Development Specialist a subject matter expert but, rather, to make the Instructional Development Specialist aware of the general nature and environment of the activity.

5. Design. One problem stands out above the rest in the design stage of the demurrage project: Even if a need existed for a training course on demurrage, the decision to use self-instruction to deliver the course cannot be justified given the large investment of time and money in its creation, and the infrequent use made of the final product.

It can be concluded:

The restrictions placed on the media selection (i.e. predominantly self-instruction) caused the development of a product that cannot be cost-justified.

As reported in a previous chapter, the final media selection produced four audiovisual modules, six audiotutorial modules, one job aid, and three lesson outlines. In hindsight, only one audiovisual module for overview and motivation purposes should have been developed, the other modules should have been developed as lesson outlines (i.e. guides to aid local instructors in preparing one-on-one training and coaching).

It is therefore suggested:

The only restrictions placed on media selection should be that the medium (or media) selected for delivery of a training course be capable of meeting the course objectives, and be cost-justifiable.

This recommendation is not carte blanche for developers to use just any medium: A decision to use classroom lecture/demonstration requires equipped classrooms and competent instructors; at this time, only six equipped classrooms are available in the

country for Traffic Systems personnel. A decision to use computer assisted instruction (CAI) requires both computers and computer programmers; both of these are expensive. Of course, depending on the situation and the circumstances, it may be possible to cost-justify transporting employees from remote locations to the classrooms and training instructors to teach them; or, it may be possible to cost-justify buying a large number of computers and hiring the programmers for CAI. The important point here is that all decisions should be cost-justified, and that prejudiced opinions on media choice should not be used to justify non-cost-effective decision making.

Another area in the design stage that bears examination is the classification of objectives into their learning categories (learning domains). As the literature is quite clear on the topic of learning categories and the benefits that ensue from their use, it is surprising that this step was overlooked for the original model. On the other hand, the final product of the demurrage project does not seem to be deficient, even though its development process lacked this step.

It is therefore recommended, on a trial basis:

Objectives should be classified by learning category.

Gagné's hierarchy (i.e. verbal information, intellectual skills, cognitive strategy, attitudes, and motor skills) seems both simple and comprehensive, and would serve to test whether this recommendation provides a worthwhile return on the investment of time and effort.

A third area in the design stage that could benefit from adjustments to the current procedures is the tryout of the test-item pool.

Butler's (1972) recommendation, as discussed in a previous chapter, to try out test-items on two groups (*untrained-unskilled* and *trained-skilled*) is excellent, but may prove to be too costly and time-consuming to be implemented by Traffic Systems Training. A compromise, however, is possible: The test can be tried out on a control

group during the formative evaluation and revision stage of the project.

It is therefore recommended:

Test-items should be tried out on a group of skilled employees during the formative evaluation and revision stage.

Unlike regular validation candidates, the group of skilled employees would not work through the prototype training material; they would just take the tests.

One final area worth noting in the design stage has already been discussed in a previous chapter, that is, the decision to expand the scope of the project during the step *select tasks for training development.*

It can be concluded:

The decision to expand the scope of the course to include the entire demurrage activity was one of the major causes of the project missing its deadline.

As already reported, a preferable strategy would have been to have kept to the original goal, and then have recalled the team at a later date to complete any outstanding training requirements.

It is recommended:

Any recommendations for major changes to the scope of a project should be subject to close review.

When the temptation arises to increase or decrease the scope of a project, it would be prudent to list all of the possible alternatives, to cost-justify each, and to make the final decision based on the facts. As stated earlier, rash decisions are easily made in the heat and emotion of a project.

6. Development. As the SMEs will no longer be writing the scripts and storyboards in the development stage of training projects (as stated in a previous

recommendation), this task will fall to the Instructional Development Specialist (with the assistance of one SME for consultation and technical editing). Script and storyboard development is a time-consuming activity and, unless aid for the Instructional Development Specialist is found, the rate of production will be slow.

It is therefore recommended:

When possible, a technical writer should be used to assist in the development of scripts, storyboards, and text.

This is not a simple recommendation to implement. Experience at Traffic Systems Training has proven that, due to the technical nature of the subject matter, free lance writers are not a viable option for assistance with module development except on basic or very simple subjects. On the other hand, CN technical writers (i.e. individuals possessing both railway background and good writing ability) are scarce. Furthermore, it is not a simple matter, even for an experienced technical writer, to just drop in part-way through a project; some committment of the writer's time would be required from the start (i.e. during analysis).

One other problem discovered during the development stage was that the treatments produced by the SMEs did not aid them in the writing of scripts and storyboards. As only one SME will remain for this stage, and all writing be done by an Instructional Development Specialist or technical writer, this should no longer cause a problem.

7. Production. As noted in a previous chapter, the contract audiovisual shop used in the production stage of the demurrage project made many small but important contextual errors that required close inspection of and revisions to the slides produced. CN's audiovisual shop is also known, occasionally, to make such errors.

It is therefore recommended:

Artwork should be checked by the Instructional Development

Specialist (and possibly a subject matter expert) at each step in the production process.

What this would entail is a check with the illustrators after storyboard creation, drawing outline, typeset production, and colouring of the artwork; and a check with the copy stand technician before camera work. The extra time and effort required by the Instructional Development Specialist to do the checking would ultimately save project time in that any production errors would be caught as soon as they were made, thus eliminating lengthy waits for corrections.

8. Formative evaluation and revision. In the formative evaluation and revision stage of the demurrage project, an attempt was made to complete the tryout of the entire course, including debriefing interviews, in three days. Some revision was even forced into this already very tight time frame.

When the course was released to the field, the advisor's notes that accompanied it indicated that it takes between 15 to 32 hours to administer. However, these advisor's notes also suggested that administration of the first part of the course (i.e. up to *Filing and Distributing Documents*, see Figure 5) should be spread over a one-week period. The reason for this suggestion was to ensure that the trainees did not become mentally fatigued, overloaded with information, and thus miss half of the teaching points. (See the results of candidate number 3 on Table 9 for a graphic example of what can happen when overloading occurs.)

It can be concluded:

Insufficient time was scheduled for formative evaluation and revision.

Formative evaluation is a costly venture. Over and above the project team's salaries, travel costs, and so forth, it requires a group of employees to spend time off the

job to act as validation candidates. Given this, it cannot be expected that unlimited time and resources be allocated for formative evaluation. On the other hand, the reason behind formative evaluation is to obtain feedback on the effectiveness of the training material before it is released to the field, as well as to catch any procedural or administrative problems; in other words, to invest in the present for a payoff in the future. If insufficient time is permitted to allow formative evaluation to be done properly, and self-instruction assumes that trainees have as much time as needed, then the practice may as well be dropped. As Bastian, Edward, Medsker, and Schimmel (1983) point out, however, a compromise is a better solution. Lowe, Thurston, and Brown's (1983) experience, and Wager's (1983) research (reported in a previous chapter) indicate that large numbers of validation candidates are not necessary if proper conditions are maintained during the tryouts.

It is therefore recommended:

Sufficient time must be scheduled for formative evaluation. However, as long as the validation candidates are drawn from different aptitude levels in the target population (e.g. high aptitude/high potential, average aptitude, low aptitude), then formative evaluation may be carried out on six or less employees.

Sufficient time for formative evaluation would include time for at least a half-hour break between modules.

Although it caused difficulties for the project team, the lack of time was not the major problem encountered in the formative evaluation and revision stage of the demurrage project. Rather, the lack of understanding of the process by the two regional training supervisors, and the consequent lack of preparedness of the validation candidates, had the greatest repercussions.

The selection, training, and qualification of regional training personnel are subjects

beyond the scope of this thesis. Suffice it to say that room for improvement exists in these areas.

Some headway, however, can be made in explaining to the field what is involved in formative evaluation.

It is therefore recommended:

A communications package must be developed to explain the concept of formative evaluation, and to outline to potential validation candidates what to expect if they participate in the formative evaluation of a training development project.

The communications package must also outline the necessity for validation candidates to be familiar with the conventions of the self-instructional training approach used by Traffic Systems Training. Discussion of the results of AV-T-B40A01 in the previous chapter outlined a disorientation felt by candidates unfamiliar with self-instructional training. To aid in overcoming the feeling of disorientation in trainees, the redundancy of instructions in the modules was increased. However, there is a point at which redundancy can be overdone (i.e. when it begins to annoy trainees who are familiar with the approach and the conventions, or when it makes modules too long). Therefore, the communications package would have to convey the message that validation candidates who have never taken a self-instructional training module must take one or two modules, in a subject of their choice, in order to become familiar with the process prior to participating in the actual formative evaluation.

9. Duplication and distribution. The majority of the work in the duplication and distribution stage of training development projects is handled by Traffic Systems Training's administrative section. In agreement with the recommendation from stage 2., pre-analysis preparation, as many administrative duties as possible (e.g. coding the

VRM) should be handled by these qualified administrative personnel, leaving the Instructional Development Specialist with more time to deal with instructional problems.

10. Monitoring and revision. The monitoring and revision stage of instructional development projects is the responsibility of the Instructional Development Analyst. The statistical package used to analyze the test scores of the modules administered in the field is of excellent quality, and serves its purpose well. At worst, it could be argued that it is too detailed, and that a smaller battery of statistical tests would produce equally useful results at a cheaper cost. However, the statistical package is not at question here, it is on the test-items whose scores that it analyzes where the key question arises: Are these test-items worth analyzing?

Given the available data, it is impossible to give a complete answer to this question. The efforts of Traffic Systems Training are concentrated on creating instruction that teaches well, instruction that uses most of the modern tools of instructional technology and all of the tricks of the audiovisual shop. Branson (1982) puts the problem this way:

> While instructional technologists overconcentrate their attention on media selection or the improvement of instruction, in the absense of content validation procedures they could easily be developing instruction on erroneous content. The user then learns bad content in a highly efficient manner. (p. 38)

He provides an excellent example to emphasize his point:

> Imagine the quality and gusto with which a course on Scientific Creationism could be developed. Thunder, lightning, bells, and blinding lights; multi-image in full stereo; revision and rumors of revision until that great ultimate criterion in the sky is achieved: All students score 100% on the posttest. A beautiful example of the craft, perhaps, but does that make it right? (p. 39)

This problem of teaching material that is worth learning loops back to the problem outlined in stage 1., needs definition. If no clear need is defined, how will it be known when the need is met? If no clear performance deficiency is defined, how will it be

known when the deficiency is corrected?

The establishment of a needs assessment team (from an earlier recommendation) should eliminate the majority of the problems here. However, it is still recommended:

Implementation of all training must be followed-up to ensure transfer of the training to the job, and to ensure content validity of the training material.

The follow-up could take the form of an annual inspection by the Instructional Development Analyst or the Instructional Development Supervisor, or even by a survey conducted by a properly trained regional training supervisor.

Summary

This thesis had, as a primary goal, to determine the strengths and weaknesses of the instructional development method used in Traffic Systems Training. It has fulfilled this goal. A secondary goal was to analyze the instructional development process within a commercial environment and to provide recommendations for future applications of instructional technology within industry. This goal has also been met and, although most of the recommendations are somewhat specific to Canadian National's Traffic Systems Training, they can easily be generalized to other industrial environments.

Since the demurrage project was completed by Traffic Systems Training, some of the recommendations have already been implemented; others still wait their time.

Many questions, however, remain unanswered; many areas remain to be studied. Within Traffic Systems alone, the following studies are required:

1. *Administrative features of Traffic Systems training.* Many complaints are received by Traffic Systems personnel on the administrative features of the training (e.g. completing the advisor's reports). An investigation of methods to streamline training

administration is needed (e.g. by computerizing the pre and posttests, etc.).

2. *Field administration of Traffic Systems training.* A study is required on how the advisors in the field actually administer the self-instructional training, and how they integrate the teaching points from the modules into the daily work routine of the carload centres. Are the advisors following the procedures outlined in the training manual? Given the rapidly changing environment, is the process of self-instructional training outmoded? These and many other questions have to be answered. Traffic Systems Training's alienation from its target population makes this an especially critical area for study.

3. *Selection, training, and qualification of regional training supervisors.* In many locations the training department is still a handy dumping ground for employees whose abilities do not meet the exigencies of the daily operations. It is felt, by some short-sighted management personnel, that these individuals will do the least amount of harm in a training department. In other locations, the training department is seen as a reward for an old and trusted employee who is not quite ready for retirement. In yet other locations, the training department is a convenient place to store a middle management employee who can be called upon in short notice to fulfill other apparently more critical duties. These few sad facts are not a general condemnation of training within Canadian National; these conditions do not, thankfully, exist throughout the corporation. Someone, after all, had the courage to introduce instructional technology into Traffic Systems Training. Much work remains to be done, however, before CN can be proud of all of its training departments. A study on the selection, training, and qualification of regional training supervisors within Traffic Systems would go a long way towards meeting this goal.

Within Canadian National as a whole, the following study is required:

4. ***Inter and intradepartemental communication.*** There is a perceived lack of

communication between, and even within, departments, divisions, functions, and subfunctions in CN. Why else did Traffic Systems Operations not communicate the intended changes to the JF Assessment Report to Traffic Systems Training during the training development project?

Within industry as a whole, the following is required:

5. *Case studies on training development projects.* An underlying hypothesis of this thesis has been to demonstrate that there is a place for instructional technology in a commercial environment, and to establish that a training department can follow the potentially conflicting goals of the principles of instructional technology and the principle of return on investment (ROI). I believe that it has gone some distance towards supporting this hypothesis, and that when the application of instructional technology did not meet its ROI was when its principles were not followed (e.g. by not conducting a proper needs assessment). More study is required, however, in the research of training and the application of instructional technology in industry. For any training manager who balks at this suggestion for reasons of the time and effort required to execute it, it should be noted that the exercise of researching and writing this thesis had several side effects beneficial to the operation of the department. The documentation of each step in the project that was used to reconstruct the events for the case study also served to bring to light certain facts that may otherwise have been overlooked, and thus forgotten in the rush to move on to the next project. By putting them in writing they will always be there to generate discussion, to aid in avoiding the repetition of errors and, ultimately, to act as a catalyst for change.

Final Conclusions

Transportation Training, the inheritor of the legacy, both positive and negative, of Traffic Systems Training, has a clear mission statement: *To improve performance and productivity in the Transportation function by developing its human resource potential through training and other performance improvement interventions.*

Towards this end, the dual masters of instructional technology and ROI are being served. As instructional technologists, we are searching for algorithms, heuristics, and replicable techniques that follow the principles of educational technology; as CN employees, we are attempting to get the job done within the parameters specified by our executive. As Leonard puts it:

> Pedagogical ideals aside, instructional effectiveness cannot be realistically measured without simultaneous reference to both economic considerations and educational outcomes. (p. 26)

The future of deregulation in the Canadian railway industry, the downsizing of the company, the increased computerization, and so forth, are all desecration in some people's eyes of the traditions of railroading. These various events are also creating a tremendous challenge for CN employees to survive and thrive and, if nothing else, promise to make the next few years interesting ones. It is a cliché that nothing succeeds like success; questionable grammar aside, it is also true. The only way to succeed, therefore, is to develop and follow strategies that achieve the department's mission of improving performance and productivity. It is my hope that this case study conveys the message that the direction of Transportation Training is set, and that we are on the right track.

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Appendix A

Please fill out this Questionnaire in your own handwriting.

BACKGROUND INFORMATION FORM

Last Name_____ First Name_____ SRB_____

Occupation_____ Location_____

Home Address_____

_____ Telephone_____

Date of Birth_____ Date Entered CN_____

Supervisor's
Name _____ Title_____ Location_____

CONFIDENTIAL

A. EDUCATION AND TRAINING

Circle highest grade completed:

Grade School	High School	College or University
6 7 8 9	10 11 12 13	1 2 3 4 5

Name & Location of High School _____

Name & Location of College or Univ. _____

Degree and Dates _____

Age Completed Grade School _____ High School _____ College/Univ. _____

Favourite School Subjects _____

Least Liked _____

Activities & Class Offices _____

_____

Additional Courses: CN sponsored and Others (Correspondence, Night School, etc.)

Type of Course	Subject	Results	Date

B. BACKGROUND DATA

Languages: Written Spoken

English ☐ French ☐ English ☐ French ☐

Other ☐ Other ☐

Marital Status:

Single ☐ Married ☐ Separated ☐ Divorced ☐ Widowed ☐

Number of Children: _____

Any personal constraints on accepting a temporary assignment in Montreal?

_____

_____

_____

How do you spend your free time?

_____

_____

_____

What vacation entitlement do you have? _____

Scheduled for _____

How firm are your vacation plans? _____

C. **EXPERIENCE**

Work Experience - CN

Position	Location	From Year	To Year	Significant Work Experience

Other Employment

Position	Location	From Year	To Year	Significant Work Experience and/or Military Service

Other significant experience, interests or activities that involve organizing or leadership:

_____

_____

_____

What aspects of your present position do you like? Dislike?

_____

_____

D. CAREER PLANS

What career plans do you have for the future? (5 yrs.) Include any academic plans

Do you feel that you have specific skills or qualities to enable you to function in the Transportation Training group? Elaborate.

What do you feel would be the advantages/disadvantages to accepting a temporary position (3 months) with the Transportation Training group?

E. AUTOBIOGRAPHY

Write a short autobiography. Include the accomplishments you are most proud of.

(if necessary, use back of page)

Appendix B

CANDIDATE'S NAME _____ TITLE & LOCATION _____

Please supply pertinent information which will help us assess potential of candidate by checking the boxes next to the best description of the candidate.

SUPERVISOR'S COMMENTS ON CANDIDATE

	INTEREST IN WORK				
1	[ ] High interest in job. Very enthusiastic.	[ ] More than average amount of interest and enthusiasm for job.	[ ] Satisfactory amount of interest and enthusiasm for job	[ ] Interest sporadic. Occasionally enthusiastic	[ ] Little interest or enthusiasm for job.
	INITIATIVE				
2	[ ] Self starter. Asks for new jobs. Looks for work to do.	[ ] Acts voluntarily in most matters	[ ] Acts voluntarily in routine matters	[ ] Relies on others. Must be told frequently what to do	[ ] Usually waits to be told what to do next
	ORGANIZATION & PLANNING				
3	[ ] Does an excellent job of planning and organizing work.	[ ] Usually organizes work well.	[ ] Does normal amount of planning and organizing.	[ ] More often than not fails to organize and plan work effectively	[ ] Consistently fails to organize and plan work effectively.
	ABILITY TO LEARN				
4	[ ] Exceptionally quick.	[ ] Quick to learn.	[ ] Average.	[ ] Slow to learn	[ ] Very slow to learn
	QUALITY OF WORK				
5	[ ] Very thorough in performing work. Errors very few, if any.	[ ] Usually thorough. Good work. Few errors.	[ ] Work usually passes review. Has normal amount of errors	[ ] More than average amount of errors	[ ] Work usually done in careless manner. Makes errors often
	QUANTITY OF WORK				
6	[ ] Highly productive in comparison to others.	[ ] More than expected in comparison with others.	[ ] Expected amount of productivity.	[ ] Less than expected in comparisons with others	[ ] Very low in comparison with others.
	JUDGEMENT				
7	[ ] Exceptionally good decisions based on thorough analysis of problem	[ ] Above good common sense. Usually makes good decisions.	[ ] Judgement usually good in routine situations.	[ ] Judgement often undependable	[ ] Poor judgement. Jumps to conclusions without sufficient knowledge
	RESPONSIBILITY				
8	[ ] Can always be depended upon in any situation	[ ] Can usually be depended upon in most situations.	[ ] Can be depended upon in routine situations.	[ ] Somewhat unreliable. Needs above average checking	[ ] Unreliable
	RELATIONS WITH OTHERS				
9	[ ] Always works in harmony with others. An excellent team worker	[ ] Congenial and helpful. Works well with associates.	[ ] Most relations with others are harmonious under normal circumstances.	[ ] Difficult to work with at times. Sometimes antagonizes others.	[ ] Frequently quarrelsome and causes friction
	WORKING UNDER STRESS				
10	[ ] Reacts positively under stress. Assumes leadership	[ ] Functions above average under stress situations.	[ ] Is unaffected under stress. Continues to function normally	[ ] Functions poorly under stress. Assumes passive role.	[ ] Cannot function effectively under stress

TENACITY

11 [ ] Sticks to task regardless of difficulty or outside influence. [ ] Sticks to task in most situations. [ ] Is not diverted from task under normal circumstances. [ ] Is easily diverted from task. [ ] Needs constant supervision

IMAGINATION

12 [ ] Has had sound creative suggestions in office procedures, new ideas for work flow, etc. [ ] Has come up with occasional ideas to improve surroundings. [ ] Has had no input in these areas.

CAN THE CANDIDATE

13 a) Set priorities? Yes [ ] No [ ]

b) Handle more than one major activity at a time? Yes [ ] No [ ]

COMMUNICATION SKILLS

14 Written Expression [ ] Very Good [ ] Good [ ] Satisfactory [ ] Needs Improvement

Oral Expression [ ] Very Good [ ] Good [ ] Satisfactory [ ] Unsatisfactory

ACCEPTANCE OF CRITICISM & SUGGESTIONS

15 [ ] Appreciative or willing [ ] Resentful or reluctant

GROOMING

16 [ ] Appropriate [ ] Inappropriate

ATTENDANCE

17 [ ] Regular [ ] Irregular

PUNCTUALITY

18 [ ] Regular [ ] Irregular

19 How long has this employee worked under your supervision? _____

20 How much current experience has the candidate in the subject proposed for training development? _____

Date

Title

Rated by

COMMENTS ON OVERALL PERFORMANCE

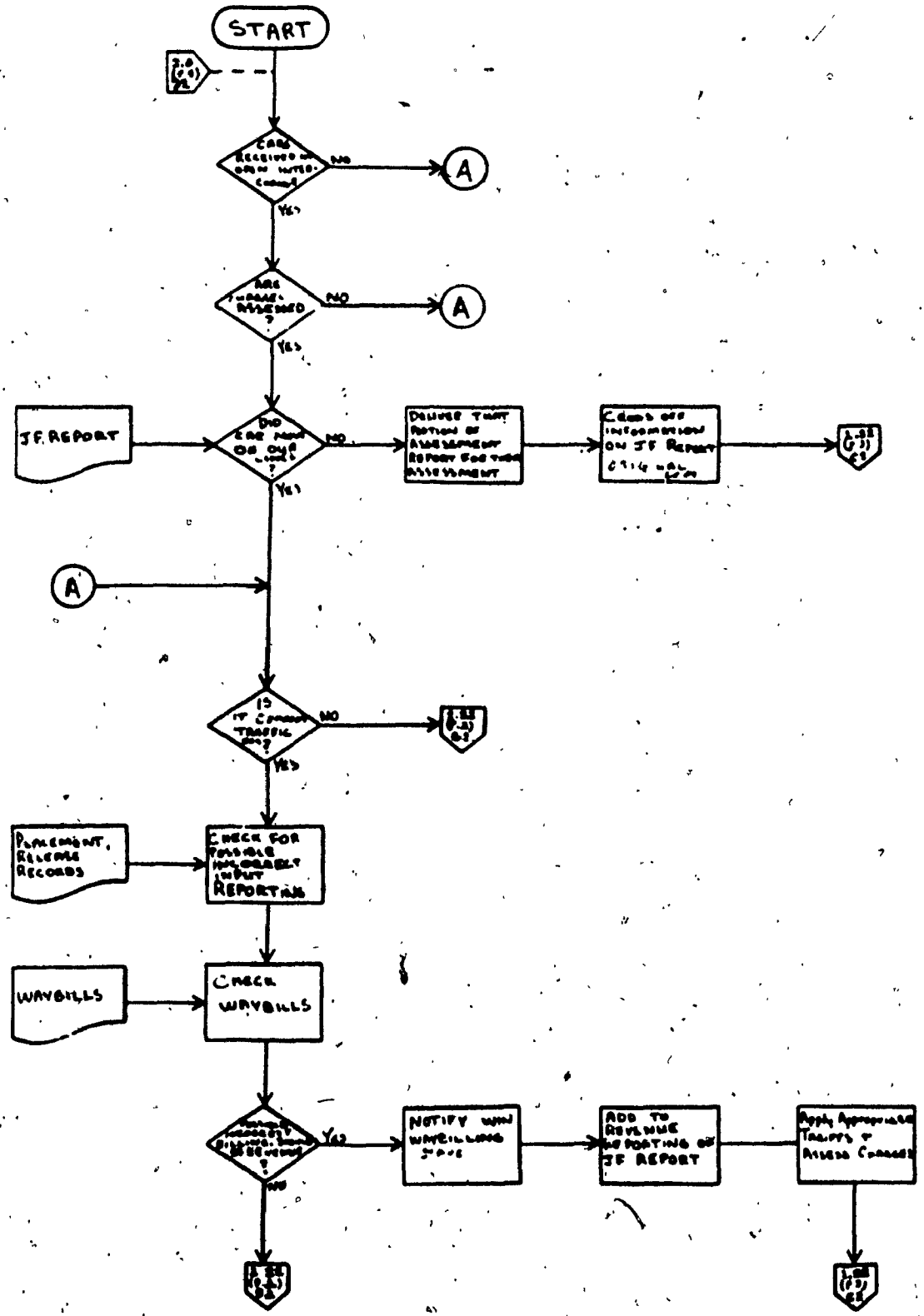
Opinions on potential, examples of ability, job knowledge, ability to follow through, etc.

Appendix C

IBM Flowcharting Worksheet

Programmer: V. Nortney Program No.: D-1 Date: Oct 8/80 Page: 1 of 5

Chart ID: 2.2.2 Chart Name: Apply Appropriate Taxes & Assess Charges Program Name: Handling Shipment Summary Information



TASK DESCRIPTION SHEET

Page 1 of 3 Pages

Task No. 3.0 Task Title PROCESS THE ASSESSMENT REPORT

Sub-Task No. 3.22 Sub-Task Title Apply appropriate tariffs & assess charges (other charges)

No. of Steps (this sub-task) 17

Difficulty 3
Hazard 2
Criticality 2
Duration 15-30 min
Frequency as req'd

Analyst V. Northey Date 19-10-80

Approved by S.R.S.

Date 20-10-80

Step No.	Description	Initiating Input (Information, Equipment, etc.)	Info Processing Decision Making	Output Action	Equipment, Material, etc.	Feedback	Comments
1.	Handling cars received in open interchange	Need to check if car received in open interchange	Cars received in open interchange? If yes, go to next step. If no, go to step 6	Verify if car received in open interchange	Interchange records	Cars received in open interchange	See I.P. Manual 81JA01 for definition on open interchange
2.	Verify if charges assessed	Need to check if assessed	Are charges assessed? If yes, go to next step If no, go to step 6	Verify if charges assessed	J.F. report	Charges assessed to cars received in open interchange	
3.	Charges assessed to cars received in open interchange that did not move on our lines	Need to check if cars moved on our lines.	Did cars move on our lines? If yes, go to step 6 If no, go to next step	Verify if charges assessed to cars received in open interchange	J.F. report	Cars did not move on CN lines	
4.	Deliver that portion of assessment report for their assessment	Need to deliver portion or information on J.F. report to other railway for assessment		Deliver portion or information on assessment report to other railway for assessment	Photocopy J.F report Telex	Portion or information assessment report delivered to other railway	See I.P. Manual 40C02 page 2 for more details on assessing cars received in open interchange
5.	Cross off information on J.F. report	Need to show information and/or charges not applicable on J.F. report		Cross off information on J.F. report (original only) Go to end	J.F. report	Information crossed off on J.F. report	Only a light line should be made over entry so that it is still readable with a notation opposite entry explaining why deleted.
6.	Handling company traffic (O.C.S.)	Need to check if it is company traffic	Is is company traffic If yes, go to next [illegible] If no, go to step 14	Verify if company traffic (O.C.S.)	Waybills	Company traffic	
7.	Check for possible incorrect input reporting	Need to check if reporting input correct		Check for possible incorrect input reporting	Placement release records etc.	Input record checked	
8.	Check waybills	Need to check reporting on waybills		Check waybills	Waybills	Waybills checked	