Training CN Technical Content Experts in Task Analysis: Production and Evaluation of a Module

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ABSTRACT

Training CN Technical Content Experts in Task Analysis: Production and Evaluation of a Module

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A training module was designed and developed to enable technical content experts involved in task analysis for CN Transportation to describe tasks that make up their jobs in the form of algorithmic flowcharts. An existing training module had been found to be ineffective in meeting expected performance requirements. A complete analysis of the problem was done and recommendations drawn as a basis for subsequent design of revised training materials. A revised module consisting of a 20-minute audiovisual filmstrip presentation with an associated workbook, and a lesson plan to guide instructors in a follow-up group practice session, was designed and developed. Formative evaluation was conducted with a team of four subject matter experts, using post-tests, embedded tests as well as questionnaires designed specifically to evaluate the module. Strenghts and weaknesses of the module re: content, sequence, quality of materials and implementation of instructions, were studied and recommendations drawn for improvement of the module. While the module was found to be generally effective in meeting stated objectives, weaknesses in instructional materials pointed to the importance of having access to naïve learners from the target population and current technical content expertise during the design of materials if the level of instruction is to be appropriate and if technical content is to be accurate. It was concluded that the merits of training technical content experts in task analysis be evaluated in the light of the quality of technical experts available.

Dedicated to my parents, in appreciation for the years of love and hard work that went into providing me with an education.

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CHAPTER I

STATEMENT OF THE PROBLEM

Keeping up with training requirements to maintain a work force that is technically current is a major concern for industry in the 1980's. If industry is to be competitive and indeed survive in an international marketplace, it must acquire and maintain skills and knowledges that will enable it to keep up with a rapidly changing technology. This last decade has seen many attempts at increasing the efficiency in the design and development of technical training materials to meet those needs. Some of these efforts have focused on improving the instructional design process, as witnessed by the dozens of instructional design models that have been developed in the last few years (Andrews & Goodson, 1980; U.S. Air Force 50-58, 1979). More recent efforts have concentrated on multiplying the impact of the individual designers by training technical content experts to perform as instructional designers with minimum consultant assistance (Terrell, 1983). The latter approach was adopted by the Transportation division of Canadian National Railways. This thesis-equivalent provides an account of the design, development and evaluation of a training module aimed at teaching subject matter experts (SMEs) from CN

Transportation how to describe the tasks that make up their jobs in the form of algorithmic flowcharts.

Background

Faced with rapid and massive computerization of their operations, CN Rail Transportation mandated their Traffic Systems training department (henceforth referred to as Servocenter Training) to produce good, technically accurate, self-instructional training programs for distribution to regional carload centers across the country within the shortest possible delay. These programs were to cover numerous complex procedures and work activities related to recent computerization of their traffic systems (this refers to systems for moving freight cars between one place and another, quantity, intensity and rate of such movement, related charges and documents). In an attempt to increase the efficiency of design and development of their materials as well as to ensure their technical accuracy, Servocenter Training decided to train SMEs from carload centers across the country in the Instructional Systems Design (ISD) process (U.S. Air Force 50-58, 1979) and have them perform as instructional designers with minimal guidance from their staff of Instructional Technologists (IT).

SMEs were typically train movement clerks whose everyday duties were clerical/technical in nature. None had any teaching or training background nor had any of them ever been involved with course design. SMEs were selected primarily on the basis of their technical expertise in a particular area of traffic systems operations (e.g. waybilling, demmurage, etc.). They were brought in to the Servocenter training department on temporary assignments to develop, in teams of 4 experts, training programs in their particular field of expertise. Following instruction on the ISD process and as acting instructional designers, SMEs were expected to conduct task analysis, write objectives, derive criterion test items to match objectives, derive course outlines and teaching points based on learning hierarchies and develop self-instructional training programs in various media, at least in rough draft form. Due to union agreements, temporary assignments of this nature could not exceed 90 days. In order to increase SMEs' productivity and decrease the amount of time spent on training during the 90 day allowance, Servocenter Training Management dictated that training on the ISD process would be provided in self-instructional modules that SMEs could study in their home locations after working hours, prior to their coming on the assignment to the Servocenter Training location. There were however, provisions for periodic 1 day group sessions guided by a qualified IT at the Servocenter Training location to supplement self-instruction.

The Problem

As Servocenter Training personnel were not available to develop the self-instructional modules, a request was made to the Corporate Training group of the Human Resources department to generate the training. A series of 24 training modules was thus produced.

Part 1 of the series consisted of 3 self-instructional modules on Task Analysis, each of which dealt with one of the activities Servocenter Training engaged in at that phase of the ISD process: DACUM, Flowcharting and Task Descriptions. Two teams of 4 SMEs who had studied the modules were simultaneously brought in to Servocenter Training to conduct Task Analysis in their respective areas of expertise. Having identified, through the DACUM process, tasks that make up their jobs, they were then expected to describe these tasks in the form of algorithmic flowcharts.

Although the SMEs performed at mastery level on the module content, they were unable to generate flowcharts without considerable assistance from the ITs. More often than not, their work had to be completely redone. This ran counter to the objective of increased efficiency pursued by Servocenter Training. Management questioned the effectiveness of the existing training module on

Task Analysis/Flowcharting and requested that Human Resources develop a new module that would enable their SMEs to perform as expected. The entire ISD process is documented in the chapters which follow.

Rationale

All too often, trainers receive a request for training because there is a "problem". The trainer is expected to provide instructional materials that will hopefully eliminate the problem. Before launching into the production of expensive training materials, the need for instruction must be carefully assessed. If the problem is due to a deficiency of knowledge or skills, training may be the solution. If however, the cause lies elsewhere in the system (in lack of proper role specification, inadequate selection procedures, working conditions, etc.), a training solution is inappropriate and design efforts are wasted.

Specialists in the systematic design of instruction such a Friesen (1973), Gagné (1979), Mager (1970) and Romiszowski (1981) agree that it pays to identify the need for instruction, and to conduct a systematic front-end analysis of the performance problem. From this flows identification of the solution, a component of which may be training.

Of the 24 self-instructional modules that had been designed to train CN technical content experts on the ISD process, the module on Task Analysis/Flowcharting was singled out by Servocenter Training management as particularly ineffective. At first sight this evaluation seemed puzzling as the average post-test score obtained by 8 SMEs who had studied the module was highly satisfactory (91%). The actual source of the stated dissatisfaction resided in SME's difficulty in performing as expected on the job. Despite instruction, SMEs were unable to generate flowcharts of their jobs without considerable assistance from the ITs, and more often than not, their work had to be completely redone. Servocenter Training management suggested that a new training module was the solution to this problem.

Was the SME's performance problem due to inadequate training or did the cause lie elsewhere in the system? A problem analysis process (Friesen, 1973) was carried out to answer some of these questions. The process pointed to two main contributing causes of the performance problem:

1. Inappropriateness of existing materials. The existing module dealt with application of flowcharting rules but failed to teach problem-solving skills required to

generate algorithmic flowcharts. In addition, it failed to link the flowcharting activity to the purpose of task analysis;

2. Unrealistic performance expectations placed on technical content experts. SMEs were typically selected from the unionized ranks. Their regular jobs involved strict and repetitive application of set procedures. It was therefore unrealistic, in a very short period, to expect them to develop the analytical problem-solving skills required to develop algorithmic flowcharts of tasks that make up their jobs.

Despite the author's aforementioned concerns about unrealistic performance expectations and quality of SMEs, Servocenter Training Management considered that a revised training module could improve SME's performance. Setting aside the possibility that this decision was incorrect, additional constraints for the subsequent design were established by Servocenter Training:

1. The module had to be self-instructional, administered after working hours. It was expected to be no longer than 4 hours so that it could be studied in one sitting.

There was, however, possibility of a follow-up group practice session of no more than 1 day, guided by a qualified IT;

2. Choice of media was restricted to approved format including print, a.v. filmstrip, and audio-cassette or combination of the above. This was a function of the delivery capabilities for self-instructional programs in local offices;

3. All training materials had to meet the 90/90 criterion of effectiveness: 90% of the students had to obtain 90% on the post-test. This was the standard for all Servocenter training programs;

4. Content had to reflect railroad reality, and use work related examples;

5. The module had to be delivered as soon as possible, before the next team of SMEs was to come in. Specific time frames were not given.

The following resources were provided to assist in the design of the module:

1. ISD process and content experts: Instructional Technologists from Servocenter Training and Corporate Training were available whenever necessary throughout design and evaluation;

2. Technical content experts: The Instructional Design Supervisor of Servocenter Training who had worked in carload centers for many years was mandated to verify technical accuracy of work related examples;

3. Target SME population: 2 SMEs were available during needs identification and 4 for the small group evaluation of the final draft of the program. There was no access to the target population during the actual design. The Manager of Servocenter Training identified his Instructional Design Supervisor as representative and knowledgeable of the target population. He was seldom available but cooperative and valuable when he was.

4. Audiovisual production experts: an illustrator, a graphic artist and a recording artist were provided as well as full access to professional production facilities.

These then were the strict parameters within which the design and evaluation of the revised training module had to be conducted. The problem therefore was to develop an effective module that would enable SMEs to develop algorithmic flowcharts of tasks that make up their jobs, within established constraints. The following chapter will examine the theoretical basis upon which the subsequent design and evaluation of this revised module was formed.

CHAPTER II

REVIEW OF THE LITERATURE

In this chapter, the current status of research on the use of algorithms, and specifically flowcharts, in task analysis is examined. This provides useful insight into the nature of expected performance and serves as a theoretical basis for the content of the module. A second section reviews relevant research regarding the problem of training SMEs in task analysis. In the final section, relevant research on instructional design, media selection and formative evaluation is looked at extensively as a theoretical basis for the production and evaluation of the revised module on Task Analysis/Flowcharting.

The Use of Algorithmic Flowcharts in Task Analysis

The first step in the systematic design of instruction is to identify "what" to teach. The purpose of task analysis is to "determine the subskills or component operations which are required to learn and/or perform a task and to identify the inter-relationships between sub-tasks" (Merrill, 1977, p.101). Gagné (in Briggs, 1977) has identified three components to task analysis:

1. Information processing analysis of the human performance, to reveal its sequence of mental operations;

2. Task classification, categorizing the type of learning outcome represented by the task, as a means of identifying necessary conditions of learning; and

3. Learning task analysis of the performance and of its mental operations, to reveal the prerequisites of learning and desirable sequence of learning events.

(p.115).

The first kind of analysis, information processing analysis, is a necessary first step to undertake when no accurate description of the expected human performance is available. It is conducted for the purpose of revealing the sequence of physical and mental operations to do a job. Performance of any job, even a job generally regarded as manual or procedural, involves a cognitive component and requires solving problems or making decisions (Landa, 1982). In simple jobs, these decisions may not be numerous and not very difficult but, without the ability to make them, one cannot do the job. Information processing analysis seeks to identify the specific operations and decisions executed in the performance of a task. It also reveals the order in which

operations are to be performed. The process normally consists of observing an individual performing the task and asking him/her to "think aloud" while he/she is doing it; detailed notes are recorded concerning the information or objects operated upon, the specific operations being performed, and all decision points encountered (Merrill, 1976, 1980; Reigeluth and Rodgers, 1980; Gagné and Briggs, 1979; Scandura, 1973). The result of information processing analysis is a task description: a list of all the operations the learner must perform in order to succeed in a task.

Instructional designers often face the problem of representing types of information collected in task analysis. Coscarelli (1978) has made a strong argument for the use of flowcharts in representing complex procedural operations when accuracy and speed are of prime consideration. In fact, use of the process/decision flowchart as a training tool was perfected by Lewis and Horabin under the monikor "algorithm" (1967). An algorithm can be defined as "a precise, generally comprehensive prescription for carrying out a defined (...) sequence of elementary operations (...) in order to solve any problem belonging to a certain class" (Landa, 1974, p.11).

Merrill (1976) and Scandura (1973) have proposed an algorithmic approach to task analysis. This approach is consistent with the structural theory of learning. According to this theory, all behaviour may be generated by rules, and a rule is essentially considered to be an algorithm for generating a set of responses for a corresponding set of stimuli (Scandura, 1971). An algorithmic task analysis thus consists of decomposing a rule into its component steps. The resulting task description is an algorithmic prescription that is:

1. a list of all the operations the learner must perform in order to succeed at a terminal task (Reigeluth and Rodgers, 1980);
2. a model of human thought processes corresponding to the sequence of operations (Merrill, 1977);
3. strongly guaranteed to give correct results under real-life conditions of usage, and;
4. communicable to anyone who needs to know about it (Lewis and Horabin, 1977).

It has been suggested that certain kinds of algorithmic task descriptions are best represented and communicated not by means of conventional prose, but by means of pictoral and graphic devices such as flowcharts and list structures (Coscarelli, 1978; Horabin and Lewis, 1977; Merrill, 1977). The flowchart derives its strength from the clear way it separates different kinds of information: questions (cognitive operations) are visually

distinguished by being placed in separate diamond shapes, and manual operations are identified as those placed in rectangle shapes. When used as a job aid, the flowchart simplifies the reasoning process for the users (Harless, 1980). Instead of leaving them to find their own way through a mass of tiresome prose, the flowchart provides a minimum sequence of simple, yes/no, questions. Each answer automatically routes them to the next question until the entire task is successfully performed. In fact, accuracy of algorithmic flowcharts that are produced through information processing analysis can be empirically tested by having an individual follow the algorithm in attempting to perform the task (Merrill, 1977).

Training SMEs in Task Analysis

As outlined in the previous section, information processing analysis is usually carried out by an analyst observing an expert while performing a task. The analyst uses conversational and observational methods which can allow certain kinds of (mainly technical) know-how to be successfully exteriorized and described as an algorithmic flowchart. It has been suggested that some efficiency can be gained if the one doing the analysis is also competent at performing the task. If so, the analyst may observe his/her own operations by introspection (Merrill, 1980).

Few attempts at training SMEs to conduct task analysis have been reported in the literature. One interesting effort has been undertaken and described by the Training Analysis and Evaluation group (TAEG), working for the U.S Chief of Naval Education and Training (Terrell, 1983). Faced with a tremendous demand for course development due to technological change, the TAEG has opted to train SMEs to perform some of the "routine tasks that make up the craft of instructional design" (p.35). These routine tasks include specific techniques for instructional design activities such as task analysis, writing objectives and tests. Whereas the "professional tasks" which require creativity, experience and interpersonal skills are left to experienced instructional designers, SMEs are provided with algorithms to assist them in the implementation of instructional strategies and actual performance of these tasks. The article reports in detail on algorithms that were developed for the evaluation of materials and production of job aids. However, no information is provided on the content of the algorithm for task analysis (on what part of task analysis is considered a "routine task"), nor on the effectiveness of the algorithm in enabling SMEs to perform as expected. Elaborate procedure documents have been produced by the U.S. military (U.S. Air Force 50-58, 1979) and a variety of manuals and articles have been written to guide novice instructional designers in flowcharting for task analysis (Bell and Abedor, 1977; Cram, 1980;

Davis, Alexander and Yelon, 1974). While these are useful sources of information for SMEs, they by no means constitute systematic training.

Landa (1974) has made a strong case against using SMEs to develop algorithmic flowcharts of tasks that make up their jobs. He argues that expert performers often cannot describe exactly how they do their jobs: they are not conscious, or not completely conscious, of their own operative processes. While they are aware of the subject of their actions i.e. the content of what they learn and apply, they are largely unaware of how they operate with the content, what they cognitively do with the knowledge. Landa further contends that use of SMEs to develop algorithms has often resulted in the production of incomplete and inaccurate procedures documents which cannot qualify as true algorithms. In order for them to develop "real" algorithms that would be of practical use, SMEs would have to learn "how to break down the cognitive process into relatively elementary operations" (p.13). What is required then it to teach SMEs problem-solving skills that will enable them to discover the manual and cognitive operations inherent in the performance of their jobs.

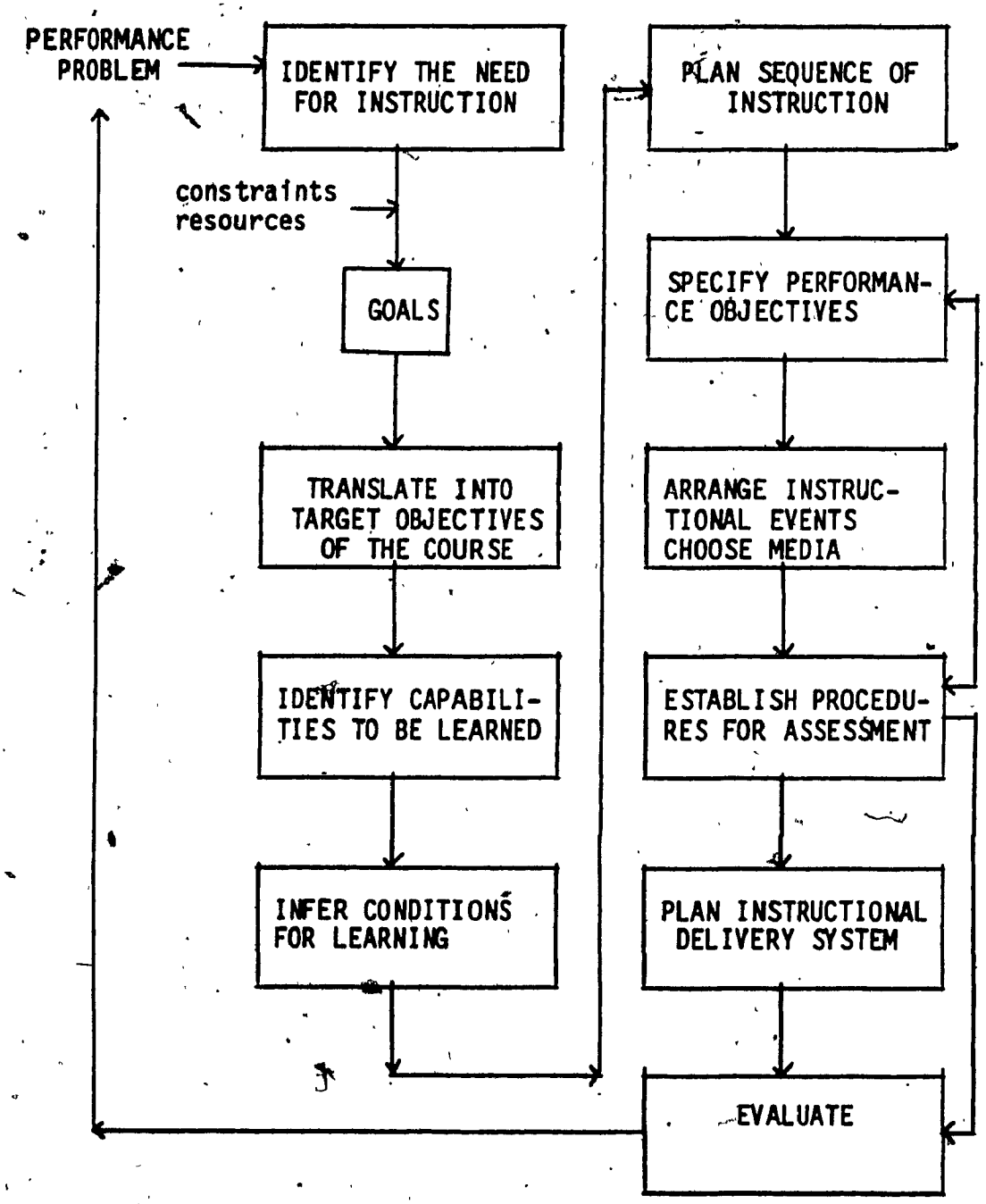
Instructional Design

Research in and application of instructional technology has demonstrated that the effectiveness of instructional design can be improved when it is done in a planned and systematic way. The "systems approach" to instructional design is now widely used in industry and in the military. Briggs (1977) defines the instructional systems design approach to developing a course/program as "the planning of instruction in a highly systematic manner where all components of the system (objectives, instructional materials, tests, etc.) are considered in relation to each other in an orderly but flexible sequence of processes; the resulting delivery system is tried out and improved before widespread use is encouraged" (p.xxi). The last decade has seen a proliferation of books and articles that describe in great detail the processes involved in using the "systems" or systematic approach to instructional design (Briggs, 1977; Davis, Alexander & Yelon, 1974; Dick & Carey, 1978; Gagné & Briggs, 1979; Romiszowski, 1981). The basic approach that was used in the production and evaluation of this module was the Instructional Systems Design process outlined by Gagné & Briggs (1979). A model of that process is illustrated in Figure 1.

Figure 1

Gagné & Briggs, 1979

Instructional Systems Design Model



Underlying Gagné & Briggs' instructional systems framework is the rationale that design rests on identification of capabilities and skills to be learned, rather than on subject matter. The basic approach involves identifying at the onset which type of capability is required. As flowcharting requires that SMEs interact with the environment by using symbols, the capability they had to acquire was characteristic of intellectual skills (Gagné, 1977). The type of intellectual skill was further specified as that of problem-solving or "higher-order rule", a skill that would enable SMEs to discover the cognitive operations and problem solving devices inherent in the performance of their own jobs (Horabin and Lewis, 1977). Once the type of intellectual skill is identified, more precise specification of sequence involves tracing backward from the outcome of learning to identify intermediate or prerequiste capabilities that must be met at each step to ensure learning of the next capability. Gagné's (1977) Hierarchy of Capabilities in the intellectual domain is useful in identifying sequence of prerequisite capabilities in order of complexity. Based on the hierarchy, it was established that in order for SMEs to acquire problem solving skills that could be applied to generating of algorithmic flowcharts of the tasks that made up their jobs, they would first need to be able to discriminate between flowcharting symbols. They would then need to acquire and recall concepts of task analysis and flowcharting,

followed by the capability to use flowcharting rules. When, and only when, SMEs had acquired these capabilities could they move on to learning of problem-solving skills.

The next step in the design process involves translating capabilities and prerequisite capabilities into performance objectives. These define what learners will be able to do at the end of a course in terms of observable behavior. Gagné's taxonomy of learning outcomes was used to develop objectives because it relates directly and specifically to the learning and teaching of each type of capability in the hierarchy (Briggs & Wager, 1981). Objectives statements also state measurable standards and criteria for performance (Mager, 1975). These provide a basis for the design of criterion-referenced assessment procedures of what students will have learned as a result of instruction (Popham, 1969). Would SMEs be able to generate descriptions of the tasks that make up their jobs in the form of flowcharts in the appropriate sequence, with all steps flowcharted as a result of instruction? Recent studies have demonstrated that the only test that could prove the accuracy of an algorithmic flowchart is to have it used as a job aid in the correct performance of a simulated task (Merrill, 1977). For this reason, criterion of effectiveness of the module in meeting the overall performance objective was established as mastery (100%). Criterion of

effectiveness for the self-instructional part of the module in meeting sub-objectives was maintained at 90/90 as had been specified by Servocenter Training.

Once this has been done, the design effort can concentrate on developing the instructional strategy. It describes general components of instructional materials and procedures to use with these materials in order to elicit the desired learning outcomes. The major components of an instructional strategy have been identified by Dick & Carey (1979) as: preinstructional activities, information presentation, trainee participation, testing and followthrough. Because of SMEs' fear of failing and high anxiety in undertaking task analysis, particular attention was paid to increasing their motivation level in the preinstructional activities: this was done by showing the SMEs what they would be able to do at the end of the program as well as reminding them of knowledge they had already acquired which related directly to what they were about to learn, thereby making instruction more meaningful to them (Briggs, 1977). Given that SMEs were adults who had been out of school for some time, care was taken to limit the amount of information presented in each "chunk" and to provide frequent opportunity for practice and feedback after exercises and embedded tests.

Following specification of the instructional strategy, design of the actual materials had to take into account the requirement that these be self-instructional. Given the SMEs' varying levels of education and the need for frequent feedback in practicing the many flowcharting rules, use of self-instruction certainly provided an opportunity for self-pacing and immediate feedback. Considering the cost and amount of time required to develop self-instructional materials, effort was placed in evaluating and using as much as possible of the already existing self- instructional module whose objectives dealt with teaching of flowcharting rules. Review of existing materials was carried out (Dick & Carey, 1979) to determine their effectiveness with respect to content, sequence, methodology and assessment procedures. Instructional segments, examples and test items which were consistent with the instructional strategy that had been developed were used in the design of the new materials. Given that the existing module failed to link flowcharting to task analysis and did not provide for the pre-instructional activities that had been identified in the instructional strategy, a completely new segment was developed to fill the gap at the front end of the self-instructional module.

The existing self-instructional module also failed to teach problem-solving capabilities to enable SMEs to generate algorithmic flowcharts of the tasks that make up their jobs.

However, as a time restriction of no more than 4 hours of self-instruction had been specified at the onset by Servocenter Training, agreement was reached with their management that instruction for this capability could be acquired in the context of the one day follow-up group session guided by an IT that was provided for in their schedule. This solution was the only one that Servocenter found acceptable from the logistics point of view. There were also advantages to this approach. On the job, SMEs worked in groups of 4, under under the guidance of an IT. Instruction in a classroom group setting guided by an IT closely reflected conditions under which actual performance would be expected. Furthermore, Servocenter Training location could provide access to computer terminals: these could be used to provide situational support in acquisition of problem-solving skills (Fleming & Levie, 1978) and be used to verify accuracy of algorithmic flowcharts through simulation of the tasks on the computer (Merrill, 1977).

A multi-media approach was used in designing both the self-instructional part of the module as well as the classroom part. Briggs, Campeau, Gagné & May (1967) have demonstrated that frequent changes in media may prevent boredom and maintain interest and attention. Established constraints of approved media were first considered. Further selection of media was based on

Romiszowski's approach (1981). Media were selected with consideration of factors which influence effective communication: objectives (what we want learners to be able to do); learner factors (literacy, motivation etc.), and content factors (stimulus- response factors).

The self-instructional part of the module consisted of a filmstrip with sychronized audiotape and printed workbook. The filmstrip was designed to gain attention from the learners and motivate them at the onset, teach them the concepts of task analysis and flowcharting as well as discrimination between flowchart symbols. Filmstrip was chosen for the following reasons:

1. The combination of still, projected media (in this case, filmstrip) and audio recording has been found to be powerful both in transmitting factual knowledge and increasing motivation (Kosma, Belle and Williams, 1978);

2. Projected media arouses and maintains high student interest (Kinder, 1959);

3. Learning discriminations between flowcharting symbols can be facilitated through color cueing (Fleming and Levie, 1978);

4. Filmstrip and slides have been found to be particularly effective where individual pacing and student participation is required (Allen, 1959); and

5. Filmstrip is compact, easily handled and always in proper sequence. Production capability was available through Servocenter and all carload centers were equiped with filmstrip projectors.

A self-instruction, printed workbook was provided to accompany and complement the filmstrip for the following reasons:

1. Testing and practice on objectives in the self-instructional part of the module required written responses either in the form of answers to questions or flowcharting of prose; and

2. The cost of producing the entire self-instructional part on flimstrip would have been prohibitive and could not be justified beyond segments where color cueing had demonstrable benefits. It was the cheapest medium available to provide instruction and practice opportunity on flowcharting rules. A printed workbook was also convenient and portable and could be used as material following instruction and on the job.

The group practice session required two media. A flipchart was used so that flowcharts could be recorded and viewed by all SMEs as they were being generated. Flipcharts are standard equipment for classroom instruction in industry and instructors are generally comfortable and skillful in using them. A computer terminal was also used to provide opportunity for feedback through computer simulation.

Once the entire module had been designed, provisions were made for complete sets of instructions for SMEs in the self-instructional part of the module as well as for the instructors in the lesson plan to guide the group practice session. These were to ensure consistent management of the delivery of instruction.

Gagné & Briggs' model finally calls for the evaluation of the instructional system. Procedures for evaluation are first applied to the design effort itself. Evidence is sought in order to revise and improve the materials prior to final delivery. This process is called Formative Evaluation (Dick & Carey, 1979). Two stages of formative evaluation were carried out: one-to-one, where objectives, tests and materials were individually reviewed and commented upon by ISD process experts and the available technical content expert who also served as a representative of the target population; and a small group evaluation, where an

actual group of 4 SMEs studied the materials in an approximate "real- life" setting to collect the required data. Formative evaluation was carried out on 4 SMEs. Given that anticipated average size of future groups was 3 to 4 SMEs, this test situation was considered as a field test. The total target population was not expected to exceed 20 in the following two years.

Criterion-referenced tests provided the basis to evaluate overall effectiveness of both the self-instructional part of the program as well as the classroom part. The Formative Evaluation process not only demonstrated if course objectives were achieved, but gathered data to analyze if content and sequence were appropriate, if course quality met the trainees' expectations and if the timing was adequate.

Results of formative evaluation served to guide revisions of the program to make it more effective in meeting the stated overall educational objective.

Having reviewed relevant research as a theoretical basis for the design and evaluation of the revised module, the following chapters will outline the methodology that was used both in the problem analysis, and in the design and evaluation of the module.

CHAPTER III

PRELIMINARY STUDY: PROBLEM ANALYSIS

The purpose of this study was to produce and evaluate criterion-referenced training materials aimed at enabling technical content experts (SMEs) involved in task analysis for CN Transportation to generate algorithmic flowcharts of the tasks that make up their jobs. The materials which had been designed to meet this need had been found to be unsatisfactory in that SMEs were not able to perform as expected following instruction. Before launching into the production of new and expensive training materials, a systematic analysis of the performance problem was conducted in order to identify precisely what the performance deficiency was and to identify what training would be required to meet the needs of CN's Servocenter Training. This chapter deals with the first step in the systems approach to instructional design. A complete analysis of the problem is presented and recommendations are drawn as a basis for subsequent design of revised training materials. The next chapter covers the design, development and evaluation of the revised materials.

Method

Target Audience

The first step in the analysis of the instructional system was to reevaluate the characteristics of the target population. It had been mandated that the target audience be technical content experts (SMEs) selected to participate in task analysis within their areas of specialization for CN Transportation Servocenter Training Department. Specifically, SMEs were train movement clerks working in carload centers across Canada whose permanent jobs involved processing of data relative to transportation of freight via rail. Typical SMEs were male, between the ages of 30 and 45, with an average of 9 to 12 years of formal education. None had any teaching or training background, nor had any of them been associated with course development before being assigned to temporary assignments as instructional designers in Servocenter Training. Most had low writing skills. These characteristics were evident in written autobiographies SMEs had submitted along with their applications for this assignment.

Nine SMEs had been trained and had subsequently been involved in task analysis, design and development of training programs on a temporary basis, and all had returned to their local carload centres upon completion of their assignment. Eight of those SMEs had completed a study of the existing self-instructional module.

when this study was initiated. It was the results of these eight which fed into preliminary assessment of the training module.

Materials

Of the 24 self-instructional modules that had been developed on the ISD process, the module on flowcharting was singled out as ineffective by Servocenter Training management. A copy of existing self-instructional materials on Task Analysis/ Flowcharting was provided for review. Other materials included a computer printout of pre-test and post-test results (see Table 1) and embedded post-test data for the 8 SMEs who had completed the program. (A copy of the post-test and of embedded post-test results can be found in Appendix A).

In order to investigate the performance problem, questionnaires were designed by the author to interview both Servocenter Training management and staff as well as SMEs who had taken the training (Appendix B). Questions reflected those contained in the Problem Identification Process outlined by Freisen (1973). Questionnaire 1 was developed to interview managers and IT staff who had worked with the two previous groups of SMEs and had requested that a new training program be developed to meet their needs. It consisted of six questions aimed at answering the following:

1. Who were the SMEs?
2. What was the expected performance? What were the standards, criteria and conditions?
3. What was the gap in performance?
4. How could training be improved?

Questionnaire 2 was developed to interview SMEs who had taken the existing training and had subsequently been involved in task analysis for Servocenter training. It consisted of seven questions aimed at answering the following:

1. What were they expected to do? Under what conditions?
2. Did they find that training had been effective and useful on the job?
3. How would they improve the module?

Procedure

Two Instructional Technologists from CN Corporate Training as well as the author reviewed the existing materials' objectives for clarity of performance desired and reviewed the post-test to evaluate it's validity with respect to stated behavioral objectives. Scores on the pre-test and post-test were compared to determine if SMEs had learned from the module and scores on

Table 1

Task Analysis/Flowcharting

Issue 1 (Unrevised)

Pre/Post Test* Results

	Pre-Test	Post-Test	Average Gain
Average Score[a]	19.6	36.37	16.77
Average %[b]	48.9%	91%	42.7%

* NOTE: The pre-test and post-test were identical.

[a]Maximum raw score possible: 40

[b]Pass: 90%

embedded post-test questions were reviewed to identify errors which could be related to problems within the instructional materials. The instructional materials were also reviewed for appropriateness of content, sequence and methodology. Interviews were then carried out in the following way:

The first interview was conducted with the Manager of Servocenter Training. The Instructional Designer and the two ITs were subsequently interviewed individually away from their work stations to ensure privacy and confidentiality. This was thought to be necessary in view of anxieties which usually accompany problem analysis interviews in industry: these are often seen as threatening because investigation of the performance problem could reveal inadequate management practices as a contributing factor. Because SMEs who had taken the training had completed their assignment and returned home, their interviews were conducted on the telephone. The instructional design supervisor could only provide access to two SMEs who had taken the training. SMEs did not know that they were going to be interviewed prior to the interview itself. SMEs were asked to cooperate but were told that their participation in the interview was optional. They were also told that their answers were confidential and would serve to improve training for the next group of SMEs.

Results and Discussion

This preliminary study was aimed at answering these questions:

1. Was the existing module effective in meeting the stated objectives?
2. What was the performance problem?
3. If ineffective training was a source of the problem, how could it be improved to solve the problem?

Was the Existing Module Effective in Meeting the Stated Objectives?

The module's objectives stated that SMEs would be able to:

1. Match the symbol to the correct function when given a number of flowchart symbols and a list of various flowchart functions.
2. Flowchart sub-tasks in the correct sequence using the appropriate symbols when given a written description of a task and its sub-tasks.

While the module had met the 90/90 criterion of effectiveness required by Servocenter with a average post-test score of 91%, analysis of the pre-test and post-test revealed that questions 2

and 3 were not valid measures of the instructional objectives. These were swiss-chesse, fill-in-the-blank type questions whose answers could be logically deduced without any instruction or prior knowledge of required skills. These questions had been weighted for 22.5% of the total marks. This accounted for high scores in the pre-test and the post-test. Nevertheless, there was a gain in knowledge of 42.7% which was attributed to success on valid test items (see Table 1). Analysis of embedded post-test items revealed that errors had occured mostly in question 4 which called for flowcharting of prose. Review of instructional materials traced these errors to two segments of instruction whose content and sequence required revision. While overall effectiveness was difficult to establish on the basis of 42% gain on two questions, SMEs had learned from the module and instructional technologists considered the materials generally adequate. Interview data collected from SMEs confirmed that they had learned from the module, had found it interesting and could not remember having had "too many problems with it". However, when asked "Did the training help you do your job?", SMEs stated that they didn't really understand what they were expected to do on the job: they remembered that part of their assignment as "putting steps into boxes and diamond shapes".

What Was the Performance Problem?

What were SMEs expected to do that they were not capable of doing as a result of instruction? Interview data collected from Servocenter training management and ITs established that SMEs were technical content experts who were involved in task analysis. They were expected to describe tasks that make up their jobs in the form of algorithmic flowcharts. Although procedure manuals were available, those were considered inadequate and outdated. SMEs therefore had to rely on their experience to analyze and describe tasks that make up their jobs as flowcharts. Management had hoped that following instruction SMEs could generate these flowcharts with minimal guidance from their staff of ITs. The 8 SMEs who had gone through the module could not produce flowcharts "without considerable assistance", "their work had to be redone because steps were missing" and "there didn't seem to be a logic to what they produced". It should be noted that it was quite difficult for Servocenter training management to specify clearly what they expected SMEs to be able to do as a result of instruction. This suggested that perhaps expected performance had not been stated explicity when the existing module was developed.

Was Inadequate Training the Source of the Problem?

Review of the instructional materials revealed that the major

problem was not due to the poor quality of existing materials. Rather, difficulty lay with the failure of the module's objectives to meet expected performance. While the existing module's overall objective was aimed at enabling SMEs to flowcharts task for which they were given written step by step descriptions, actual on-the-job performance required that SMEs use analytical problem-solving skills to generate algorithmic flowcharts. Existing training was generally effective but incomplete: it failed to provide instruction to develop problem-solving skills, and failed to teach the concept of task analysis, linking it to the activity of flowcharting. This explained SMEs' view of the whole activity as "futile" and "meaningless", a mere "putting of steps into boxes and diamond shapes". Of course, there were many factors that could not be overlooked in this problem, such as individual learner factors (varying levels of education, general lack of experience with teaching or training, poor writing skills) and environmental influences (organizational expectations, anxiety and fear of failing as success or failure would determine career development opportunities, long hours, tight and sometime unrealistic dead- lines). Despite these factors, the preliminary study concluded that the existing module was generally effective in meeting the stated objectives and that what was needed was that additional instructional segments be developed for those components that were missing.

How Could Training be Improved?

As a result of the preliminary study, a number of recommendations were made for improvement of the training:

1. That the module's overall objectives be modified from enabling SMEs to translate given task descriptions into flowcharting format, to enabling them to generate task descriptions as algorithmic flowcharts; and, that a sub-objective dealing with the teaching of the concepts of task analysis and flowcharting be added;

2. That existing materials be used particularly for teaching of flowcharting rules and modified as required to permit integration with new materials;

3. That new instructional segments be developed to teach the concept of task analysis and to develop problem-solving skills required for SMEs to generate algorithmic flowcharts; and

4. That invalid test items be eliminated and that tests be modified to meet revised objectives. It was also concluded that no pre-test needed to be administered:

SMEs' entry level with respect to content of the program was assumed to be zero and no potential benefit could be found in administering such a pre-test.

These recommendations served as a basis for the design and development of a revised module on Task Analysis/Flowcharting which is outlined in the next chapter.

CHAPTER IV

DESIGN AND DEVELOPMENT OF THE REVISED MODULE

This phase consisted of the design, development and evaluation of actual training and evaluation materials. The materials consisted of a 20-minute audio-visual filmstrip presentation with an associated workbook, and a lesson plan designed to guide instructors in a follow-up group practice session. The evaluation design consisted of the development of evaluation materials which were used to assess the effectiveness of the module for purposes of revision prior to final delivery. The activities of this phase were based upon the recommendations of the Preliminary Study. This chapter therefore describes the method used in the generation and implementation of the instructional and evaluation materials based upon previously established needs.

Production Design

The entire product was developed using Gagné's Instructional System Design approach as outlined in the Review of the Literature. Once

the need for instruction had been clearly established through the Preliminary Study, instructional objectives were developed for the revised module.

Objectives

The instructional objectives of the module were:

1. Upon completion of the 20-minute audio-visual presentation and associated workbook (approx. 3 hours of instruction) students will be able to:

   - state 3 reasons for doing task analysis;
   - when given 5 flowchart symbols and a list of definitions, match the symbols to the definitions; and
   - when given 2 written descriptions of the steps required to complete a task, flowchart these steps in the correct sequence using the appropriate symbols

Criterion of effectiveness: 90% of the students would score 90% on the post-test.

2. Upon completion of a practice session guided by a lesson plan (1 day group session led by a qualified IT), students will be able to:

when given a title of a task that makes up their job, and using reference manuals, generate a flowchart of the steps that make up the task in the correct sequence, using the appropriate symbols.

Time allowed:	1½ hours
Task complexity:	15-20 steps
Criterion of effectiveness:	performance of the given task can be simulated without error by a naive learner using the flowchart as a job aid.

Instructional Design

Selection of content and sequence was based on identification of capabilities and sub-capabilities required for SMEs to meet the instructional objectives. These were contained in an instructional analysis which detailed the hierarchy of capabilities (Gagné, 1977), and identified the structure of the

various components of the module, it's content and the prerequisites at each level of the hierarchy.

A Design Evaluation Chart (Table 2), which specified enabling objectives and test items for each capability and sub-capability in sequence, was produced. Two instructional technologists (who in this case were ISD process and content experts) and the Instructional Design Supervisor (who was considered as representative of the target population) reviewed the Design Evaluation Chart. The instructional technologists were asked to evaluate the design for:

1. accurateness of subskills identified in the analysis
2. accurateness of sequencing of subskills
3. adequacy of objectives in relation to subskills
4. clarity of test items and match with stated objectives

The Instructional Design Supervisor was asked to evaluate the design for:

1. clarity of statement of objectives and test items
2. whether test items appeared to be a fair test of the objectives
3. whether the sequence made sense.

Table 2

Design Evaluation Chart

INSTRUCTIONAL LEVEL	ENABLING OBJECTIVE	TEST ITEMS
Subskill 1: Concrete concept (flowchart symbols)	Sub-Objective 1: When given flowchart symbols and a list of definitions, match symbols to definitions.	Embedded Tests: 1.1 Match symbols to definitions. 1.2 Match symbols to steps. 1.3 Read a flowchart and write descriptions in prose.
Subskill 2: Defined concept (task analysis) (motivation & recall)	Sub-Objective 2: State 3 reasons for doing task analysis.	Embedded Test: 2. State 3 reasons for doing task analysis. (3 questions)
Subskill 3: Rule (flowchart task descriptions)	Sub-Objective 3: When given 2 written descriptions of the steps required to complete a task, flowchart these steps in the correct sequence using the appropriate symbols.	Embedded Test: 3A) Given missing steps, fill in symbols with appropriate missing steps. (2 questions) Exercises 1, 2, 3 & 4 Flowchart parts of task descriptions.

Table 2

Design Evaluation Chart

INSTRUCTIONAL LEVEL	ENABLING OBJECTIVE	TEST ITEMS
		3B) Given 2 written descriptions, flowchart steps in a correct sequence using appropriate symbols. Exercises 586 Flowchart complete task descriptions.
Skill 4: Higher Order Rule: Problem Solving (generate algorithmic flowcharts when not given a task description).	Overall Objective: When given the title of a task that makes up their job, SMEs will be able to generate a flow chart in the correct sequence using the appropriate symbol. Criterion: The flowchart can be used to successfully simulate completion of the task.	Exercises: 2 practice exercises. Final Test: When given a TRACS inquiry guide as reference and assuming a Datapoint 3360 CRT, flowchart all the steps required to make an F4 inquiry in the correct sequence and using the appropriate symbols. Performance Criterion: The flowchart can be used to successfully simulate an F4 inquiry on a 3360 CRT.

This initial check insured that the materials developed would address skills that were viewed as being necessary for successful completion of the overall objective.

Materials

Materials that were developed and produced on the basis of the instructional analysis consisted of 3 parts: a motivational and information component on task analysis; an information and practice component on flowcharting rules; and a final component which would allow for development of problem-solving capabilities through guided practice opportunity.

A 20-minute, self-instructional filmstrip with synchronized audio-tape was produced to provide for the motivational and information component on task analysis and flowcharting that had been lacking in the existing module. It consisted of 60 illustrations and graphics. Illustrations portrayed a character with whom SMEs could identify and were used to gain their attention and hook them into the module. Colour cueing was used within the graphics to enhance retention of flowcharting symbols. The storyboard for this component was developed by the author (See Appendix C). Production of illustrations and graphics for the filmstrip was handled by professional artists. Professional photography and duplication of

slides was done by CN Staff. A semi-professional narrator was used for voice, and recording was done at CN Headquarters.

A 3 hour, self-instructional workbook accompanied the filmstrip and also provided the information and practice on flowcharting rules. It was based on the existing module which consisted of a self-instructional workbook dealing precisely with information and practice on flowcharting rules. These materials had been found to be generally effective in the Preliminary Study. They were examined to determine what parts could be used entirely and what parts would need to be modified to permit integration with the overall instructional strategy for the revised module. They were also reviewed to establish what problems could be found in content or sequence. Although the Preliminary Study had established general effectiveness of the existing module, no data on embedded test or exercises within the course had been made available to point to problems in content or sequence within the instructional materials. Given that constraints prohibited access to naive SMEs to review the existing materials, these were examined by the two SMEs who had been interviewed in the Preliminary Study. They were asked to study the materials and provide their comments on clarity and appropriateness of content information, practice

exercises, sequence and test items. They were asked to note any difficulty they had encountered in the margins of the workbook. These were later discussed in debriefing conversations with each one. Two ITS were asked to do the same. The existing self-instructional workbook was thus modified in the following way:

1. The first segment of the workbook was modified so as to include information and test referred to in the filmstrip component, and to include the modified objectives of the modules. Instructions for study of the revised module were also added;

2. The post-test was replaced by an entirely new test consisting of five questions, two which were work related;

3. Three of the nine practice exercises that were considered "childish" and "meaningless" to SMEs (specifically exercises on flowcharting of tasks such as vacuming and brushing their teeth) were replaced by items which, while they assessed the same skills, were more work related. Fourteen practice exercises and test items were added in the workbook: ten for reinforcement and extra practice

opportunity where SMEs had suggested more practice would be appropriate, and four where instruction had been given (on two flowcharting symbols and rules) but had not been tested;

4. While existing examples and exercises on flowcharting rules were varied and unrelated to each other, revised materials consistently presented examples and exercises on flowcharting rules which allowed SMEs to gradually build a complete algorithmic flowchart (of making a phone call) and used existing examples as well as new work related examples and exercises to provide practice and reinforcement when needed;

5. Sequence was modified in two exercises where content needed to complete the exercises was erroneously given only in the feedback, and was therefore moved as input.

Revision of existing materials as well as development of new instructional segments, exercises and test items were carried out by the author. The author also handled all the graphic work in the workbook. Reproduction and printing was done by CN Staff.

The final component of instruction which was designed to allow development of problem-solving skills consisted of a one day group practice session guided by an I.T. A lesson plan was produced to guide the IT in conducting this session. (This is referred to as a "Lesson Directive" by Servocenter Training.) It consisted of instructions relative to teaching strategy and provided problem-solving exercises where SMEs were to generate descriptions of tasks in the area of waybilling with progressively less guidance from their IT. A post-test was included at the end of the lesson plan. It required that SMEs generate a flowchart of a specific task in the area of waybilling. SMEs were given a time limit to complete the work and were considered successful if their flowchart could be used to simulate the task on a computer terminal. The post-test was developed by the author with the assistance of the Instructional Design Supervisor. It was considered by Servocenter Training Management as a representative and fair test of what SMEs were expected to do on the job. Task complexity was judged appropriate and so was the allotted time. The post-test was included as a handout to the students, and instructions were provided for administration of the test.

Instructions were then developed to guide SMEs in the study of the self-instructional program, and a separate set was developed to guide the advisors who would distribute the module and mark its post-test. Some of the materials used for evaluation

of the module were developed as part of the instructional materials. These included tests, a student comment form and a training log for the students, and a post-test correction guide and report on training administered for the advisors. All these materials are included in Appendix D and are outlined below.

Instructions to students introduced the module and gave students information about the evaluation process in which they were going to take part, including the purpose and basic sequence of events.

Advisor notes, post-test correction guides and report on training administered were provided to assist advisors in the administration of the program (advisors are personnel who would normally mark post-tests and report on these at Servocenter Training). These materials were also used as correction guides for the evaluators during the small group evaluation.

Two post-tests were designed: one to evaluate effectiveness of the self-instructional part of the module, and one which followed the group session to evaluate the effectiveness of the entire module in enabling SMEs to meet stated objectives to established criteria. No pre-test was administered as the subjects' entry level was assumed to be zero with respect to

stated objectives. The post-test following the self-instructional part of the module consisted of five questions, each of which called for application of subskills identified in the objectives stated at the beginning of the workbook. The total possible score was 100 and pass mark was 90. Items were weighed according to complexity of responses required and criticality in the performance of the overall objective. The post-test for the lesson plan consisted of a test situation where subjects were asked to generate a flowchart of a task that made up their jobs. Most of the tasks involved computer application. To estalish validity of the flowcharts, a naïve learner would be required to perform that task without error on a computer, using the flowchart as a job aid.

Within-course test items and exercises were provided as part of the instructional materials. Analysis of embedded test items and exercises data would provide indications as to difficulties in content and sequence. All items and exercices were numbered with reference to labeled objectives and sub-objectives in the Design Evaluation Chart (see Production Design, Table 2) so as to facilitate later compilation of results.

The student comment form and training log were included at the end of the self-instructional part of the module. The student comment form was designed to collect data on the quality of instructional materials as perceived by the students. Students

were also asked to record, in their training log, time spent on preparation and set up, training, post-test, and total time. This was designed to collect data to help determine the administrative feasibility of instruction.

Evaluation Design

The evaluation design consisted of a Formative Evaluation based on methodology outlined in Dick and Carey (1979). Two stages of formative evaluation were carried out: one-to-one evaluation where a draft set of self-instructional materials and tests were reviewed by individuals to essentially debug and improve them prior to the actual field test and; a small group evaluation where the entire module was tried out on a representative sample of the target population in an appropriate real-life setting. The purpose of formative evaluation was to collect data on effectiveness of the module with a view of using this data to improve the module prior to final delivery. The materials outlined below were developed and used for this process. Subjects and procedure for each segment of the evaluation follow.

Subjects

The sample consisted of a group of 4 experts in the area way-billing. Given that the target SME population was not expected to

exceed 20 in the following two years, Servocenter Training management considered that a team of 4 SMEs would be sufficient to evaluate the program, representing a small group evaluation and field test (Dick and Carey, 1979). Given the small number of the target population, randomization was not possible: the 4 subjects were chosen according to the same criteria as the target SME population by the Servocenter Instructional Supervisor who usually selected SMEs on the basis of the following established criteria:

1. technical subject matter expertise (years of experience, type of experience);

2. general attitude and capacity to adapt to new situations (subjective evaluation made by the Instructional Design Supervisor based on a personal interview held prior to final selection);

3. Writing Skills (based on written autobiographies); and

4. Geographical location (SMEs had to come from various locations across Canada).

The author had no control over the selection of subjects. As education level and learning ability were not considered in the selection of the target SME population, these were also not considered in the selection of candidates for evaluation. However, this was taken into consideration when designing the materials. The four subjects were considered by Servocenter Training as highly representative of the target SME population.

Materials

Materials were generated specifically for the small group evaluation: these included instructions to the participants, instructions to the evaluators, an evaluation form based on the course outline, student and instructor debriefing questionnaires and student reaction questionnaires for both the self-instructional and group practice parts of the module (see Appendix E).

Instructions introduced the module to the students, and gave them information about the evaluation process in which they were going to take part, including the purpose and basic sequence of events.

Instructions to evaluators and an evaluation form were provided. Instructions spelled out their role, how to proceed with

the evaluation, what to observe and how to record the data on the evaluation form. The evaluation form was designed so that the evaluator would tally right answers (with a 1), wrong answers (with a 0) and omissions (with an X) to numbered embedded tests and exercises based on the course outline. Next to it, they also recorded both their own observations and subjects' remarks upon debriefing. Compiled data based on this course outline could later provide an "instructional map" (Dick and Carey, 1979) upon which the validity of assumptions on sequence and content could be established.

Finally, student and instructor debriefing questionnaires were developped to provide additional data on effectiveness of the group practice session with respect to appropriateness of activities, suitability of materials, grouping patterns, time and SME interest in activities.

Procedure

One-to-one evaluation. One-to-one evaluation was conducted following the development of a draft set of instructional materials and test for the self-instructional part of the module. This part of formative evaluation was carried out with the

Instructional Design Supervisor and one of his designers in Servocenter Training. Although both were not typical of the target population with respect to entry level, they were the only resources made available for this segment of the evaluation. They were however considered by Servocenter Training as knowledgeable of the target population, as they had come from their ranks. The purpose of the one-to-one evaluation was to seek their comments and suggestions with respect to:

1. technical content accuracy and currency;
2. appropriateness of the material in vocabulary, interest, sequence, chunk size;
3. any other difficulty they encountered in the module including omissions of content, missing pages, etc.; and
4. timing.

One-to-one evaluation was also carried out with two instructional technologists who were also asked to review the module and provide their comments, and suggestions with respect to:

1. appropriateness and clarity of content and sequence;
2. clarity and appropriateness of test items; and

3. any other difficulty they encountered when going through the module themselves.

The Instructional Design Supervisor and the Designer from Servocenter Training as well as two instructional technologists were brought individually to a room where a Caramate slide projector has been preloaded with a slide-tape version of the audio-visual part of the module. They were presented with a typed, photocopied version of the workbook and asked to go through self-instructional materials, ask questions and point out difficulties verbally as they went along. They were specifically asked to note typographical errors, inaccuracies in content, missing content and pages, difficulties in understanding content, problems with sequence and any other comment which they felt would help improve the module before field tryout. Their comments were noted and appropriate revisions were made prior to small group evaluation.

Small group evaluation. After the materials had been revised on the basis of information obtained from the one-to-one process, four SMEs were selected to participate in the evaluation of both the self-instructional and group practice parts of the module. Selection of subjects for this segment was undertaken in the same

manner as for the target user population selection. Individuals who were involved in the development of this module were not part of this segment. Thus, selection bias was controlled. Apart from the above, two other persons were involved in the small group evaluation: an evaluator who supervised all activities, observed and collected data throughout the entire process; and an Instructional Technologist/assistant who also took part in the observation and collection of data during the self-instructional part of the module and who acted as instructor in the group practice session guided by the lesson plan. This instructional technologist had not been involved at any time in the design and development of the module.

The purpose of this segment of formative evaluation was to collect data on the:

1. effectiveness of the entire module;
2. appropriateness of content and sequence;
3. quality of instructional materials and;
4. implementation of instructional materials: clarity of instruction to students and instructors, and administrative feasibility (time).

Small group evaluation lasted two days. On the morning of the first day, the four SMEs who had been selected as subjects were brought into a room together. The evaluator introduced herself and her assistant. Subjects were told that this study was being conducted to determine the effectiveness of a training module. They were asked to cooperate and follow instructions carefully. "Instructions to Participants" were read aloud by the evaluator and time was given to clarify any doubts or questions.

Evaluation of self-instructional materials was then conducted individually with each subject. Each subject was brought into a room where a Caramate projector had already been set up with a slide-tape version of the audio-visual part of the module and was provided with a printed version of the workbook put together in a three ring binder. As there were two evaluators, two subjects were tested simultaneously: in order to have internal validity, subjects were given the same instructions and the same materials. Two subjects were tested in the morning, and two in the afternoon. Evaluators were provided with the same Instructions and the same instrumentation to record data. Subjects were asked to study the self-instructional materials and answer questions as instructed in the workbook and filmstrip. They were told that evaluators would only answer questions if instructions were not clear during the study period but that their comments would be solicited at the end of the period.

Data were recorded on study time and testing time by both the subjects and the evaluators. Evaluators corrected the post-test using the Post-Test Correction Guide at the end of the study period and notified the subjects of their post-test results prior to debriefing. Comments were solicited from learners after the instructions and test had been completed, both orally through an interview with the evaluator and written on a student comment form. Following the debriefing interview, subjects were thanked for their cooperation and asked to come back the following day to take part in a group practice session.

When all subjects had gone through the self-instructional part of the module, the instructional technologist/assistant was given the lesson plan and was asked to review it in preparation to instruct the next day's practice session.

On the morning of the second day, subjects met in the Servocenter Training Location where they would normally be called upon to conduct Task/Analysis. The classroom was equiped with standard materials, a flipchart, masking tape and markers. Technical reference manuals were provided in sufficient quantities. A computer terminal was available in another room and computer time had been reserved to accommodate for simulations required in the exercises.

The Instructional Technologist/assistant informed the subjects that she was going to be their instructor for the day. Subjects were told that they would use the knowledge they had acquired in the previous day to analyze tasks that make up their jobs and describe them in the form of flowcharts. They were informed that they would be working as a group on some of the exercises with progressively less guidance from the instructor and that they would be tested at the end of the day. Time was given to clarify any doubts or questions. Subjects were notified that the evaluator who was present in the room would only observe and not participate in the instruction and were assured that they could ask the instructor questions during the session whenever they needed to. The instructor, on the other hand, was instructed in the lesson plan to provide less guidance to subjects as the lesson progressed.

The evaluator noted all comments and questions which the subjects raised during the session, as well as difficulties they encountered and discussed with their instructor. Success or failure on practice exercises was noted as well as time required. At the end of the day, students were asked to fill a questionnaire individually. Debriefing was done by both the evaluator and the instructor with the entire group present: reactions to the entire module were sought as well as comments as to how the module could be improved. All were thanked for their cooperation. The

instructor was also asked to individually fill out a questionnaire evaluating the lesson plan for content, sequence, methodology and asking for suggestions for improvement.

Following the actual evaluation, all workbooks were reviewed and embedded test items data were tallied. Results were compiled from all other data gathering instruments that had been designed to evaluate the module. These are presented in the following chapter.

CHAPTER V

RESULTS

Data were collected during the small group segment of Formative Evaluation of the revised module on Task Analysis/ Flowcharting to determine the:

1. effectiveness of the module;

2. appropriateness of content and sequence;

3. quality of instructional materials; and

4. difficulties with implementation of instruction: clarity of instructions to students and instructors, and administrative feasibility (time).

This chapter outlines the main findings of this evaluation and reports data in sufficient detail to justify subsequent recommendations as to how the module could be improved.

Instructional Effectiveness

Performance on the post-test following the second day's group practice session (post-test 2) was used as the dependent measure for instructional effectiveness of the module in meeting the stated overall objective. Performance on the post-test following self-instruction (post-test 1) was used to measure effectiveness of the self-instructional part of the module in meeting sub-objectives 1,2 and 3 that were aimed at teaching task analysis, flowcharting symbols and flowcharting rules. Criterion of effectiveness had been set at 100% for the overall program and 90/90 for the self-instructional part of the program.

Student performance on post-tests revealed an average of:

- 100% on post-test 2, which satisfied the criterion of effectiveness for the module in meeting the stated overall objective;

- 89.5% on post-test 1, .5% short of the 90% criterion of effectiveness for the self-instructional part of the module (Table 3).

Table 3

Student Performance on Post-tests

Students	Post-Test 1	Post-Test 2
1	96%	100%
2	78%	100%
3	90%	100%
4	94%	100%
Average percent	$\overline{x}$ = 89.5%	$\overline{x}$ = 100%

Post-Test 1 refers to the test which follows the Self-Instructional part of the module.

Post-Test 2 refers to the test which follows the Guided practice session.

Following instructions on Task Analysis/Flowcharting, students were able to generate algorithmic flowcharts of a task, a computer enquiry, that makes up their job. A naïve learner was able to perform the task without error using the flowcharts as job aids, thus establishing validity of the algorithms and, consequently, effectiveness of the module.

Percentage of correct scores on post-test questions clustered by objective (Table 4), indicated that all students had been successful in meeting sub-objectives 1 and 2 (concept of task analysis and discrimination of flowcharting symbols). However, on questions 4 and 5 which dealt with sub-objective 3 (application of flowcharting rules), the average score was 86.6% and 78.3% respectively. Each of these questions required SMEs to draw a flowchart when given a step-by-step description of a task. Analysis of responses to these two questions revealed that:

1. On question 4, 3 out of 4 students drew the statement "check for" as an action and not a cognitive operation, and; two symbols, the connector and reference symbols, were used incorrectly 50% of the time.

2. On question 5, 3 out of 4 students obtained a "wrong" score on one segment of the flowchart they had drawn. While

Table 4

Percentage Correct on Post-Test Questions, Clustered by Objective

	Post-Test 1 Sub-Objectives					Post-Test 2 Overall Objectives
	1	2	3			4
	1	2	3	4	5	
Student						
1	100	100	100	100	86.6	100
2	100	100	100	73.3	53.3	100
3	100	100	100	86.6	86.6	100
4	100	100	100	86.6	93.3	100
Average Percent	100	100	100	86.6	78.3	100

their flowchart was technically accurate, the post-test correction guide had indicated they were wrong and consequently they lost 4% of the total marks. During debriefing, students stated that the problem lay with technical inaccuracy of that part of the question: they had disregarded the inaccurate information given in the question and had relied on their experience to draw that segment.

Student 2 stated that the inaccurate information "threw him off" and that this "contributed to his difficulties in completing the rest of the flowchart".

To summarize, post-test results revealed that the program was effective in meeting the stated overall objective. Data also indicated that the instructional materials had some shortcomings. Further investigation was conducted to identify problems in content and sequence which could explain students' difficulties on questions related to sub-objective 3.

Content and Sequence

Day 1: Self-Instruction

Embedded test and exercise results within the self-instructional part of the module were tallied by the evaluators on

the "evaluation based on course outline" form, as students were going through the materials. Correct answers were tallied with a 1, incorrect with a 0 and no answer with an X. Accuracy in recording of these data was later verified by the evaluator and data were displayed as an "instructional map" (Dick & Carey, 1979). By displaying students' performance on embedded test questions and exercises, patterns of wrong responses emerged pointing out possible difficulties with content of materials or sequence of presentation (Table 5). Problem areas were identified as those for which at least two wrong answers to test questions or practice exercises had been tallied. Data collected in debriefing interviews provided further evidence and explanations for difficulties encountered. Results were as follows:

1. For sub-objective 1: while students performance on the post-test questions had been 100% for this sub-objective, question 3 within the course was consistently answered incorrectly. Upon debriefing, two students said they considered the question "useless", "silly". Another stated he "didn't see why it had to be answered". In fact, students considered the question unnecessary in the learning of the sub-objective and suggested it be taken out all together.

TABLE 5

Student Responses on Embedded Tests and Exercises withing the Self-Instrutional Part of the Program

Objectives		1			2			3													
Embedded Tests		1	2	3	1	2	3	1	2												
										1		2	3						4	5	6
Exercises										1	2		1	2	3	4	5	6			
Subject	1	1	1	X	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
	2	1	1	0	1	1	1	0	0	0	1	0	0	0	0	1	1	0	1	0	X
	3	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	0
	4	1	1	0	1	0	1	0	1	0	1	1	1	1	1	0	1	1	1	0	0
			*					*	*	*										*	*

1 = correct answer
0 = wrong answer
X = did not answer
NOTE: all questions marked with an * indicate problem questions.

2. For sub-objective 3:

(a) embedded tests 1 and 2: SMEs did not identify "check that..." or "make certain..." as cognitive operations requiring a decision symbol and a question mark. These were drawn as "action" statements. This same difficulty had been noted in post-test 1, question 4. Upon debriefing, three SMEs stated that "not enough instruction" had been provided to help make the distinction;

(b) exercise 1.1 and 5: two SMEs flowcharted the task relying on their experience rather than on the given task description, a similar situation to that found on post-test 1, question 5. In these two cases, the task description on "making a phone call" required "using another telephone line" if one "did not hear a dial tone." Students #2 and #4 came from smaller carload centers where there is typically only one line to each phone. When interviewed, SMEs suggested examples used within the module should not be subject to different interpretations depending on local conditions;

(c) exercise 6: Students #3 and #4 failed to use the "connector" and "reference" symbols in drawing this partial flowchart, and Student #2 failed to answer the question at all. Again, this situation paralleled the one in post-test question 4. Students put the blame on lack of instruction, stating "the information went by too fast".

It should be noted that the "instructional map" also indicated Student #2 had difficulty throughout the self-instructional part of the module. The student could not explain why and said he had found flowcharting "confusing". Biographical data could not shed any light on this problem. While this student did not fare well in the self-instructional part of the module, he obtained 100% on post-test 2 following group practice with a qualified IT.

Students' responses on interviews following self-instruction provided supplementary data on appropriateness of content and sequence, and suggestions for improvement (see Table 6). This data supported and confirmed conclusions of embedded test items analysis, particularly with respect to instructional materials on sub-objective 3. It is of interest that conflicting views were expressed on the use of work related examples: while one student

Table 6

Students' Responses to Interviews following Self-Instruction

Q1 How did you find instruction?

a.	Interesing	4
	Boring	0
b.	Too long	1
	Too short	0
	Appropriate	3
c.	Too difficult	1
	Too easy	0
	Just right	3

Q2 Did you understand whay you were supposed to learn?

Yes	4
No	0

Q3 Did you find that the materials were related to the objectives stated at the beginning of the workbook?

Yes	4
No	0

Q4 Were there enough practice exercises?

yes	4
No	0

Q5 Were practice exercises appropriate?

Yes	3
No	1

Q6 Did you get enough feedback on practice exercises?

Yes	4
No	0

Q7 Did you have any problems with any section or parts of the instructions?

Yes	4	(details are given throughout this section)
No	0	

Q8 Did the post-test measure what it said it would?

Yes	4
No	0

Q9 Were you sure of your answers all the time or did you sometimes guess? Where?

Guessed	1	(student #2)
Did Not Guess	3	

Q10 How would you change instruction if you could?

More exercises on loops	2
More instruction on connector and reference symbols	2
Fewer work related examples	2
More work related examples	1

argued more work related examples would have made the content of the program more "meaningful and relevant to hi ", two students suggested that "fewer work related examples should be used" so that they could "concentrate on the process rather than on technical content of exercises and examples".

Days 2: Group Session

Comments and questions on content and sequence were noted by the evaluator as the group session progressed. Success or failure on practice exercises was also noted. These data as well as debriefing interview data were used to evaluate appropriateness of content and sequence of the lesson plan and to guide revisions. Results were as follows:

1. Whereas the lesson plan called for review of the main points covered in self-instruction, SMEs unanimously requested that this part be skipped and that the instructor go on to practice exercises. Two students stated a review was "unnecessary" while another suggest it would be an "overkill". The "review" part of the day was therefore omitted.

2. Content of exercise 1 was accurate but incomplete. Students spent a considerable amount of time (25 minutes) trying to clarify the question. During debriefing, SMEs suggested that exercise 1 be modified to include the missing information.

3. All students were successful on practice exercises.

When interviewed at the end of the day, all students found the group session "interesting" and generally "appropriate" in terms of content, sequence and methodology. However, both students and the instructor agreed that "more instruction should be provided on a systematic approach to generating flowcharts". During the course of the day, Students #1 and #3 had discovered that flowcharting the "main flow" of a task first, followed by "branching" eliminated a lot of confusion. Student #2 who had had problems in sequencing throughout self-instruction stated that understanding this systematic approach marked a "turning point" in developing his capability to generate flowcharts. The instructor suggested

that the lesson plan should "incorporate this approach into the instructional strategy" and "include notes on the instructor's role as a facilitator in the development of group problem-solving skills."

Quality of Instruction Materials

Overall appeal of the self-instructional part of the module was high, with 3 out of 4 students finding the module interesting, as expressed in the student's comment forms:

Did you find the program:

1. Interesting	75%	Boring	0%	Did not answer 25%
2. Confusing	25%	Did not answer 75%		
3. Practical	75%	Did not answer 25%		

Regarding their general opinion about audiovisual production and workbook quality, comments were as follows:

Visuals:	excellent	0%
	very good	100%
	good	0%
	fair	0%

Audio:	excellent	25%
	very good	75%
	good	0%
	fair	0%
Workbook:	very good	100%

Overall satisfaction with the group practice session was also high, all students finding the module interesting. Interview data with the instructor revealed that she had found the lesson plan "well done" and its format "useful and appropriate".

Implementation of Instructional Materials

Clarity of instruction to students and instructors

Instructions to both students and instructors were found to be generally clear. However, data collected during observation of the self-instructional part of the module revealed 6 instances where additional instructions such as "start now" "end of test", or other instructions were required.

Table 7

Time Required for Completion of Self- Instruction

	Preparation and Set Up	Training	Post-Test	Total	
				Minutes	Hours
Student					
1	10	140	60	210	3.5
2	10	165	60	235	3.92
3	20	200	92	312	5.2
4	15	120	45	100	3
Average (minutes)	13.75	156.25	64.25	235.25	
Average (hours)	.23	2.6	10.07		3.9

Administrative feasibility

Self-instruction required an average of 3.9 hours to complete (Table 7) and the group practice session took 6.4 hours. Both fell within established constraints.

CHAPTER VI

DISCUSSION

The results outlined in the previous chapter strongly suggest that the revised module on Task Analysis/Flowcharting was effective in enabling CN technical content experts to generate algorithmic flowcharts. The original hypothesis that a revised module could meet Servocenter's needs was upheld. The purpose of formative evaluation was to identify problems within instruction and revise the program. A number of weaknesses in content and implementation were discovered and recommendations were made for improvement. This chapter is divided as follows: the first segment discusses instructional effectiveness of the module; the second segment deals with weaknesses in the instructional materials; and; the final part outlines recommendations for further improvement. The chapter closes with conclusions regarding instructional design in industry.

Instructional Effectiveness

The primary goal in the design, development and production of this module was to enable technical content experts to describe tasks that make up their jobs as flowcharts, in a motivating and effective manner. Results obtained in the post-test following

self-instruction and guided practice determined the amount of learning which occurred as a result of instruction. Students' scores on the post-test following group practice indicated that all students had met the overall objective of the module to the specified criterion of effectiveness (100%). Although some weaknesses were noted in the instructional materials, all students stated that they had found the module interesting, understood what they were supposed to learn and found the post-tests measured what was called for in the objectives. A majority judged the quality of the audio visual presentation and of the workbook as "very good" and estimated the timing to be appropriate. From an instructional and aesthetic standpoint, therefore, the module succeeded in meeting the primary goal.

Was this new module more effective than existing (unrevised) materials in meeting Servocenter's needs? Whereas SMEs had been unable to generate algorithmic flowcharts following instruction with existing materials, they were able to perform as expected following instruction with revised materials. This was measured by a revised post-test that was considered as fair and representative of expected on-the-job performance by Servocenter Training Management. SMEs were given the title of a task requiring a computer application and were asked to describe this task as a flowchart. This is, in fact, what they would be expected to do in

reality. The flowcharts they generated were empirically tested for accuracy by having a naïve learner follow the algorithm in performing the task on a computer (Merrill, 1977). A naïve learner was in fact able to perform without error the task on the computer using the flowcharts that were generated by students, as job aids. All students obtained mastery (100%) on the test. It has been hypothesized that the major problem with existing materials was the inappropriate level of objectives; that existing materials failed to teach problem-solving skills required to generate algorithms. It had been further hypothesized that revised materials could effectively meet Servocenter's needs if they provided additional instruction on task analysis and an opportunity to develop problem-solving skills. All other factors remaining equal (selection criteria for SMEs, individual learner factors and environmental influences as outlined in Chapter II), the difference in actual performance following instruction is attributed to revisions made to the module, thus confirming the original hypothesis to the extent possible under the circumstances.

Weaknesses in Instructional Materials

The purpose of formative evaluation was to identify problems within the instructional materials in order to revise them prior to delivery and full scale implementation. Percentage of correct responses on post-test questions clustered by objectives, and

embedded test and exercise results within the course revealed problematic areas in the materials. Debriefing interviews provided explanations for the difficulties that were encountered.

Weaknesses in the module were as follows:

1) Inaccurate technical content or content not seen as relevant to SMEs' experience. In answering test questions or exercises, SMEs tended to disregard any information which they thought was technically inaccurate or which they considered incorrect based on their personnal experience and perception of reality. Consequences were twofold: on the one hand, answers to those questions were marked "wrong" based on the post-test correction guide; on the other hand, and more importantly, this distracted them from learning the process and concentrated their attention on accuracy or relevancy of content. This particular weakness raised the question of the merits of using work related examples in acquisition of process information or skills. While a good argument can be made for rendering content as meaningful as possible to students, it may be more effective to use work related examples in the application or practice of those skills rather than in their acquisition. In any case, given the requirements that these materials had to reflect railroad reality and use work related examples, this weakness is attributed primarily to constraints

encountered during the design. These were twofold:

(a) there was no access to naive learners from the target population or at the one-to-one stage of evaluation. Content that was not relevant to railroad reality or information that was subject to personal interpretation was therefore not identified prior to the small group evaluation.

(b) the technical content "expert" that was provided to assist in the development of work related examples and to verify accuracy and currency of materials prior to small group evaluation had been, as is often the case with head office managers, removed from the operations for many years. As a result of computerization, procedures had been modified substantially, thus rendering the content person's knowledge outdated and inaccurate.

2) <u>Insufficient instruction on two of the flowcharting symbols in a segment of the self-instructional part of the module</u>. That particular segment had been adopted entirely from existing materials. Effectiveness of that segment had not been questioned prior to small group evaluation. This is explained by the fact that it had not been tested in the original post-test

and that no results on embedded items within the unrevised module had been compiled to point to this weakness.

3) Although the overall strategy for teaching SMEs to generate algorithmic flowcharts was effective, two areas were identified for improvement:

(a) In the self-instructional part introducing the various flowcharting symbols, no explicit instruction was given to stress the distinction between cognitive and manual operations. It had been hoped that SMEs would discover the distinction through various exercises where they had to fill in missing steps in given flowcharts. While steps were placed in the correct sequence, mental operations such as "check that" and "make certain" were consistently written as action statements and not as decisions requiring a question. The impact of this situation became evident in the post-test where SMEs could not discriminate cognitive and mental operations in the written task descriptions, and consequently, flowcharted parts of the tasks incorrectly. This suggested that the discovery approach was not appropriate to teach the concepts of "cognitive" and "mental operations" and that more guidance should be provided in the instruction on that segment of self-instruction.

(b) The lesson plan for the group practice session did not specify in enough detail the nature and amount of guidance that instructors would be required to provide in the session. The overall strategy which was taken was that of guided discovery with minimal guidance, as is proposed by Gagné (1977) for effective learning of problem-solving skills. In fact, students discovered a systematic way of developing algorithmic flowcharts which called for identifying the "main flow" followed by "branching". One student emerged as a leader in the practice exercises, and group dynamics played an important role in enabling the students who had had the most difficulty in the self-instructional part of the program to meet the program's overall objective. While this confirmed appropriateness of the instructional strategy, the lesson plan did not supply enough information on the instructor's role as a facilitator in the group process nor did it specify in enough detail the nature of guidance to provide.

4) A final weakness was identifed in the instructions of the self-instructional part of the module. The amount of instructions required had been underestimated. This is again a consequence of not having had access to naive learners during design. Individuals who had contributed to the module and

subsequently reviewed it were familiar with programmed instruction and therefore, required fewer explicit instructions such as "end of test" or "turn the page". While these could be seen as trivial, absence of such instructions caused confusion in some students, thereby creating unnecessary difficulty in learning.

Recommendations

Based on analysis of the weaknesses of the instructional materials, recommendations were made for the revision and improvement of materials prior to implementation. It was recommended that:

1) the number of work related examples be reduced at the beginning of the self-instructional part so that SMEs could concentrate on the process; that some work related examples be added gradually for application of rules rather than at the stage of acquisition of knowledge and skills and; that all work related examples be verified for accuracy by content experts currently working in carload centers;

2) additional instructional segments be provided in the self-instructional part of the program to:

- teach the "connector" and "reference" symbols, and;
- enable SMEs to distinguish cognitive and manual operations;

3) the lesson plan be modified to include specification of the instructor's role as a facilitator and details on amount and nature of guidance to give in the group session;

4) more instructions to students be included in the self-instructional materials.

CONCLUSION

To fully understand this study, one must look at the circumstances in which it was conducted. First, as discussed in the rationale, a number of constraints were established at the onset on the design of the module. This situation is not unusual in industrial training where instructional technologists must recognize and work within limits imposed on their design efforts. Secondly, as outlined in the review of the literature, few attempts at training technical content experts to conduct information processing analysis have been reported. The present study was therefore part of an innovative attempt at training technical content experts in task analysis. A number of conclusions linked to the aforementioned circumstances can be drawn from this study:

1. While some constraints imposed on design of instructional materials must be recognized and accepted (those linked to cost, time and media selection, for example), constraints on availability of human resources required for development of effective materials need to be reevaluated. Weaknesses in the instructional materials pointed to the importance of having access to naive

learners from the target population and current technical content expertise if the level of instruction is to be appropriate and if technical content is to be accurate.

2. The revised module on Task Analysis/Flowcharting was found to be generally effective, enabling SMEs to generate algorithmic flowcharts of tasks that make up their job. There are, however, a number of limitations to this study that should be considerd:

   a) Due to organizational constraints, no cost-effective analysis of the training module could be performed. This is due to the type of confidential information which would have been necessary (i.e., salaries).

   b) Although the sample was representative of the target population and included 20% of the total expected population in the following two years, the small number of students involved in the study makes it difficult to generalize the findings. However, data that were gathered may in fact be indicative of the sorts of results that could be expected from SMEs with similar technical backgrounds who are required to meet similar performance objectives.

c) Summative evaluation could not be carried out to see whether or not training directly affected job performance. Students involved in this study had been selected to participate in evaluation and were not subsequently involved in task analysis for Servocenter. In fact, in its search for increased effectiveness in designing instructional materials, Servocenter questioned, as a result of this experience, the merits of training SMEs as designers for temporary assignments, and had temporarily reverted back to using them strictly as technical content experts.

3. The merits of training technical content experts in task analysis should be carefully evaluated in the light of the quality of SMEs that are available. The production of useful and accurate algorithms requires that the analyst "know how to break down the cognitive process into relatively elementary operations" (Landa, 1982, p.13), a skill that is difficult to acquire in a short period of time, particularly so for SMEs whose jobs don't require a great deal of problem-solving. If one should want to adopt this approach, attention should be paid to selection criteria for SMEs. Perhaps the use of management personnel whose duties require some analytical

and problem-solving skills should be considered. Failing availability of technically current managers, it may be more realistic to have SMEs participate in designing activities that require application of specific techniques rather than extensive analytical capabilities, as is suggested by Terrell (1983). In essence, the SME's prerequisite skills must match their role in the ISD process in the same way a learner's must to instruction. Equivalent analyses are therefore required.

While the present study has provided useful information about the ISD/SME interaction, more research is required to identify the most effective ways of involving SMEs in design of instructional materials. Only by successfuly addressing this issue will industry be able to meet the challenge of keeping up with technical training requirements emanating from a rapidly changing technology.

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APPENDIX A

POST-TEST

CST-2
7/76

CC 1 5 Page 1 of 5

TASK ANALYSIS; FLOWCHARTING

CC 2 RE-KC-1

Name:

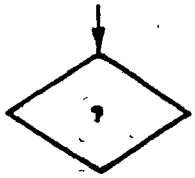
Issue CC 20 1 Version CC 21

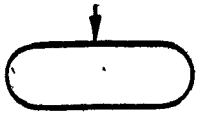
SRB CC 22

Date CC 28 MO. DAY YR.

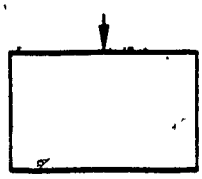
1. Below are five flowcharting symbols. Identify their names (or functions) by writing the code letter corresponding to your choice in the appropriate box to the left of the symbol.

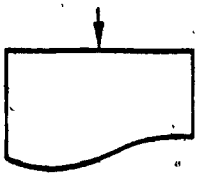
DECISION POINT	Code with letter "A"
CONNECTOR	Code with letter "B"
BEGINNING OR END	Code with letter "C"
DOCUMENT	Code with letter "D"
ACTION ELEMENT	Code with letter "E"

CC 34 a) 

b) 

c) 

d) 

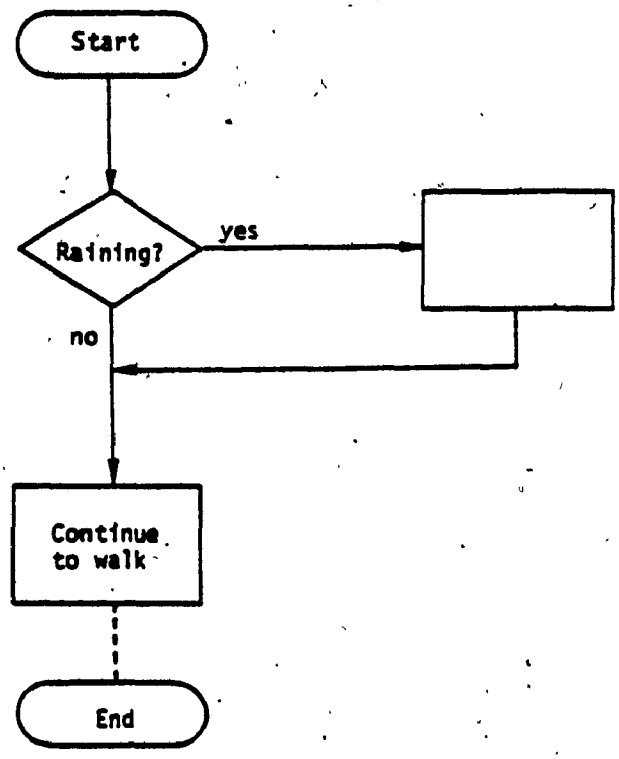
e) 

Page 2 follows

For the next two questions (2 & 3), you will find written descriptions of sub-tasks and incomplete flowcharts of these sub-tasks. Using the descriptions, complete the flowcharts for each of these questions.

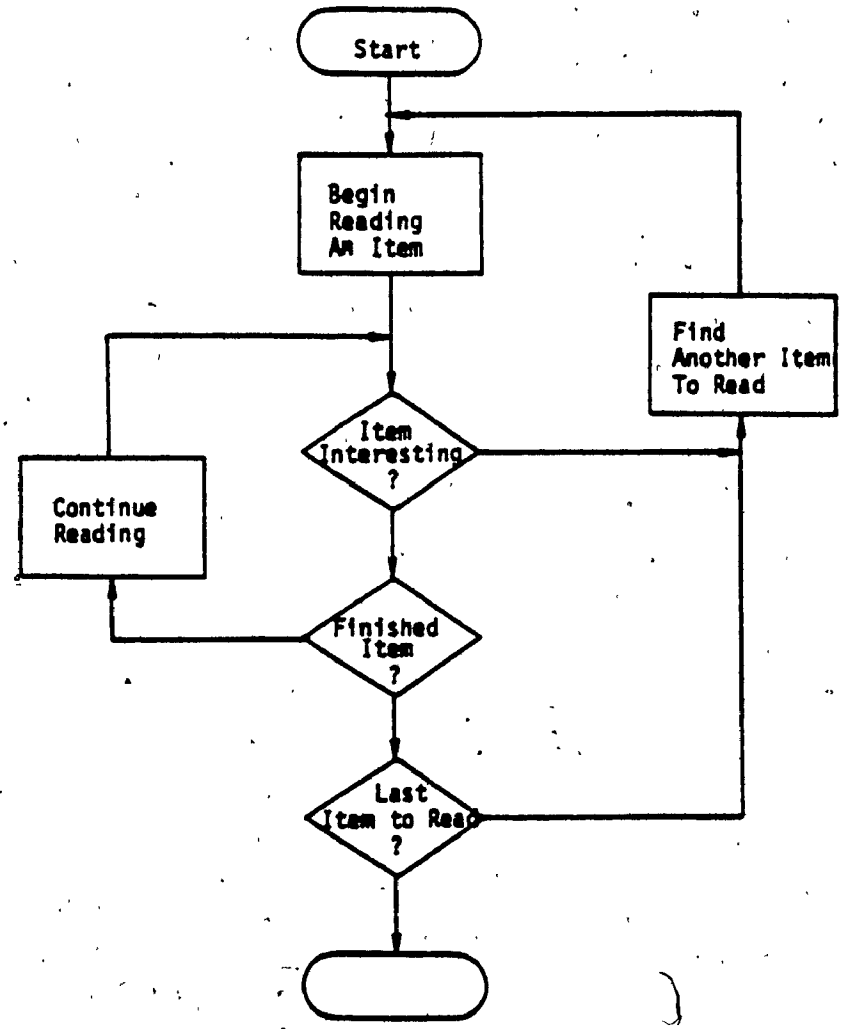
cc 39 | 2 | x

2. If it begins to rain, I open my umbrella and continue my walk. If it is not raining, I simply continue on my walk.



3. I begin reading a newspaper item. If the item is interesting, I continue reading the same item to the end. If the item is not interesting or if I have finished reading it, I go on to another item unless this is the last item. Then I've finished reading and this is the end of the task.

CC 40	1	x	a)
	1	x	b)
	1	x	c)
	1	x	d)
	1	x	e)
	1	x	f)
	1	x	g)



Page 4 follows

USE FOR QUESTION NO. 4

The task described below is that of sharpening a pencil in either a manual or electric pencil sharpener which may or may not be in use and which may or may not be in working order. Make sure that you use the right flowchart symbols for the right steps, and that you chart all the steps in the correct sequence.

When I start, the first thing I do is find a pencil sharpener. Once I've found one, I ask myself if it is being used; if it is, I wait. If it is not being used, I then ask myself if it is an electric sharpener.

If it is an electric sharpener, I proceed as follows:

I put the pencil in the guide and press lightly on the pencil.

I then listen for the motor turning.

If it is not turning, I check to see if the plug is in.

If the plug is not in, I put it in and again listen for the motor.

If the plug is in, it must be that the sharpener is not functioning and I go and look for another sharpener. (First step).

If the motor turns when I put in the pencil, I wait a few seconds.

I then take out the pencil.

I then check to see if the pencil is sharp; if it is, that is the end of my task.

If the pencil is not sharp, I re-insert the pencil in the guide and repeat the process.

If I have found a manual sharpener, instead of an electric sharpener, this is how I proceed:

I put the pencil in the guide and press lightly on the pencil.

I then turn the pencil sharpener's crank clockwise several times.

I then take out the pencil and then check and see if it is sharp.

If it is, again, that is the end of the task.

On the other hand, if the pencil is not sharp, I re-insert it into the guide and repeat the process.

Direction
1
X
4 a
1
X
4 b
1
X
4 c
4 d
1
X
4 e
1
X
4 f
1
X
4 g
1
X
4 h
4 i
4 j
Direction

106

4. On the opposite page is a description of a task. On this page, you should flowchart the task from beginning to end. We recommend that you first flowchart this task on a separate piece of paper and then transcribe your answer to this page when you have finished. Drawing the flowchart symbols freehand will be sufficient for both your rough and final drafts. You may want to use a ruler.

FOLD OUT

Page 5 follows

On completion, give this test to your advisor for marking.

Correct

Alternates

Maximum Score - 40 Total Score 0

NOTE: Normally, the advisor will discuss with the student and correct errors made on the Post-Test only.

However, if 90% is attained on the Pre-Test and the student will not be completing the training unit, then the advisor must discuss correct answers to the errors made on the Pre-Test.

Task Analysis/Flowcharting

Issue 1 (Unrevised)

Student Scores on Embedded Post-Test Questions

Number of Students	: 8
Maximum Raw Score Possible	: 40
Responses	: 23
Average Score Obtained	: 36.37 = 91%
Pass	: 90%

Question																						
Part	A	B	C	D	E		A	B	C	D	E	F	G	A	B	C	D	E	F	G	H	I	J
Score	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	6	8
Total Correct	8	8	8	8	8		7	7	8	7	8	8	8	7	7	6	7	8	8	8	8	8	8
Wrong							1	1						1	1	1							
Blank										1						1	1						
Total Errors							1	1		1				1	1	2	1						

APPENDIX B

PROBLEM ANALYSIS

INTERVIEW QUESTIONNAIRE 1

ITS AND MANAGERS

1. Who are the SMEs? What can you tell me about their background (education, experience, etc.)?

2. What do you expect SME's to do as a result of instruction? Specify standards, criteria and conditions?

3. What are they doing now and how does that fall short of what you want them to do?

4. Why do you think they are unable to do task analysis?

5. What do you find unsatisfactory in the existing program and do you have any ideas as to how it should be improved?

6. How would you explain the high pre and post test results on the existing program?

PROBLEM ANALYSIS

INTERVIEW QUESTIONNAIRE 2

SME'S

1. What exactly were you expected to do in your job at HQ?

2. Do you feel the training materials helped you do your job?

3. Was the instruction interesting?

4. Did you understand what you were supposed to learn?

5. Were there enough practice exercises? Did you know when you were right or wrong in your answers?

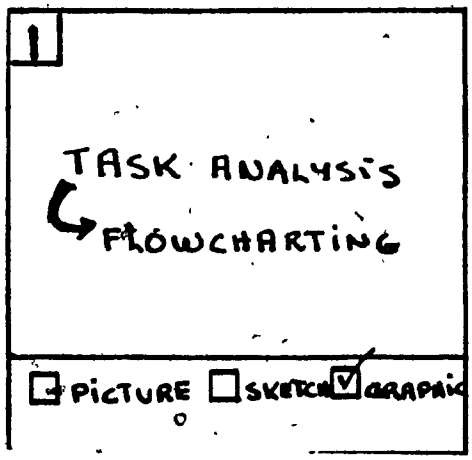
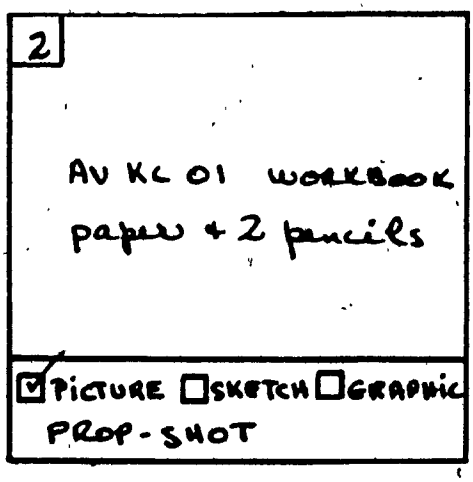
6. How do you think the program should be improved?

7. Other comments?

APPENDIX C

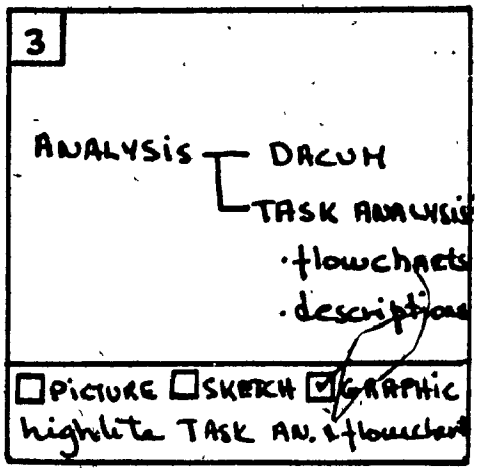
TASK ANALYSIS / FLOWCHARTING

A - V SCRIPT

VISUAL #		NARRATION
1		This is the beginning of the unit on task analysis - flowcharting.
2		You should have some pencils, the AV-KC-01 workbook and some paper in front of you. If you don't, stop the machine while you get them.

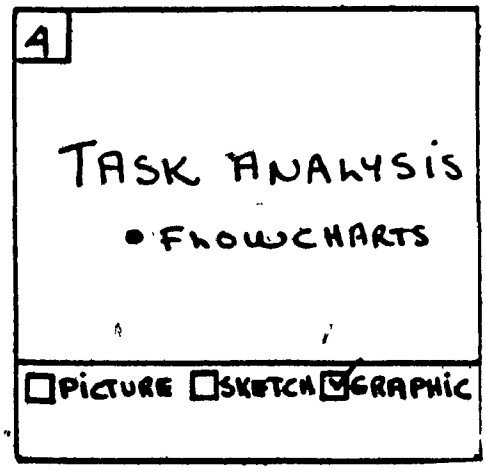
VISUAL # | NARRATION

3



This unit will show you how to analyze the parts of the job you are going to teach and how to describe these parts in a flowchart. We won't go into great detail but you will have a good understanding of task analysis and flowcharts when you've finished this unit.

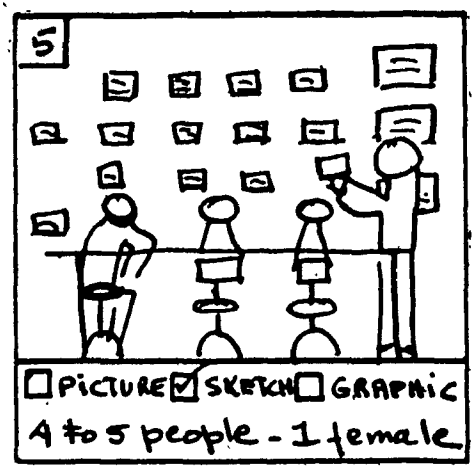
4



Let's start by talking about what these terms - task analysis and flowcharts - mean.

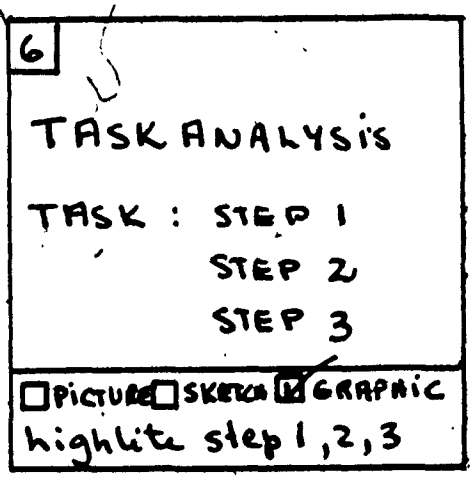
VISUAL # | NARRATION.

5

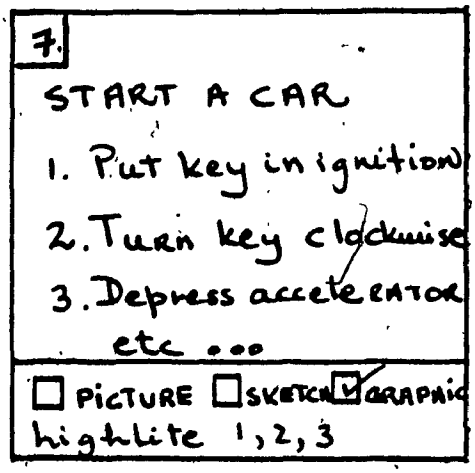
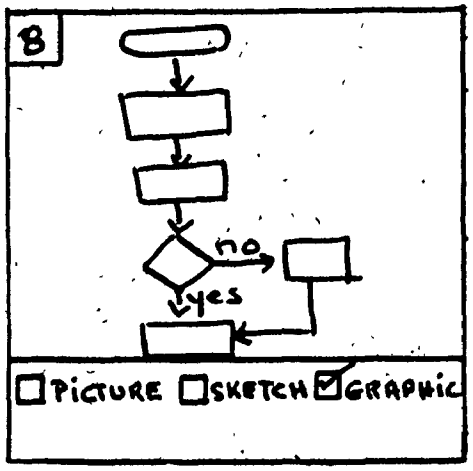


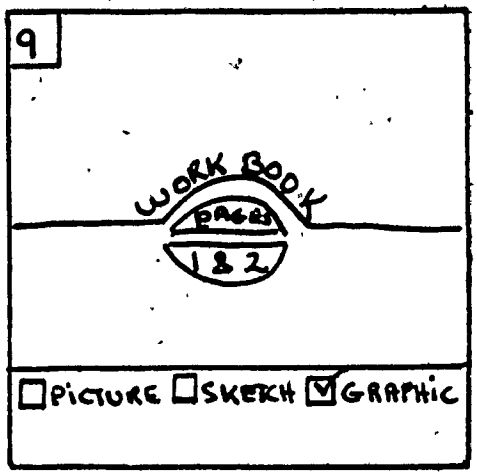
The preceding unit discussed the DACUM approach where you and other experts are asked to analyze the ins and outs of your job, to break it down into definite pieces of work to be done or tasks. The outcome of the DACUM session is a DACUM chart, a list of the tasks that make up the job.

6



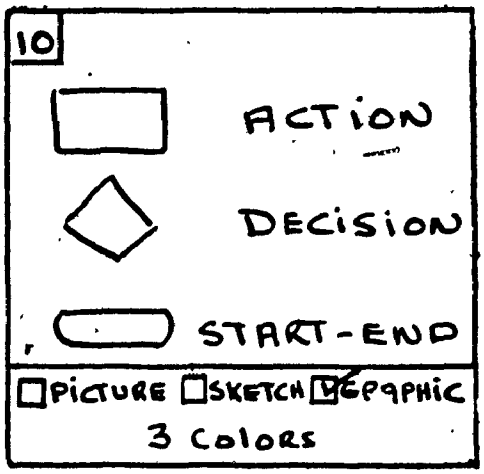
Once you've done the DACUM, the next step is task analysis. When you do task analysis, you examine a task and break it down into every step.

VISUAL #		NARRATION
7		So the task, start a car, is broken down into all the steps that you have to take from beginning to end.
8		One way of breaking down the steps that make up a task is to write the steps as a flowchart. A flowchart uses symbols to show what happens from beginning to end when you do a task. This training unit is going to teach you how to draw flowcharts for tasks.

VISUAL #	NARRATION
9 	This is a good time to read the objectives for this training unit. Open your workbook on page 1 (3 secs.) Read the objectives. Then turn the page and look at the flowchart on page 2. When you finished, restart the machine. Stop the machine now. (5 secs.)

VISUAL # | NARRATION

10



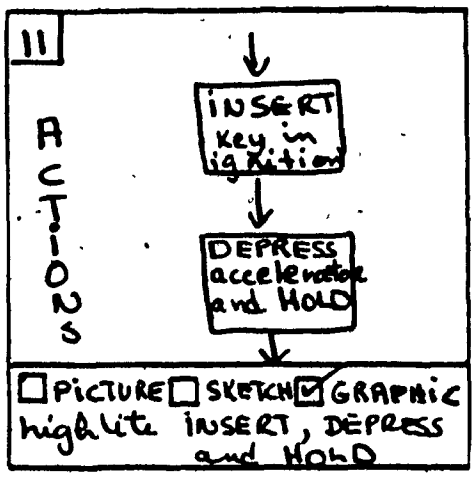
As you can see, a flowchart describes the steps that make up a task in graphic form. The symbols used in describing tasks have been borrowed from computer programmers. They first used flowcharts as a way of describing computer applications.

The shape of the symbols you use depends on what is being performed:

An action, a decision, the beginning or end of a task.

VISUAL # NARRATION

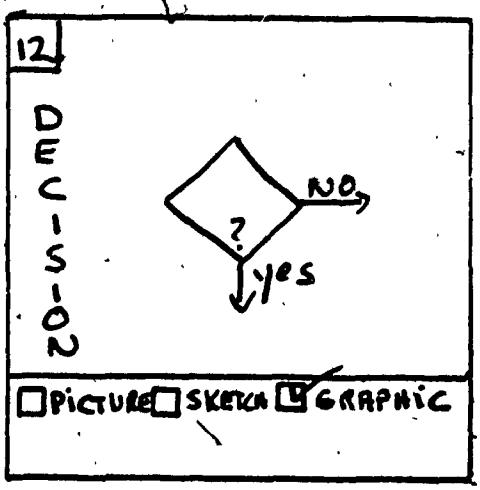
11



The action or operation symbol is used to represent the actions you take to perform a task.

You describe each action with an action verb such as insert, depress, hold, and so on to describe the action.

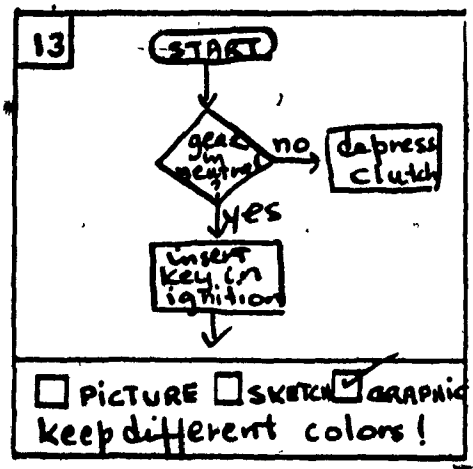
12



The decision symbol is used to identify decision points - sort of like cross-roads where you decide which course of action to follow.

VISUAL # | NARRATION

13



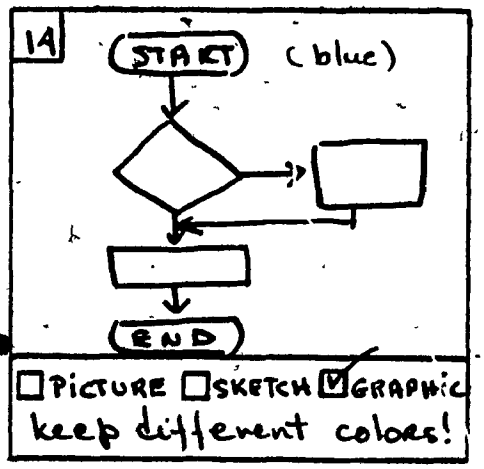
The decision symbol makes you ask yourself a question. For example, ask yourself: "Is the gear shift in neutral?" The answer, yes or no, will tell you what you do next. If the answer is no, then the no arrow on the right leads you to one action. If the answer is yes, then the yes arrow leads you straight down to a different action.

This flowchart reads: "When I start a car, I check if the gear shift is in neutral. If it isn't, I depress the clutch and then I insert the key in the ignition.

VISUAL #

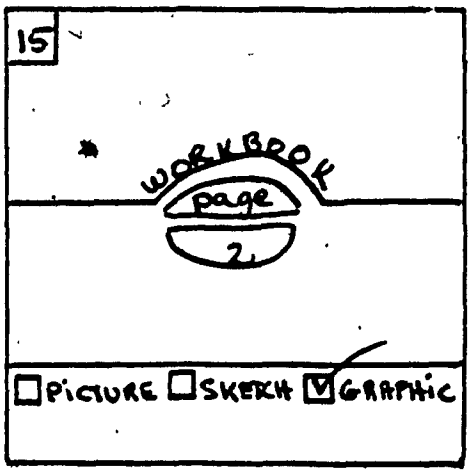
NARRATION

14



Finally, the symbol drawn in blue is used at the beginning and end of a task. It indicates where a task starts and where it ends.

15



Look at the flowchart on page 2 again carefully.

(3 sec. pause)

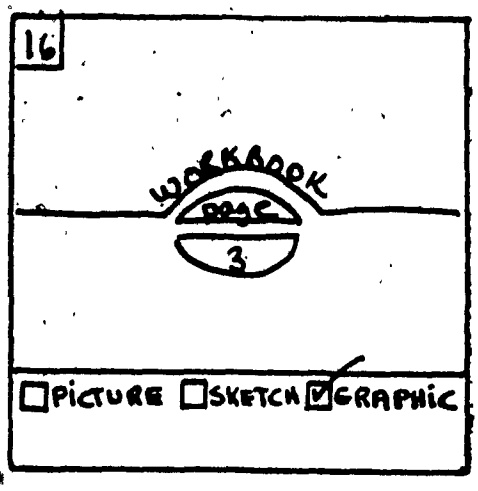
Try to imagine you are someone who knows absolutely nothing about driving. Does this diagram describe in enough detail what you do to start a car and in what order? Assume that the car is a four on the floor, that the weather is nice and that you have enough gas.

(pause 2 secs.)

126

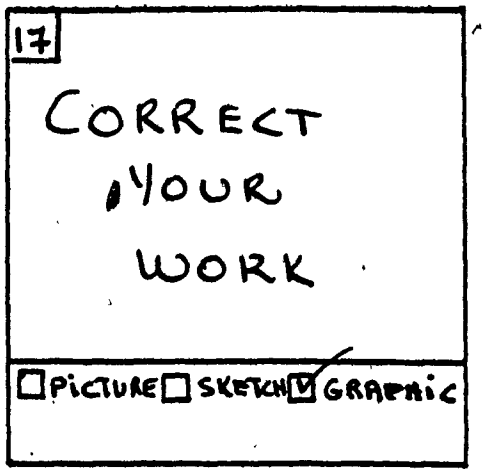
VISUAL #	NARRATION
	Go through it on your own; when you think you understand, turn the machine on again. Stop the machine now.
	(5 secs.)
	Let's see if you read it correctly. Follow along as I read it.
	- When I start, I check if the gear shift is in neutral.
	- If it isn't, I depress the clutch
	- I then insert the key in the ignition
	- I turn the key clockwise
	- I depress the accelerator pedal 1 inch and hold.
	- If the motor starts, I release the key and accelerator.

VISUAL #	NARRATION
	- If it doesn't start, I release the key and accelerator, wait 10 seconds and try turning the key and depressing the accelerator pedal until it starts.
	I finally release the key and accelerator.
	(Pause - 3 secs.)
	O.K. Now that you've read the chart on page 2 let's look at the symbols and how they are used. First, notice that all the <u>actions</u> you take to start a car are written in rectangular blocks. They are lined up from the top of the page to the bottom in the order they are to be done.

VISUAL #	NARRATION
	The arrow leads you from one step to the other. This tells a learner which action to do first, what comes second and so on.
	(pause)
	Decision points, the diamond shapes, are also checkpoints. They tell a learner to ask a question: the answer to the question will indicate what action to take next in order to complete the task.
16 	Now turn to page 3.
	(3 secs.)
	Answer these questions. When you have corrected your answers, restart the machine. Stop the machine now.
	(5 secs.)

VISUAL # NARRATION

17



Have you corrected your answers? If not, stop the machine and go to page 4 in your workbook. If you've already corrected your answers, you can go on.

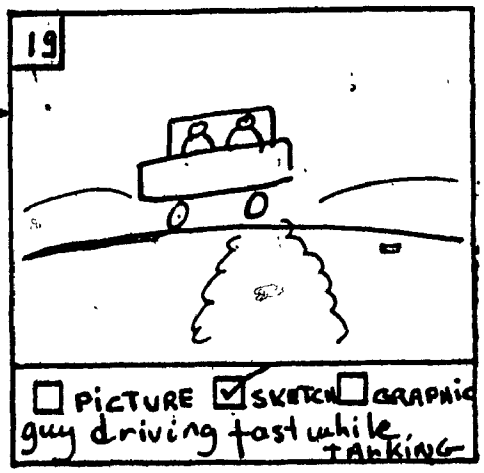
(Pause 3 secs.)

18

Congratulations! you can now read a flowchart. However, you may be wondering why you need to be able to read flowcharts, and what you will be using them for in writing your courses.

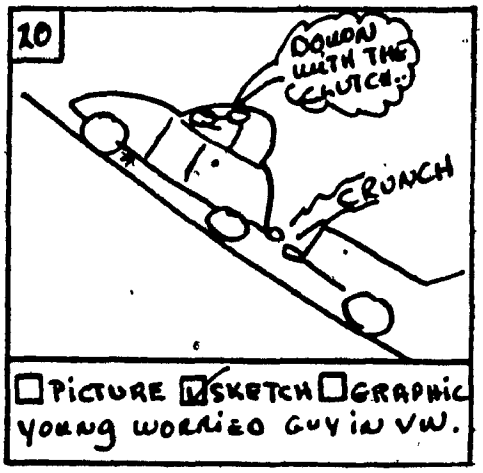
VISUAL # NARRATION

19

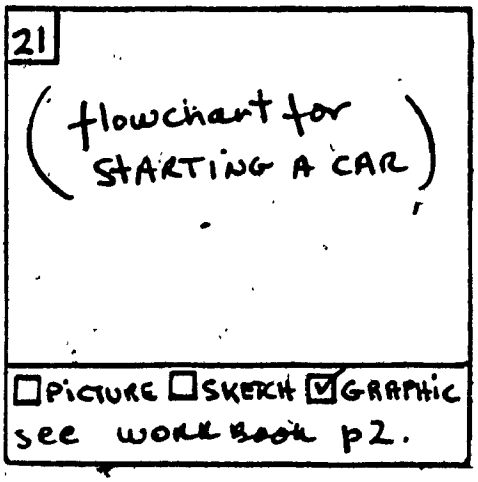
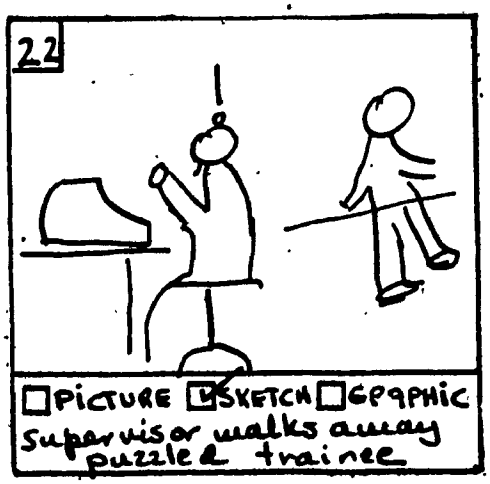


Being an expert in your field, you probably do your job as automatically as you would ... drive your car for instance.

20



But remember how difficult it seemed when you first had to learn how to put your car into gear? Remeber how difficult it was when you didn't know anything about your job? What you now find simple because you have experience may seem quite complex to someone who is new to it.

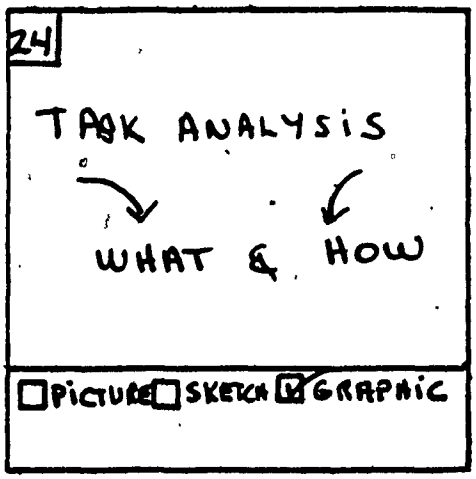
VISUAL #		NARRATION
21		The flowchart for starting a car, shows you how complex a task that seems simple to an expert really is for someone who hasn't done it before. There are all the actions to learn, the order in which they have to be performed and the check points to remember.
22		When you write a training unit, you have to teach someone who probably knows little or nothing about the job, how to do it. Would you just walk away from your desk and say to a new person: "Go ahead, you're on your own?..." Of course not.

VISUAL # | NARRATION

23

You would spell out to him or her exactly what has to be done. That means you would have to pause and think about it. Perhaps write it down so you don't forget anything.

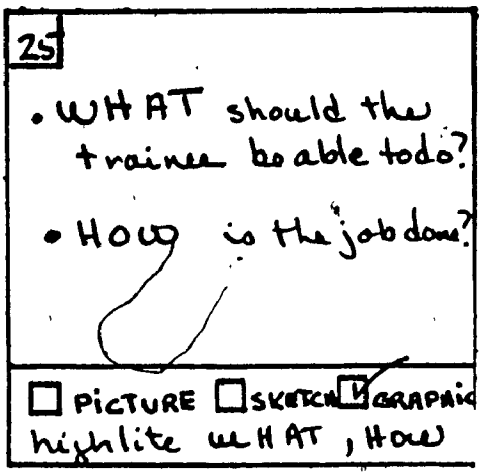
24



So when you design training, you sit down and spell out <u>what</u> the trainees must be able to do and <u>how</u> they should do it. This is called task analysis.

VISUAL # NARRATION

25



You begin your task analysis by answering these two important questions:

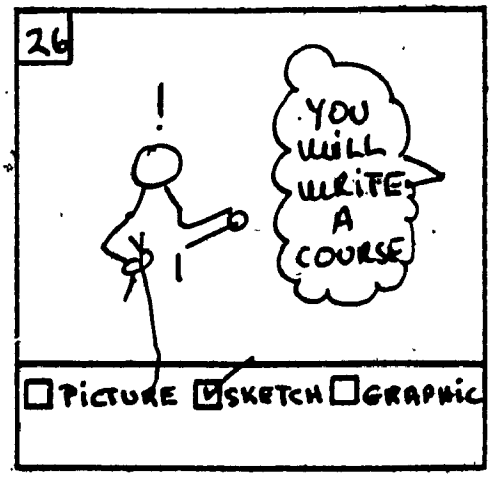
"What should the trainee be able to do?" This helps you identify what big chunks of knowledge or skills you'll need to teach.

Second -

"How is each task done?"

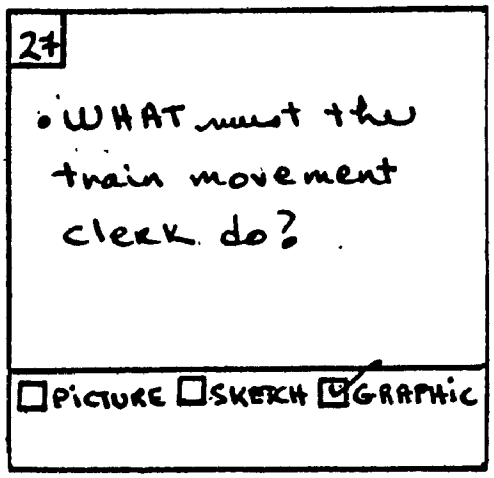
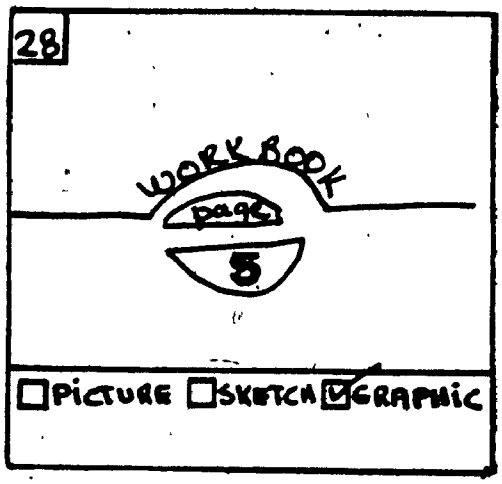
This is the finer detail. It makes sure you don't forget anything and reminds you what comes first, then second, and so on.

26

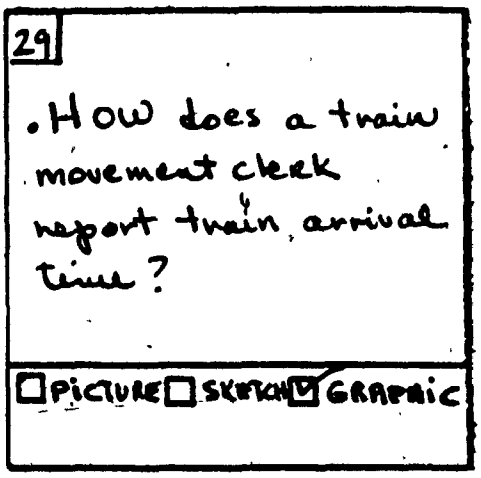


Let's say you're asked to write a course for new train movement clerks.

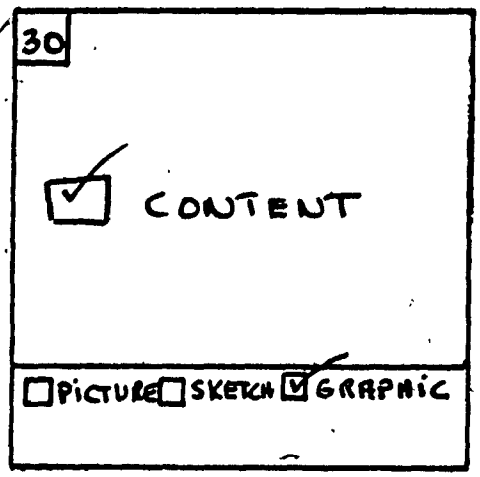
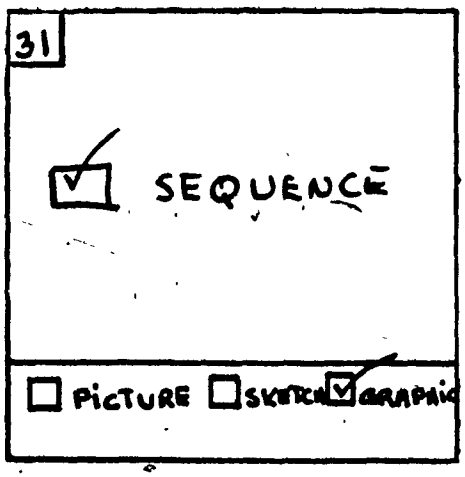
Where do you start?

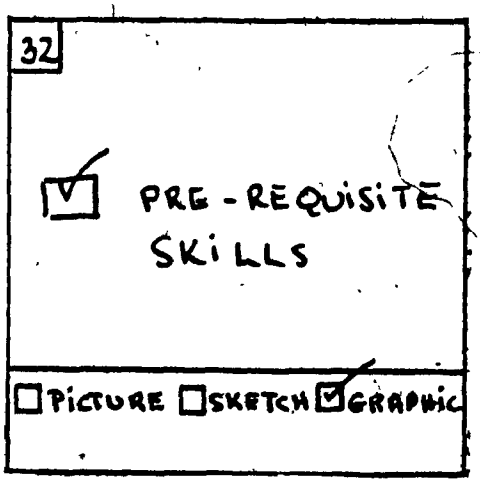
VISUAL #		NARRATION
27		Well, first you answer the question: "<u>What</u> must the train movement clerk be able to do?" You'll find your first clues in your DACUM chart.
28		Turn to page 5 in your workbook. (3 secs.) Take a look at this partial DACUM chart for a train movement clerk. I'll wait for you. (7 secs.)

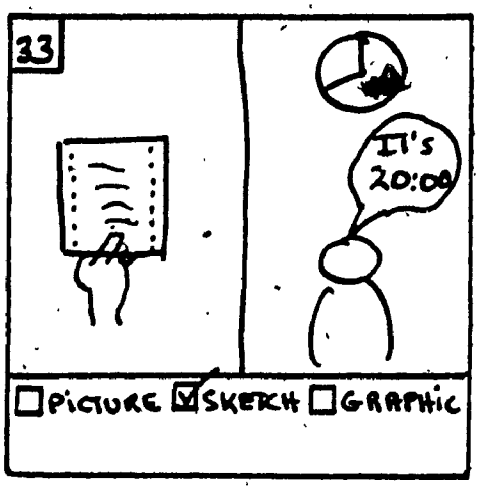
VISUAL #	NARRATION
	This DACUM chart breaks the job down into general areas of work. They are listed on the right. A train movement clerk reports train departures, handles documentation, processes train arrivals, and does other work.
	The chart also breaks each general area of work down into smaller chunks of work - into specific tasks. They are listed to the left of each general area of work. For instance look at the 3rd block down. It tells you that to process train arrivals, a clerk: - reports train arrival time

VISUAL #	NARRATION
	- compares bills, journal, consist and physical check and - reports work performed en route.
	So with this DACUM chart you know <u>what</u> the train movement clerk has to be able to do. The next step is to spell out <u>how</u> the job is done.
29 	For example, you know your train movement clerk has to report train arrival time. (3 secs.) Take a look at page 6 in your workbook. Look it over while I (10 secs.)

VISUAL #	NARRATION
	This flowchart breaks "reporting train arrival time" into the steps needed to do it. It tells you that to report train arrival time, a clerk first has to locate the train number, journal number and arrival time in the train journal; then he has to locate the track number where the train arrived, and so on.
	When you do your task analysis, this information is very useful to you.
	Look back at the screen now.

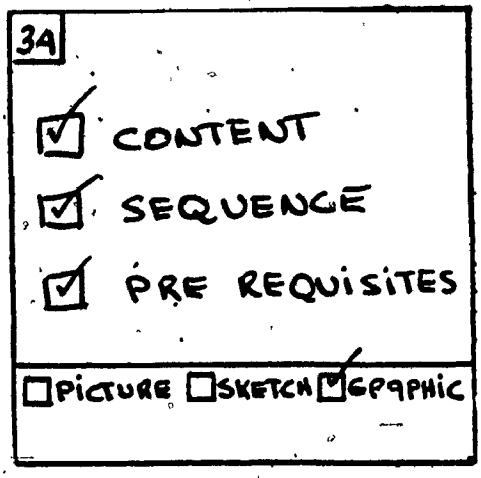
VISUAL #	NARRATION
30 	For one thing, the information makes sure you've covered everything the trainee needs to be able to do - that the content of your course will be complete. The train movement clerk will be able to report train arrival time because you haven't left any of the steps out.
31 	Second, the information helps you identify the order or sequence you will teach those steps. When you teach a train movement clerk how to report train arrival time, the first thing you have to cover is how to

VISUAL #	NARRATION
	locate the train number, journal number and arrival time in the train journal, then how to locate the track number and so on.
32 	Finally, a close look or analysis of the steps will help you identify what is called "prerequisite skills". That means skills that your clerk must have before he can do these steps. Let's say we want to analyze the first step: locate train number, journal number and arrival time in a train journal. What does a clerk need to be able to do before he can do this step?
	(3 secs.)

VISUAL #	NARRATION
33 	To locate a train number, journal number and arrival time in a journal, your clerk has to know what a train journal looks like - he has to be able to identify a journal first. He also has to be able to tell time with a 24-hour clock system. So before you teach the clerk to report train arrival time, you'll have to make sure he's seen a train journal first and that he can tell time with a 24-hour clock system.

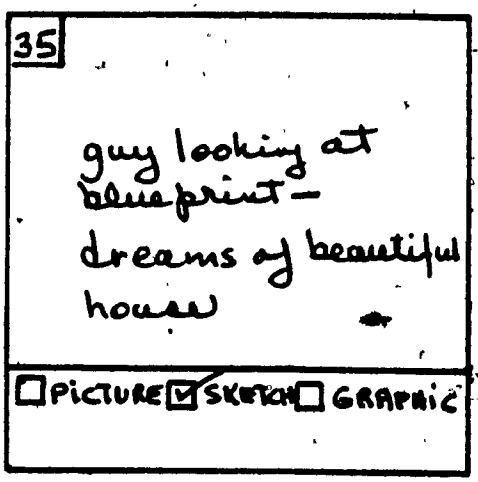
VISUAL # NARRATION

34



As you can see, task analysis is very useful when you write your course. It helps you make sure you've covered all the content, that you're teaching your material in the right order or sequence and that your trainees have all the prerequisite skills for the job.

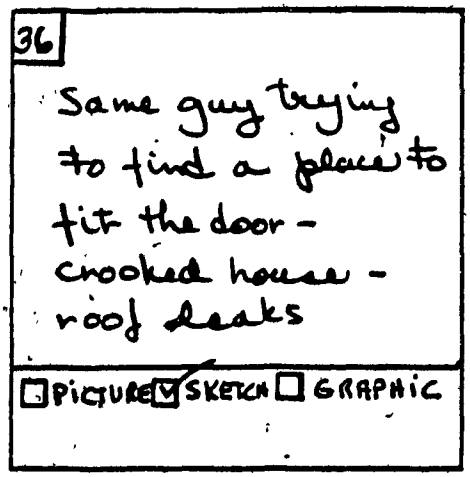
35



A flowchart is like a road-map. Flowcharting the job will help you make sure you don't forget anything and will help you see what your course could look like, just like a blueprint let's you see your dream house.

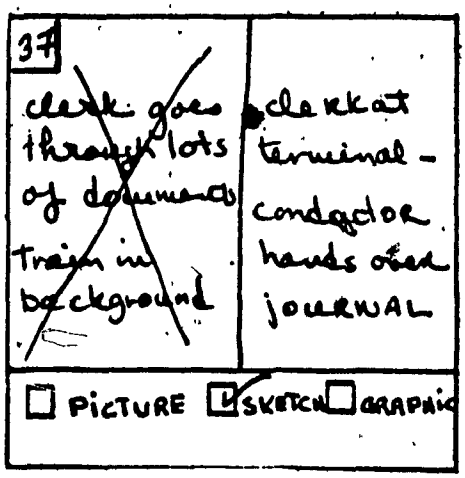
VISUAL # | NARRATION

36

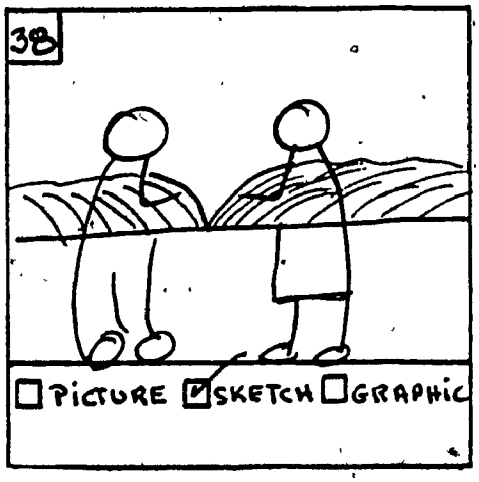


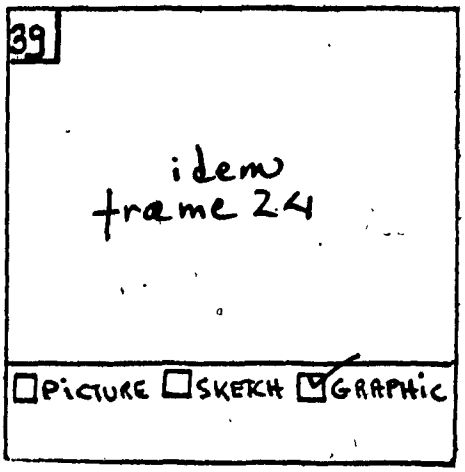
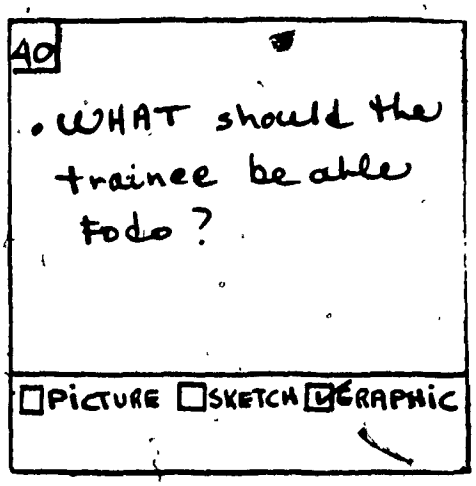
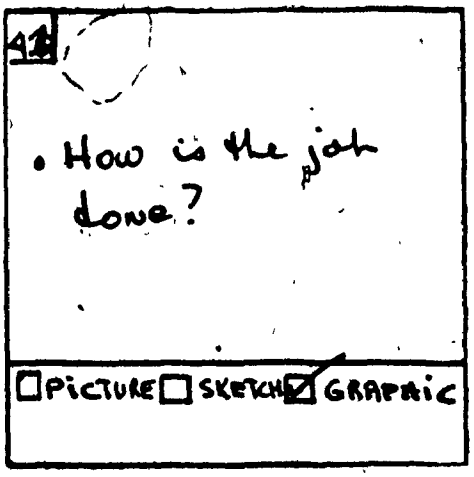
If you try to do a quick and dirty job, and don't pay attention to detail, the results will be botched - your course won't teach or just as bad it will teach incomplete material. It's worth taking the time to do a good task analysis so you don't have to waste time patching your course up later.

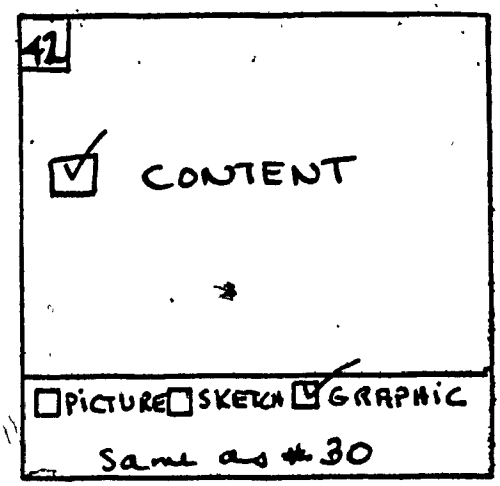
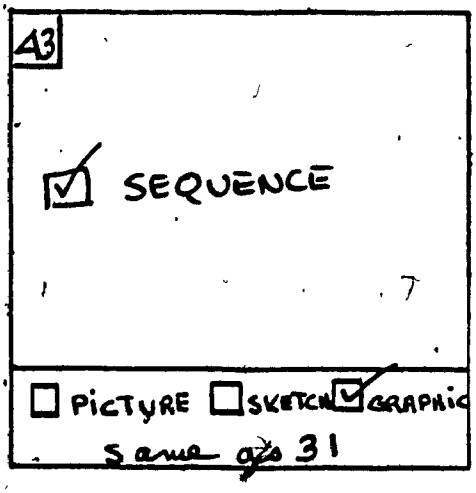
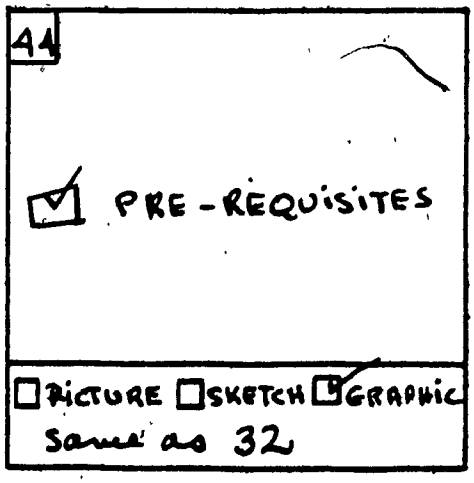
37

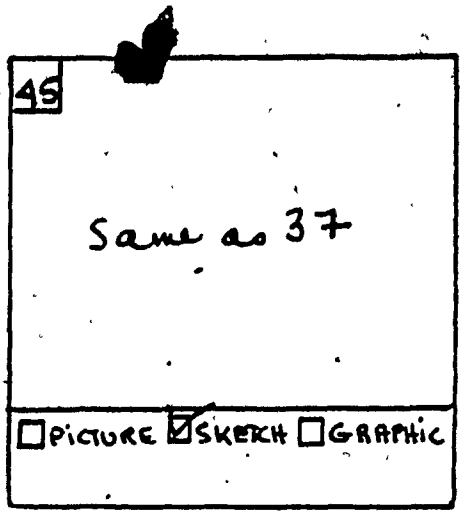
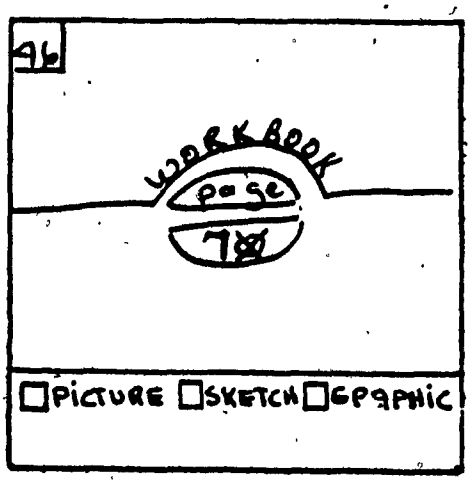


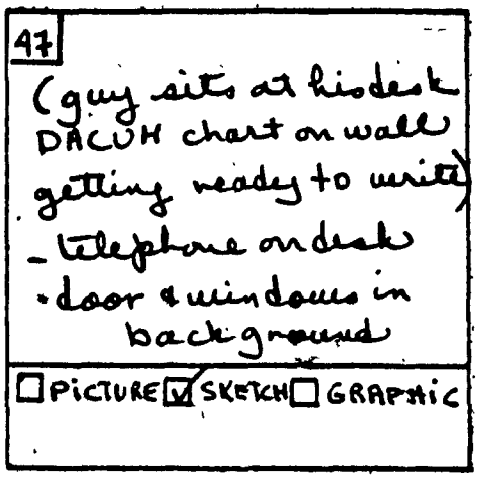
One last note of warning. When you list the steps in a task, or when you flowchart them, make sure you've described the correct way of doing it. Local exceptions or ways of doing things may not be the correct way. For example, many clerks report train arrivals to TRACS after

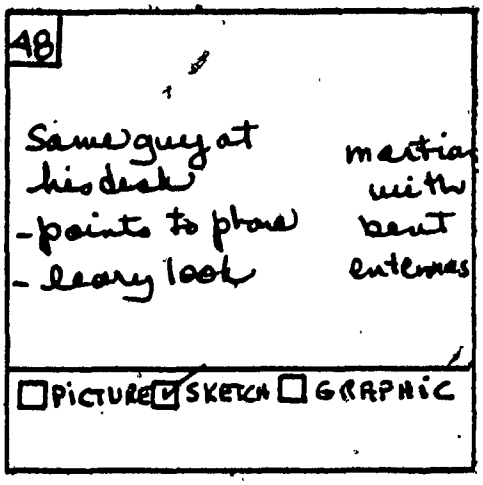
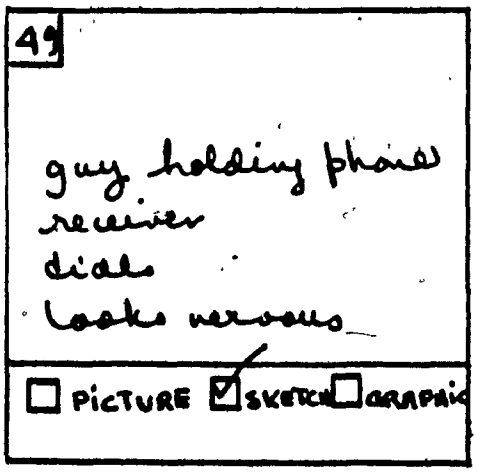
VISUAL #	NARRATION
	having checked all the documents. The correct procedure is to report train arrival on arrival.
38 	When you describe how the task is done, check with other SMEs and with reference documents such as the Integrated procedures manual and the tariffs if you need to - just to make sure you've pinned down the correct way of doing the task.
	(3 secs.)

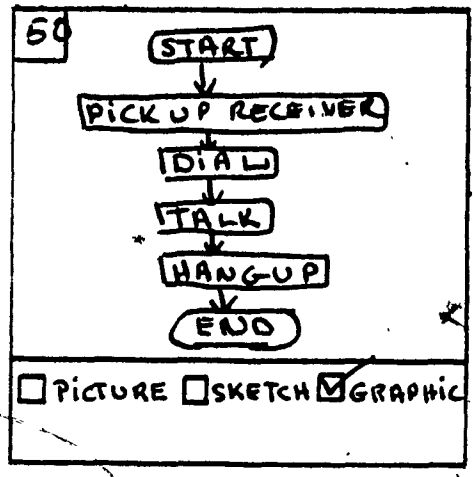
VISUAL #		NARRATION
39		O.K. time to review before you go on. You've seen that the first step in designing a course is to do a task analysis: you describe what you want the trainees to do and how they should do it.
40		You first ask "What should the trainee be able to do?" This gives you a detailed breakdown of all the tasks that the trainee must be able to do.
41		Then, for each one of those tasks you ask "How is the job done?" That's when you break down each task into the steps that make it up.

VISUAL #		NARRATION
42		Your task analysis helps you make sure that you haven't left anything out - that the content of your course is complete.
43		It also helps you make sure you've got all the steps in the right order - so that you'll teach your course in the right sequence.
44		And finally, it makes sure you've identified prerequisite skills before you teach each part of the job.

VISUAL #		NARRATION
45		If you want your course to teach the correct way of doing the job, make sure that when you flowchart the parts of the job, you describe the <u>correct</u> way of doing the job.
46		Go to your workbook page 7 and answer the questions. When you've finished, restart the machine. Stop the machine now. (5 secs.)

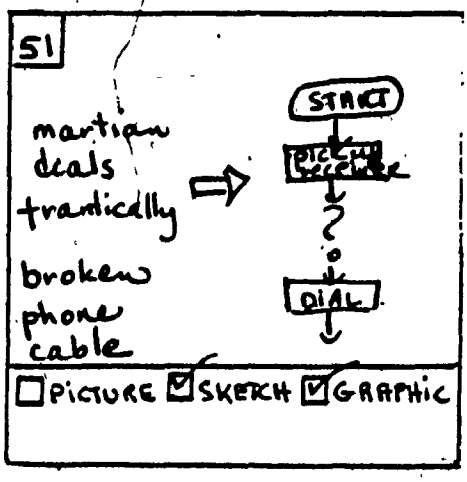
VISUAL #		NARRATION
47		O.K. So now you're all ready to start your analysis! You know what tasks make up the job and you now have to describe the steps in each task.
		But... (pause 2 secs.)
		What's this? ...
		(Sound of flying saucer) 3 secs.

VISUAL #		NARRATION
48		A martian's stumbled into your office! He wants to get in touch with a distant earth cousin but his mental telepathy system is out of wack.. You offer him the use of your telephone but he doesn't seem to know what to do with it. Looks like you'll have to describe how to make a phone call.
49		Since you're a bit nervous and this situation is a bit unusual, you simply say: "It's easy: Pick up the receiver, dial, talk and hang up." Then you discover martians only speak flowchart language - you'll have to draw the steps as a flowchart.

VISUAL #	NARRATION
50 	Let's tackle it. First, you use the start symbol to show where to begin. Next, you chart each action with an action symbol. You use action verbs, like pick up, dial, talk and hang up. At the bottom, you put an END symbol to show the task of making a phone call is finished. That's it. Those are the actions for making a phone call. But stop and take a look at the flowchart - By going through the steps, will the martian be able to make a phone call? (pause 5 secs.)

VISUAL # | NARRATION

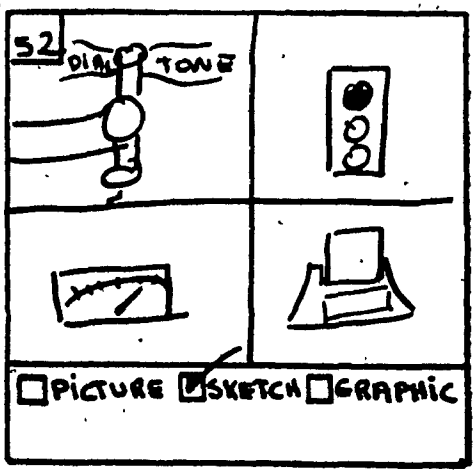
51



Maybe, but then again maybe not. What if the line is dead? Your martian can dial all he wants - he'll never complete his phone call. What is the missing step?

You have to tell the martian that he has to check that there is a dial tone before he dials.

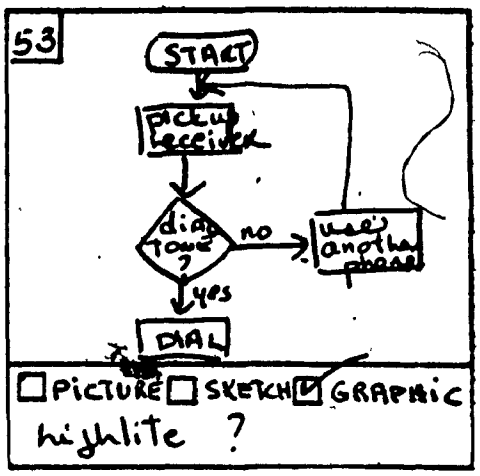
52



Every action or series of actions we take is usually preceded by some kind of signal. It could be a dial tone, a red light, a meter reading, a computer printout. Those signals tell us that we have to take some action.

VISUAL # NARRATION

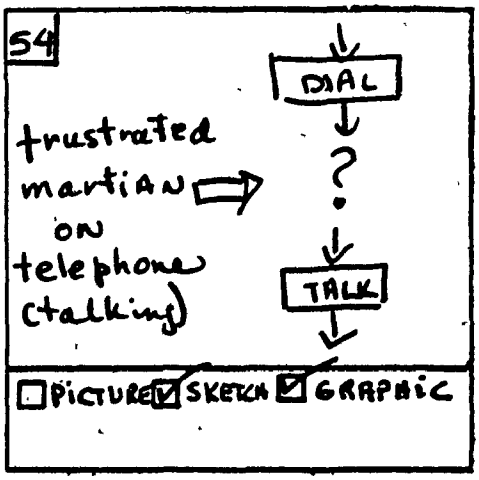
53



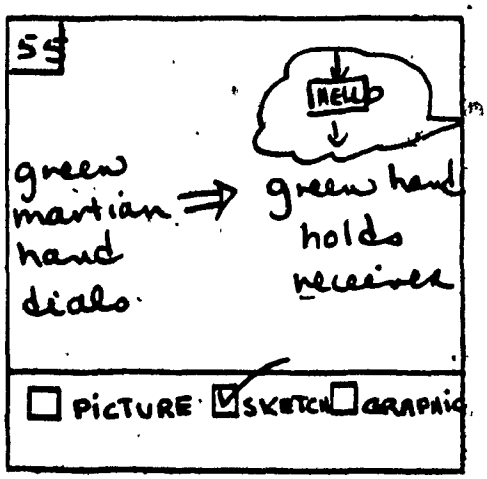
In flowchart language, signals are shown by the decision symbol, the diamond shapes. They ask questions. Your answer, yes or no, leads to the next action.

So the dial tone will tell (or signal) the martian he can dial. No dial tone would tell him to use another phone and start again by picking up the receiver.

54

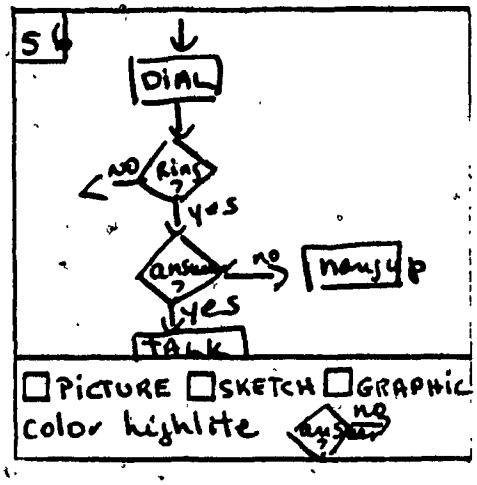


So now your martian has checked that there's a dial tone, has dialed, and is now talking. But he's becoming more and more frustrated. You discover that he's been talking but the line is busy.

VISUAL #	NARRATION
	Where did you go wrong?
	(pause 3 secs.)
	There's a step missing. You have to tell your martian to check that someone answers before he can talk.
55 	When we do something, we usually expect some kind of result or feedback. When the martian dials, he should expect the phone to ring and then be answered. This feedback will then act as a signal for his next action. When the phone is answered - the feedback, he can talk - his next action.

VISUAL # NARRATION

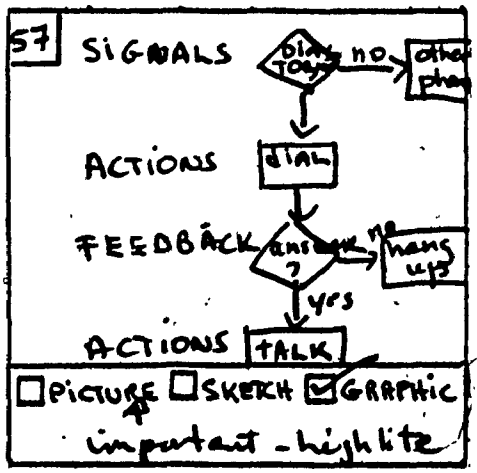
56



In flowchart language, feedback is drawn just like signals, in the decision symbols.

It also asks a question. Once you have dialed, does the phone ring? Is there an answer? If there is, then you talk; if there isn't, you hang up.

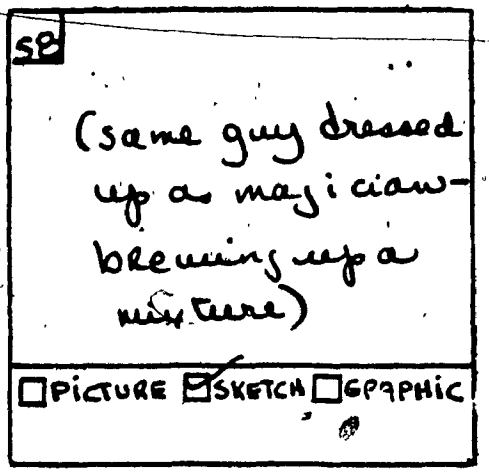
57



So you see, even a simple task like making a phone call is like a chain of signals, actions, and feedback. If you forget just one of those steps, you could break the chain, and your trainees won't be able to do their tasks.

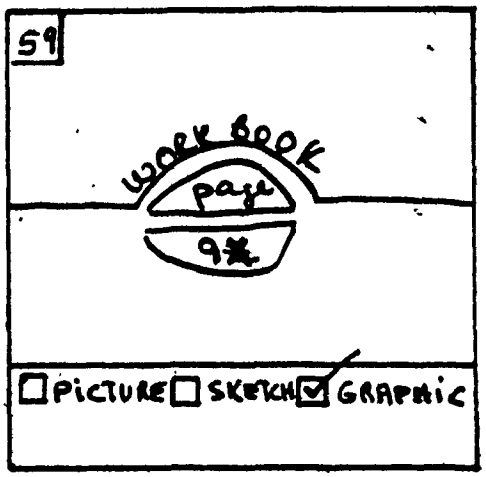
VISUAL # NARRATION

58



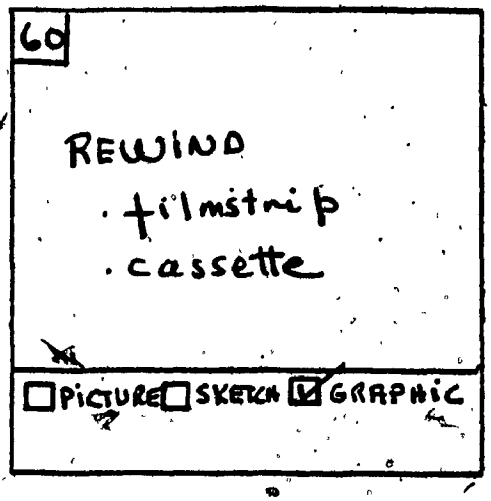
Unfortunately for us, there isn't one magic recipe for describing tasks. But there are three basic ingredients: your in-depth knowledge of your job, a bit of flowcharting techniques and a lot of practice.

59



Since you know your job, we'll concentrate on flowcharting techniques and give you some practice. From now on, you'll be working with the workbook only. Pull your workbook over and turn to page 9.

From now on, just follow the instructions at the bottom of the pages in the workbook.

VISUAL #		NARRATION
60		Please rewind the filmstrip and cassette. Stop the machine now.

APPENDIX D

MATERIALS

SELF-INSTRUCTIONAL PART

OF THE MODULE

POST-TEST

TASK ANALYSIS: FLOWCHARTING

ISSUE 1

AV KC 01

Date: _____

NAME: _____ S.R.B: _____

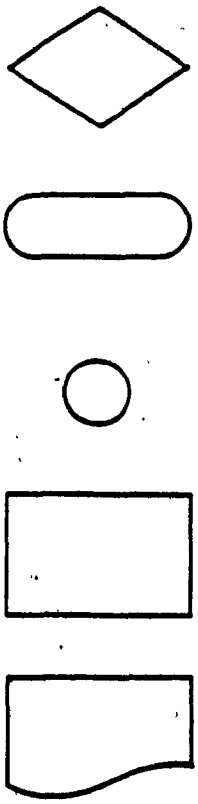
PRESENT POSITION: _____

LOCATION: _____

	MARK
1. When you do task analysis, which 2 questions do you need to answer?	
1) _____	☐
2) _____	☐
2. Give 3 reasons why it is important to do task analysis before you write a course	
1) _____	☐
2) _____	☐
3) _____	☐

Continued on Page 2

3. Below are five flowcharting symbols and five definitions of those symbols.
Match the symbols to the definitions using an arrow.



ACTION

DOCUMENT

DECISION

BEGINNING OR END

CONNECTOR

Continued on page 3

4. Below is a task description for obtaining and recording Bill of Lading information. Flowchart the steps in the correct sequence using the appropriate symbols. Use the next page to draw your completed flowchart. (Try drawing it out on other paper before).

When obtaining and recording bill of lading (B/L) information:

1. First obtain source information
2. Check if the car was previously billed
3. If it was, prepare for accounting and forward to accounting.
4. Then go to step 12 (check to see if there are more documents to prepare/check)
5. If it wasn't, verify if you are the first person receiving the information.
6. If you are, contact the other internal departments involved to relay information, then go to the next step. (step 7)
7. If you aren't the first person receiving the information, check if the information is on billable format.
8. If it isn't, transcribe the information onto the bill of lading form and then go to the next step. (step 9)
9. If it is, then check the bill of lading for completeness.
10. If it is complete, then go on to submit the complete B/L for coding.
11. If it isn't complete, go to flowchart on page 00 for instructions
12. Check to see if there are more documents to prepare or check.
13. If there aren't, you've finished.
14. If there are, start again from step 1.

Continued on page 4.

FLOWCHART THE STEPS FOR QUESTION 4 ON THIS PAGE

Continued on page 5

5. Here is a task description for making a TRACS inquiry. Flowchart the steps in the correct sequence using the appropriate symbols. Use the next page to draw your completed flowchart (Try drawing it out on other paper before).

When making a TRACS inquiry:

. First select the appropriate inquiry from the Integrated Procedures manual

. Check if the printer light is on

. If it isn't, turn it on

. Check if the paper is loaded properly in the printer

. If it isn't, load the paper

. Check if CRT is operating

. If it isn't, call on line control (possible computer processing problem)

. Wait till the CRT is operating

. When the CRT is operating, input the inquiry

. If the inquiry is accepted you've finished

. If it isn't accepted, check CRT to see if you've incorrectly inputed the inquiry:

. If you've incorrectly inputed, then correct the inquiry and check if it is accepted.

. If you've inputed correctly, call on line control (computer processing problem) and wait until CRT is ready before you re-input.

(Continued on page 6)

FLOWCHART THE STEPS FOR QUESTION 5 ON THIS PAGE

Continued on page 7

WHEN FINISHED, GIVE THIS POST-TEST TO YOUR ADVISOR FOR MARKING.

STUDENT'S TOTAL SCORE	
MAXIMUM POSSIBLE SCORE	100

STUDENT'S COMMENTS

We would appreciate your comments on this training unit to help us to make any future improvements. You can do this by completing this questionnaire and dropping it in the mail. You don't have to sign your name or show it to your supervisor or training advisor unless you wish to do so.

UNIT TITLE: _____ CODE: _____

1. Location instruction taken at _____ Date _____

2. Did you take the instruction by yourself? _____

   Was an advisor (Instructional Technologist) available for counseling?

   _____

3. I found this training

   Interesting ☐ Helpful ☐ Boring ☐

   Confusing ☐ Practical ☐ Useful ☐

4. I would rate the quality of the material as

	Visuals	Audio	Workbook
Very good			
Good			
Fair			
Poor			

   If rated fair or poor, please tell us why _____

   _____

   _____

5. I have the following suggestion(s) for improving the course:

   _____

   _____

   _____

(If more space is needed, continue on a separate sheet of paper and attach it to this form).

Please fold, staple and mail the completed form. Your cooperation is much appreciated.

FOLD STAPLE MAIL

STUDENT'S TRAINING LOG

UNIT TITLE _____ CODE NO. _____

STUDENT NAME _____ DATE: _____

This form is used to record the time you actually spend on studying this unit. As Headquarter records require the total time you must also include any time spent on preparing for the study session and counselling from your training advisor on your results.

TIME SPENT ON:	TIME STARTED	TIME STOPPED	TOTAL ELAPSED TIME
Preparation and set up			
Training			
Post-test			
Counselling			
TOTAL TIME (hours and minutes)			

ON COMPLETION OF TRAINING GIVE THIS FORM TO YOUR ADVISOR.

NOTES TO THE ADVISOR

UNIT NAME: TASK ANALYSIS: FLOWCHARTING UNIT CODE - AV-KC-01

This self-intructional unit is the first part of the training that will be administered to Subject Matter Experts in order to develop their skill in analyzing the tasks that make up their job and flowcharting them. It is designed to provide information on task analysis and flowcharting as well as practice in applying basic flowcharting rules to the description of tasks. The self-instructional part of the training will be followed by a practice session guided by a lesson directive designed to develop the analytical skills required to analyze tasks.

This unit consists of a 20-minute A.V. filmstrip with synchronized audio tape and an associated workbook. The total estimated time for completion in 3 hours, allowing for a break after about an hour of concentration and another before the post-test if the trainee so wishes.

There is no pre-test for this unit. It is assumed that the trainee entry level is 0. There is a post-test which must be handed in or mailed to H.Q. Servocentre Training for correction.

This unit can be administered either in home location or in the Servocentre training area. It is strongly recommended that it be taken in the servocentre training area so as:

- o to provide immediate feedback on post-test results from a qualified IT

- o to shorten the time lag between completion of this unit and participation in the follow up guided practice session, thereby increasing the possibility of retention.

Should the unit be taken in home location, the trainees are instructed to mail in their answers. The post-test correction guide will assist in correcting the post-test and can serve to diagnose where remedial training will be required in the "review"" part of the guided practice session.

VERY IMPORTANT:

This unit provides trainees with information on task analysis and practice exercises in applying flowcharting rules when describing tasks. Because the unit is self-instructional, feedback is provided for each exercise usually on the page that follows the exercise.

*** Flowcharting is a skill that implies logical thinking as well as application of rules. Because thinking processes vary amongst individuals, so the end-product: the flowchart, may vary as well, at least in its form.

Consequently, flowcharts drawn by trainees may differ from the ones drawn as feedback to the exercises on the answer pages that follow those exercises - yet they could still be correct. The same holds true for answers to the post-test, question 4 and 5 (where trainees are required to draw flowcharts).

Correct performance is to be evaluated not in terms of whether the flowchart drawn by SMEs look the same as the ones in the workbook but in the basis of the flowchart criteria:

- o all steps must be drawn (actions and mental processes)
- o in the correct sequence
- o using the appropriate symbols.

Trainees are reminded periodically throughout the units that the flowcharts they draw may differ from the one contained in the answer pages of the workbook. Should they have any questions, they will consult with an I.T. after they have taken the post-test (if an It is available) - (counselling time).

Before you administer the training unit:

Please remove both copies of the "Advisor's Report on Training Administered" from the back of the AV-KC-01 Workbook.

POST-TEST

CORRECTION GUIDE

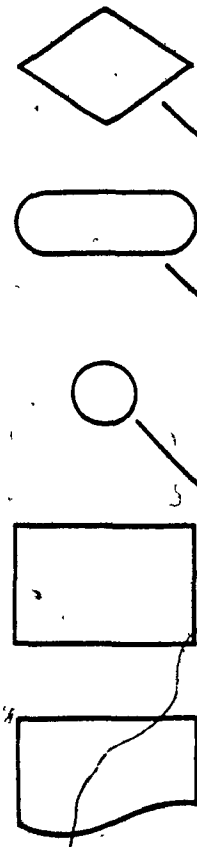
ANSWERS TO POST-TEST

TASK ANALYSIS: FLOWCHARTING | ISSUE 1 | AV KC 01

	MARK
1. When you do task analysis, which 2 questions do you need to answer?	
1) What does the trainee need to be able to do?	3
2) How is the job done?	3
2. Give 3 reasons why it is important to do task analysis before you write a course	
1. Content	3
2. Sequence	3
3. Pre-Requisites	3

Continued on Page 2

3. Below are five flowcharting symbols and five definitions of those symbols.
Match the symbols to the definitions using an arrow.



ACTION

DOCUMENT

DECISION

BEGINNING OR END

CONNECTOR

5

5

5

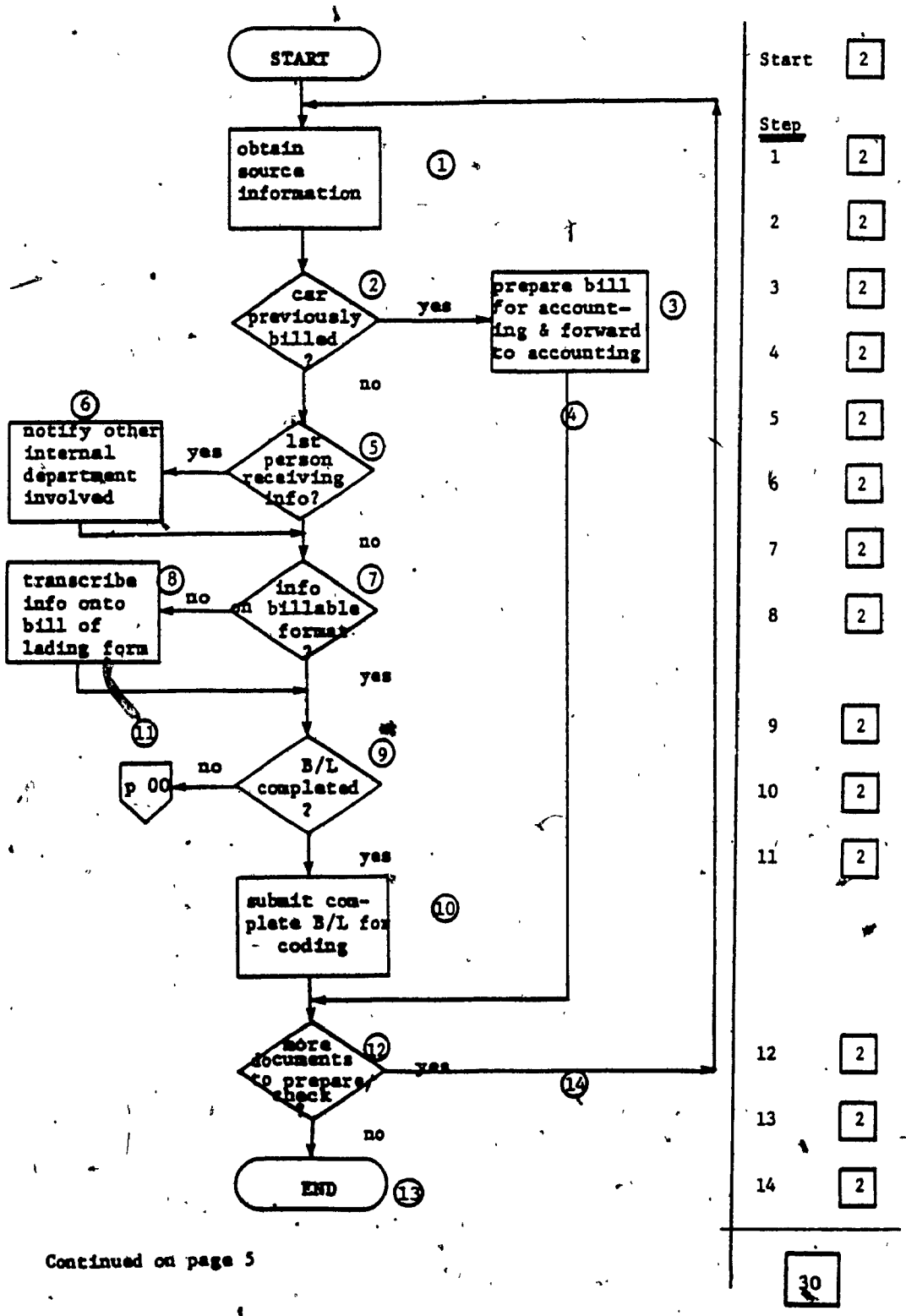
5

5

Continued on page 3

ANSWER TO QUESTION 4.

When obtaining and recording Bill of Lading (B/L) Information:



Continued on page 5

4. Below is a task description for obtaining and recording Bill of Lading information. Flowchart the steps in the correct sequence using the appropriate symbols. Use the next page to draw your completed flowchart. (Try drawing it out on other paper before).

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4. Then go to step 12 (check to see if there are more documents to prepare/check)
5. If it wasn't, verify if you are the first person receiving the information.
6. If you are, contact the other internal departments involved to relay information, then go to the next step.
7. If you aren't the first person receiving the information, check if the information is on billable format.
8. If it isn't, transcribe the information onto the bill of lading form and then go to the next step.
9. If it is, then check the bill of lading for completeness.
10. If it is complete, then go on to submit the complete B/L for coding.
11. If it isn't complete, complete with appropriate info (the flowchart for that is on another page - page 00)
12. Check to see if there are more documents to prepare or check.
13. If there aren't you've finished.
14. If there are, start the whole process again from step 1.

Continued on page 4.

5. Here is a task description for making a TRACS inquiry. Flowchart the steps in the correct sequence using the appropriate symbols. Use the next page to draw your completed flowchart (Try drawing it out on other paper before).

When making a TRACS inquiry:

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. If it isn't, call on line control (possible computer processing problem)

. Wait till the CRT is operating

. When the CRT is operating, input the inquiry

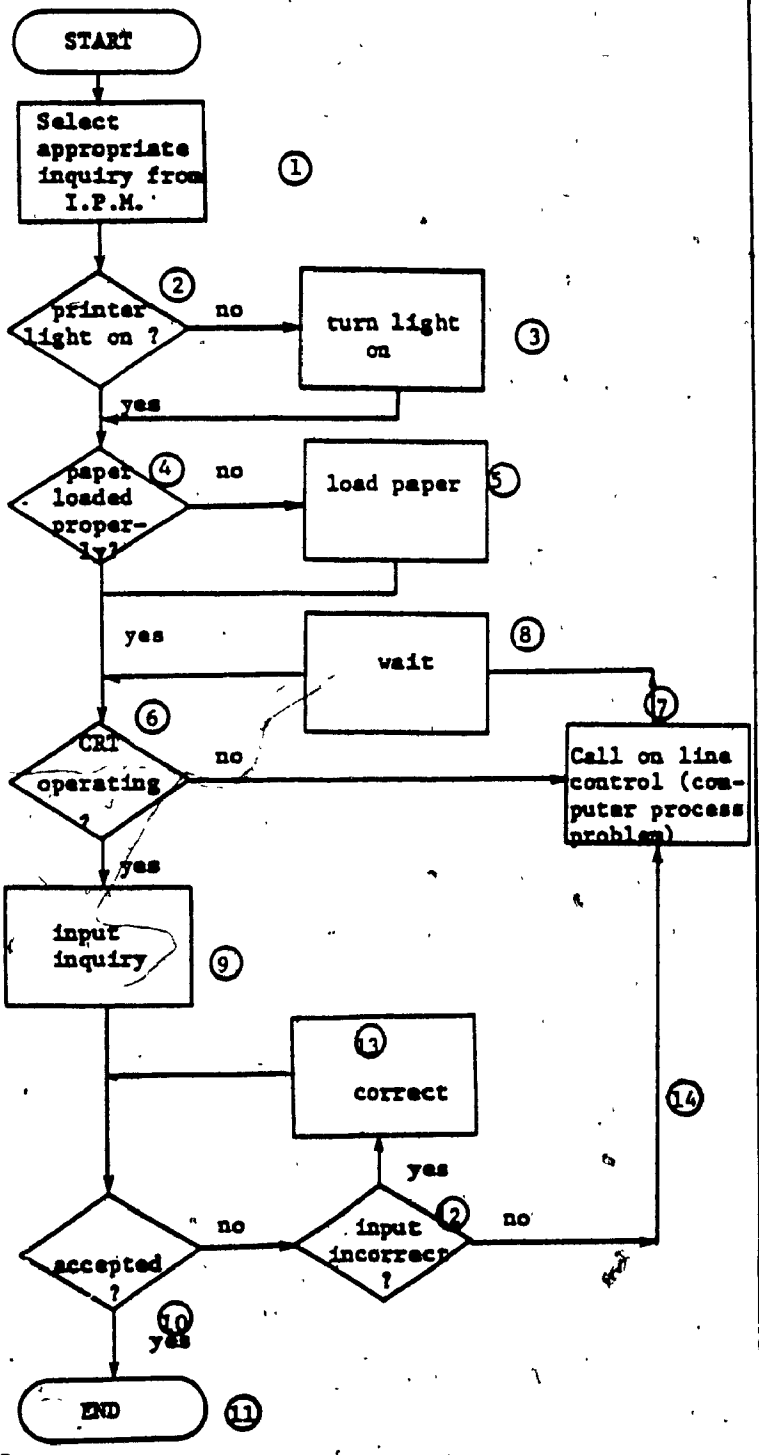
. If the inquiry is accepted you've finished

. If it isn't accepted, check CRT to see if you've incorrectly inputed, then correct the inquiry and check if it is accepted.

. If you've inputed correctly, call on line control (computer processing problem) and wait until CRT is ready before you re-input.

Continued on page 6.

ANSWER TO QUESTION 5



Start	
Step	
1	2
2	2
3	2
4	2
5	2
6	2
7	2
8	2
9	2
10	2
11	2
12	2
13	2
14	2
	30

Continued on page 7.

ADD UP STUDENT'S TOTAL SCORE

STUDENT'S TOTAL SCORE	
MAXIMUM POSSIBLE SCORE	100

ADVISOR'S REPORT ON TRAINING ADMINISTERED

UNIT CODE _____ ISSUE NO. 1

UNIT TITLE _____ DATE: _____

STUDENT NAME _____ S.R.B. _____

PRESENT POSITION _____

LOCATION _____

1. TIME AND COST TO TRAIN

	hrs.	minutes	rate/hour
STUDENT			
ADVISOR	hrs.	minutes	

2. SCORE

POST-TEST _____ STUDENT FAILED ☐

UNIT DISCONTINUED ☐

2. COMMENTS

_____

_____

_____

_____

NOTE on receipt of this report at Headquarters a replacement workbook for this training unit will be mailed to you to replenish your supply

ADVISOR'S SIGNATURE _____

TITLE _____

DO NOT FORGET TO ATTACH THE POST-TEST WHEN SENDING THIS REPORT TO H.Q.

POST-TEST

GROUP PRACTICE SESSION

PART 3 **POST-TEST**

Step 1: Instruct trainees they are to complete a post-test.

Step 2: Before handing out the task to be flowcharted, inform trainees that:

- o this flowchart is to be done individually
- o they will have 1h30 minutes to complete their flowchart
- o they may go to the machine to verify the accuracy of their flowchart if need be
- o the criterion for success will be the same as in the previous exercises. The flowchart can be used as a job aid to successfully simulate the inquiry on a 3360 CRT. Therefore all the steps must be drawn in the correct sequence.

Step 3: Hand out the post-test question

Step 4: After 1h30 minutes has elapsed, pair trainees and ask them to exchange their flowcharts. Each trainee is to simulate performance of the task on a 3360 CRT using his pair's flowchart as a job aid. The instructor and the remaining members of the group evaluate performance.

POST-TEST (hand-out)

Flowchart an F4 inquiry decision flowchart.

Assume your trainees already know how to make inquiries on a 3369 CRT but not an F4.

Draw your flowchart so that the trainees could use it to correctly do an F4 inquiry for the following train:

> Train 252 destined to Turcot for today's date - obtain an advance consist.

Use the TRACS inquiry guide as reference.

APPENDIX E

GENERAL INSTRUCTIONS TO EVALUATION CANDIDATES

Good Morning!

My name is Suzanne Taschereau and this is Patty Janega. We both work in Human Resources - more specifically in Technical Training Services.

Do you have any idea why you are here?

Reasons you were brought here:

You were all interviewed at one point as candidates for Servocenter Training to come in on temporary assignment as SMEs in the field of waybilling. Tim G. says you could have been chosen. You were not chosen because of the size of the group and were all next on the list of possible candidates.

The SMEs who came did get some training: like you, they knew their jobs well but none of them knew very much about training. They were given training on task analysis, on how to analyze the parts of their jobs, on how to design and develop courses, and so on.

The training they got was developed by Human Resources. One of the courses in the program needed to be reworked: the course on task analysis/Flowcharting. The reason you have been brought here is to help us see if this new training works.

YOUR ROLE:

- hopefully learn from the program and be able to flowchart tasks at the end of it;
- help make the program better by pointing out where you have difficulties, when you think the program isn't clear, where more practice would have helped you learn, and so.

The training program has 2 parts to it:

- a self instructional part with a workbook. It will take you about 3 hours to complete it.
- a one-day group session where we practice flowcharting.

Here's how we'll proceed:

1) For the a.v. and the workbook:

° You will work individually;
° Either Patty or I will be in the room with you.

We'll ask you to:

° go through the program
° where you have difficulties and comments, write them in the margin of the workbook.
° at the end, go over the trouble spots with us.

At the end of the workbook, we'll also ask you to fill our student comment form and hand it in to us.

2) For the group practice session:

Tomorrow, all of us will get together. Patty will lead the practice session. We'll practice what we learnt in the self-instruction and try out our flowcharts on a 3360 CRT on the 4th Floor.

Again, we'll ask you to fill out a student comment form and evaluate the session with us.

NOTE:

a) This is all anonymous - We won't ask you to write your name in the workbook. Results won't be transmitted to anyone but those who design the program. The information will be used by them to revise the program, make it better.

b) Some of you may be brought in as SMEs in the future, some not. Although you yourselves may not be coming in as SMEs in the future, this training may help you in other ways: Flowcharting can be useful for solving problems, developing job aids, etc. in your work location.

Are there any questions?

INSTRUCTIONS TO THE EVALUATORS OF SELF-INSTRUCTIONAL PROGRAM

1) BEFORE INSTRUCTION

- Instruct the student to go through the program.
- Ask him to circle any unclear words and put a check (✓) or comment in the margin beside any unclear or difficult passage.
- There is to be no discussion through the study. You'll discuss the difficulties at the end of the instruction - after the post-test has been handed in for correct.

2) DURING INSTRUCTION

Make notes about either suggestions to the advisor or changes to make in the instruction or procedures as a result of observation of students interacting with the materials.

3) AFTER INSTRUCTION

Proceed with student interview questionnaire after he has handed in the post-test.

AV-KC-01 EVALUATION (based on course outline) TRAINEE'S NAME _____

1 Content	type of learning	Test/Exercise	Frame # Page #	Difficulty ☑	Trainee Comments	Advisor Comments
Instructions: Read this first	-	-	-			
Define terms: . task analysis . flow charting	Information	-	(1-10)			
OBJECTIVES			1			
Identify flowcharting symbols	Information		(10-17)			
		.Read flowchart .Note how symbols are used	2			
	Discrimination	test 1 #1 . match symbols to definitions	3			
		test 1 #2 match symbols to steps	3			
		test 1 #3 . read flowchart . write description	5			

AV-KC-01

TRAINEE'S NAME _____

2 CONTENT	type of learning	TEST/EXERCISE	(frame #) page#	Difficulty ☑	TRAINEE'S COMMENTS	ADVISOR'S COMMENTS
Why do task analysis? 1 What are you looking for? . what must trainers be able to do? . how is the job done? 2 What it [illegible] you . content . sequence . prerequisites	Information		(19 - 45)			
		Test #2 Recall of info	10			
Task Descriptions - Logical Components Signal - action - feedback 1 Actions: use action verbs .+ Signals: . what it is . which symbol . consequence if not yet identified .+ Feedback: . what is it	Information Discrimination		(47 - 60)			

AV-KC-01

TRAINEE'S NAME _____

3. CONTENT	type of learning	TEST/EXERCISE	(frame #) page#	Difficulty ☑	TRAINEE'S COMMENTS	ADVISOR'S COMMENTS
. which symbol . consequence if not identified . CHAIN Task Descriptions - Logic & components (cont'd.)		Test #3 1 Fill in/ match symbols to steps	13			
		2 Complete flowchart with symbols, lines, words	14			
WORKBOOK ONLY	RULES					
Decision symbol . Simple 2 alternatives			19			
		Exercise 1 1 & 2	20			
. more than 2 alternatives			23-24			
		Exercise 2	25			

Evaluation based on course outline

AV-KC-01

TRAINEE'S NAME _____

4 CONTENT	type of learning	TEST/EXERCISE	(frame #) page#	Diffi-culty ☑	TRAINEE'S COMMENTS	ADVISOR'S COMMENTS
. Loops		Exercise 3 1 2 3 4 complete with missing words, symbols, lines	27 - 30 31			
Single loop		Exercise 3 4 single loop	32			
Dougle loop		Exercise 3 5 double loop	33			
2 conditions to break the loop			36-37			
		Exercise 4	38			
Complete flow-chart		Exercise 5 draw complete flowchart	40			
Document symbol connectors			43-47			
		Exercise 6 Draw Complete flowchart	47			

STUDENT INTERVIEW QUESTIONNAIRE

1) How did you find the instruction?

Interesting - Boring? _____

_____

Too Long - Too Short _____

_____

Too Difficult - Too Easy _____

_____

2) Did you understand what you were supposed to learn?

_____

_____

_____

3) Did you find that the materials were related to the objectives stated at the beginning of the workbook?

_____

_____

_____

_____

4) Were there enough practice exercises?

_____

_____

_____

5) Were the practice exercises appropriate?

6) Did you get enough feedback on practice exercises?

7) Did you have any problems with any section or parts of the instruction?

USE EVALUATION BASED ON COURSE OUTLINE TO RECORD ANY COMMENTS.

8) Did the post-test measure what it said it would? (stated in the objectives at the beginning of the workbook)

9) In answering both the exercises and test, were you sure of your answers all the time or did you sometimes guess? If you guessed, where did you?

_____

_____

_____

_____

10) How would you change the instruction if you could?

_____

_____

_____

_____

_____

_____

_____

_____

HAVE THE STUDENT FILL OUT THE STUDENT COMMENT FORM AND HAND IT IN ALONG WITH THE TRAINING TIME LOG.

STUDENT # _____ EVALUATOR _____

INSTRUCTOR EVALUATION

GROUP PRACTICE SESSION

(1) Did the lesson plan provide sufficient information for you to plan the lesson?

(2) Were the grouping patterns adequate?

(3) Time allocation: was time allocation sufficient? too long? too short?

(4) What difficulties did you encounter?

(5) How would you improve the lesson plan?

STUDENT EVALUATION

GROUP PRACTICE SESSION

1) How did you find the instruction?

Interesting - Boring?

Too Long - Too Short

Too Difficult - Too Easy

2) Did you understand what you were supposed to learn?

3) Were there enough practice exercises?

4) Were the practice exercises appropriate?

5) Which did you prefer: working in a group or working on your own?

6) Did find you were getting enough time for the exercises or not enough?

7) Did you find you were getting enough help/feedback from your instructor?

8) Did you find that the post-test was too difficult - too easy or just all right? Why?

9) Did you have any problems with any part of the instruction? If so, which ones?

If you had difficulties, why do you think you had them?

10) How would you change the instruction if you could?

Other comments: