The Design and Evaluation of a Tape-Slide Program for students in Construction Electricity

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ABSTRACT

The Design and Evaluation of a Tape-Slide Program for students in Construction Electricity

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The purpose of this thesis equivalent was to design, produce and evaluate a tape-slide production for students in the construction electrician program at Riverside Technology Centre. The production was part of the module dealing with the installation of a Low Voltage Service Entrance.

A needs assessment with the content requirement was reviewed with experts from the electrical trade in order to plan the production. After the tape-slide was produced it was reviewed and evaluated. Initial formative evaluation was undertaken with experts. Subsequent field test evaluation was undertaken with a sample from the target population.

A one group pretest-posttest design was used for the evaluation of the production with the sample. The data collected from testing were analyzed to determine the effectiveness of the program. The class exhibited a notable change in knowledge levels (from 20% to 84%) and therefore the production was termed effective for learning. For the production to be successful an overall grade of 70% must be obtained.

Changes to the presentation were recommended based on the test results. In addition to training apprentices the producer felt that this production could also be used to train electricians transferred to the Province of Quebec.

Acknowledgements

Having completed the task, it is sincerely gratifying to have the opportunity to express my appreciation to the parties that contributed their time, guidance and co-operation so that this thesis could successfully be completed. To the following persons I extend my appreciation:

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The use of the PSPGM's recording studio facility.

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Chapter 1

Background

The author of this thesis has been teaching Electrotechnology since 1975. He has been teaching the Construction Electricity program at LaSalle High School now called Riverside Technology Centre since 1978. An interesting situation developed that provided an opportunity to design and develop a tape-slide presentation using 35-mm slides controlled by a two track audio cassette playback system.

Within the Canadian construction industry there exists a trade from the Electrotechnology sector. This trade title is Construction Electrician. Responsibility for training of electricians is planned and controlled by the Ministry of Education with the co-operation of industrial representatives.

In the early 80s many defects or short comings were identified with some of the vocational programs. In 1986 a study was initiated by the then-minister of education Claude Ryan, to undertake a review of many vocational programs, including Construction Electricity.

A large committee containing representatives from both industry and education reviewed the construction electricity curriculum, and a new package was developed. The new

program contained major changes to the course content and the evaluation process. Instead of a final paper-type theoretical examination held at the end of the program, the course was divided into 28 modules with each module evaluated separately. Many modules now contained practical skill measurement. The passing mark varies between the modules. However, the final mark is reported as pass or fail. The program was implemented in December 1988 and in late 1991 a further modified program was introduced which is still in effect.

Division	Electrotechnology
Course	Construction Electricity
Program of Study	EZU - 512
Course No.	1930

The program contains 25 modules with a total class time of 1350 hours. The modules range from a minimum of 15 hours to a maximum of 90 hours each. For each 15 hours of course material one credit is earned. The total number of credits for the complete Construction Electricity course is 90 and all modules must be successfully completed prior to the issuance of the Secondary School Vocational Diploma (SSVD).

One of the modular topics in the program centres upon the installation of Low Voltage Service Entrances, Module No. 786-135. The duration of the module is 75 hours and counts for five credits. Due to the large physical size of service entrances full size installations are not possible at Riverside Technology Centre. Although simulations are done in the shop, full size projects are not convenient. To

learn the fine points of construction of a full service, students would have to work on a job site. Since this cannot be done the second choice is to bring the project to the shop. This is done through in class practical projects. To demonstrate the fine details of the necessary job tasks to the students, some form of visual presentation should be developed. English language AV materials on the installation of a service entrance were not found.

Based on the ministry set learning objectives, review of educational research, availability of AV equipment and skills of the teacher, it was suggested that a tape-slide production about service entrances be done. With this idea in mind, this thesis equivalent concentrates on the design, production and evaluation of an Audio Visual Production that centres around the replacement of an old low voltage service entrance with an increased capacity modern system.

Literature Review

Perception and Communication

Learning is defined as "a general term for a relatively lasting change in performance caused directly by experience; also the process or processes whereby such change is brought about." (Heinich, Molenda & Russel 1982). To know more about learning the process of perception and communication should be understood.

Perception is the process where a person becomes aware of the world around oneself. The eyes, ears and nerve endings of the skin are the primary means through which the human maintains contact with the environment. The impressions received are converted to electrical impulses which then trigger electrical and chemical events in the brain. This results in an internal awareness of the object or event. "The instructional media field rests on the assumption that people learn primarily from what they perceive and that carefully designed visual experiences can be common experiences and thus influence behaviour in a positive way" (Kemp & Smellie 1989). Fleming and Levie (1978) complied a useful summary of research based on principals from the behavioral sciences that can be applied to instructional media. Areas of study covered perception, memory, concept formation and attitude change. Some of these principles can be used to improve instructional media.

Once perception takes place communication can follow. The transfer of information from a source to a receiver is called communication. Instruction is the arrangement of information to produce learning. Shannon and Weaver (1949) developed a model of communication whereby the sender encodes the information, and sends or transmits it to the receiver, who then decodes the information.

Schramm's model is cited in Heinich et al. (1982) that expands Shannon's model for instructional purposes. He states that for successful communication the "field of experience" of both sender and receiver must overlap. Effective communication is influenced by many human factors. Matters such as cultural background, experience with the subject message, and a personal attitude can influence the success of communication.

Efficient communications relies upon the participation of the receiver. Responses sent by the receiver back to the sender is an important part of communication. This part of the process is called feedback. It enables the sender to correct omissions and errors of the transmitted message. The instructional package will therefore have feedback built into the instructional design. Feedback from the learners will come from discussions with the instructor, in class written tests, home assignments and practical project evaluations.

"Noise" is any disturbance that interferes with or distorts the transmitted message. Kemp and Smellie (1989) recommend the use of redundancy in the instructional design to overcome the effects of evident or anticipated noise. Redundancy refers to the repeated transmission of a message, possibly using different channels in order to bypass distracting noise. Redundancy will be incorporated into the different lessons as well as in the tape-slide presentation. Topics will be repeated within different lessons to provide additional practice and therefore improve learning.

Learning Theories

In designing this instructional package learning theories should be reviewed so that an effective design can be chosen.

Gagne (1985) examined the complex nature of learning and found that learning is a cumulative process. In order to learn more complex knowledge and skills, the basic information and simple skills must first be mastered. Gagne suggested two things were needed for training applications.

1) The first was a psychological analysis of the many required component skills.

2) The second was the assembly of the required component skills so that the student can perform some new complex educational skill (Bower & Hilgard 1981).

This led to his idea of task skill hierarchies which tells us how to sequence the training of some skills before others.

Gagne also identified five categories of learning. These are verbal information, intellectual skills, cognitive strategies, motor skills and attitudes. Also he identified nine phases of learning that has been grouped under three headings (Bell-Gredlor, 1986). The three headings are Preparation for Learning, Acquisition and Performance, Retrieval and Transfer.

Another important learning theory that works with humans was proposed by the cognitive psychologists. Cognitive psychologists try to understand the mind and its abilities in perception, learning, thinking and language use. Most cognitive psychologists follow the information-processing approach and view the human brain as a kind of computer. The human brain contains feature analyzers, pattern recognizers, sensory memories and conceptual memories.

The information processing system consists of,

1) Sensory receptors that receive input from the environment;

2) Effector units that produce responses;

3) Memory units that holds data structures or action programs and a;

4) Central processor.

The central processor is the area where major mental activities such as thinking, judging and making decisions occur.

The theory recognizes two types of memory. Short term memory and Long term memory (Kemp et al., 1989). The short term memory holds information for immediate recall. To retain information this area of memory should not be overloaded. This has implications in considering the quantity of information to be included in a segment of media material. When information is retained in long-term memory, learning is said to have taken place. Using advanced organizers and/or developing instructional aids can be used to enhance information recall and pattern recognition.

Bruner (1966) as cited in Bower & Hilgard (1981) who is a cognitive psychologist developed a theory of instruction. He proposed rules for achieving knowledge or skill and provided techniques for measuring or evaluating outcomes. The four features that a theory of instruction must encompass are:

1) Predisposition to learn - Instruction recognizes learner experiences so as to make the student willing and able to learn.

2) Structure of knowledge - Structure the instruction so that it can be readily grasped by learners.

3) Sequence - Effective arrangement of sequences in which to present instructional materials.

4) Reinforcement - it should specify the nature and pacing of rewards.

Instructional Design

In developing an instructional strategy for this unit of instruction it was decided to combine some of the work done by the researchers mentioned. By combining the different theories an effective unit of instruction could be developed. It was decided to use the Systematic Design of Instruction as presented by (Dick & Carey, 1990). By using their model, the instructional designer completes the following important tasks. These tasks are;

- Identify Instructional Goals,
- Conduct Instructional Analysis,
- Identify Entry Behaviour Characteristics,
- Write Performance Objectives,
- Develop Instructional Strategy,
- Develop and Select Instructional Materials,
- Conduct Formative Evaluation,
- Design and conduct Summative Evaluation,
- Feedback that may result in Revision.

Gagne's nine phases for learning are incorporated into the Systematic Design of Instruction. The gaining of learners' attention and informing of the lesson objectives is done at the beginning of each lesson. This helps the student understand what they are expected to learn. Each

lesson also contains a review section in order to stimulate the retrieval of relevant information needed for the new lesson. This completes the first three phases for learning. By conducting an Instructional Analysis, Writing Performance Objectives and then developing Instructional materials that allow for the evaluation of student's progress with feedback, the next four phases of Gagne's learning theory are covered. These four phases are;

Selective perception of stimulus features,

Semantic encoding,

Retrieval and responding, and

Reinforcement.

Summative Evaluation is used to meet the needs of the Cueing retrieval phase in which students performance are assessed.

The final phase of generalizing occurs with the completion of the practical shop projects and future activities that require the knowledge from this module. Further information is available in chapters two and three of the thesis.

Use of Multi-channel media

The shop facilities at Riverside Technology Centre do not provide the opportunity to construct a full size electrical service entrance. To teach students about upgrading a service entrance it was decided that some form

of multi-channel media might be suitable. Much research has been done in the use of multi-channel media. The tape-slide combination is an example. It involves the integration of each channel into a structured systematic presentation. The whole multi-channel system becomes greater than its parts (Heinich et al, 1982). For example Mowbray (1953) found that a combined visual and auditory presentation of the same material resulted in better comprehension than the presentation of either auditory or visual material alone. The process of combining the visual and audio information focuses towards the most pertinent features of the message. Travers (1970) suggests that simultaneous presentations of Audio and Visual portions of the same instructional message eliminates all but the essential visual features and auditory message necessary for transmitting pertinent information. Travers believed that the audio channel is used to cue perceptual processes in the visual channel.

MacInnes (1980) points out the tape-slide presentations have the following features.

1. Works for large or small groups.
2. Easy to find a still picture.
3. Quality of projected slide is far superior to the best video picture.
4. Greater control of presentation by the teacher.

5. For slow learners tape-slide may be more effective.

Janssens (1977) conducted research on stimulating motivation by using audio-visual methods. It was found that the tape-slide can bring the real world into the classroom. Advantages cited are:

1) Slides incite the student to critical observation and give support to their memory,

2) Slides can correct vague or false concepts and,

3) They can provide a link to follow-up activities.

Johnson (1971) conducted research in the use of film, television and tape-slide for use in university teaching. Where the movement element of the picture is not essential, tape-slide is an inexpensive alternative to television or film. Slides have the highest score in picture quality and have high resolution.

Comparison of two channel media

Clark (1983) introduces some interesting thoughts on selecting media for instruction. His position is that media selection is not important in determining benefits of learning. The instructional design produces most of the results. Improved instructional design results in improved learning. The selection of the media is not critical.

Examples exist of research conducted by unbiased educational investigation on the cognitive and affective

impacts of multi-channel productions. Some of the studies use television video tape productions for comparison purposes. Neilsen (1981) conducted a comparison study between a Video tape using a narrator and a 35-mm slide set using an unrehearsed spoken description given by the instructor, for illustrating Natural Resource Techniques. This research project used the same instructional development package as designed by one individual. The only difference was that in one case the slide set accompanied by instructor comments was the multi-channel media and in the other a moving image video with narration was used. One group of students used the slide set package and the other group the video tape. Both groups were given a 20 question exam and the average score was 18 correct for each group. The results indicated that both media systems resulted in similar outcomes. This tends to support Clark's views that the instructional design determines whether the package will be successful.

Advantages of Multi-channel media

Multi-channel media presentations can help a wider range of students increase their knowledge. Kozma (1991) suggests that Clark's (1983) ideas should be modified: What is concluded is that some students will learn a particular task regardless of delivery device, while others will be able to take advantage of a particular media's

characteristics to help construct knowledge. Kozma (1991) cites research done by Stone and Glock (1981) that compares college students exposed to text-only instruction compared to text-with pictures instruction. The text-only group made significantly more assembly errors, particularly errors in orientation. The picture-text group was most accurate in its constructions.

The use of only a single channel in the instruction package did not produce the best results. By integrating channels learning was enhanced. By carefully selecting the multi-channel media students should find it easier to gain the required knowledge.

Benefits of tape-slide

Tape-slide presentations can lead to multi use production. Hoover (1988) developed a program on the city and culture of Muncie during the 1920s and 1930s. The materials gathered by the producer gave rise to two useful productions. One program was for fourth year elementary school history lessons and the other for a senior citizen entertainment package to be used in retirement and nursing homes. Two different presentations with different purposes evolved from the same production.

In addition to training apprentices, the proposed tape-slide production could be used by electrical suppliers to

illustrate current techniques and also serve as a refresher program for construction electricians transferred to Quebec.

The tape-slide program can also be successfully converted to video tape. Brandt (1991) discusses the techniques of conversion. The process is relatively simple and inexpensive. The program could therefore be used for many years as long as video tape machines are available.

Chapter 2

Educational Context

Educational Objectives

The first level operational objective for the Low Voltage Service Entrance module is to demonstrate the required competency in calculating the electrical ampacity size of a main and then to install the service entrance following Hydro and Quebec Code regulations with appropriate application of safe working habits. Appendix A outlines the First Level Objectives that indicate the Expected Behaviour, Conditions for Performance Evaluation and General Performance Criteria.

In order to reach this terminal objective a set of second level objectives must first be completed. Appendix B outlines the second level objectives that should be attained.

Instructional Analysis (Whole Module)

Although the instructor has taught this module for many years he decided to do a review of the module. Using the first and second level objectives as required by the ministry of education the instructor conducted a procedural analysis as outlined in Dick and Carey (1990). Entry level skills required by the students were identified. Skills

such as, the correct use of electrician hand tools, running of wires in conduit, cutting and gluing PVC conduit, connecting of wires, installing boxes, following safe practices are some of the major items. In order that students be permitted to take this module, required prerequisites must have been successfully completed. The instructor in collaboration with a master electrician discussed different ways in which to present the instructional material. Using the ideas of the electrician and the instructional analysis, a set of lesson topics was chosen. The following is the list of lesson topics to be presented in a sequential order.

Lesson Topics

1) Single Phase Power - Generation & Distribution

2) Three Phase Power - Generation & Distribution

3) Major Parts of an Overhead Service.
   - Service Drop
   - Consumer's service
   - Panelboard

4) Parts identification of both Major and Minor components used in Overhead Residential Electrical Service.

5) Rules regarding the Installation of a Mast.
   - Height of mast
   - Clearance across roadways, lawns etc
   - Number of supports
   - Types of masts - Self Supporting or attached to building
   - out of reach rule
   - Mounting of Spool rack - on mast or building

6) Types of cable drops used by Hydro.
   - Triplex cable
   - Steel core neutral support cable
   - Other types

7) Types of wires used in conduit.
   - Use of bare neutral
   - Identification of wires
   - Amount of wire left free for connection purposes

8) Rules for installing meters.
   - Inside or outside locations
   - Before main or after main switch

9) Explanation of an "open neutral condition".

10) Methods of grounding the electrical main.
   - Using a metallic cold water pipe
   - Using ground rods
   - Testing resistance of ground circuit
   - Ground wire size

11) When and how to use code tables
   Table nos. 1 to 4, 6 to 10 & 17.

12) When and where are bonding jumpers required.

13) How to upgrade a 100A to a 200 Amp electrical main for a single family home.

14) How to calculate the size of an electrical main;
   - based on area of the structure (60A or 100A),
   - based on an estimate load determination (with use of teaching aid).

15) Service entrance calculation for a duplex.
   - Using separate drop
   - Using common drop

16) Service entrance calculation for a small apartment (less than 10 units).

   While lesson topics 14, 15, 16 are being presented students complete 17 as in class activities.

17) Students build three different types of service entrances and have them evaluated. They also produce diagrams and parts lists.

Most of the tasks in lesson one through 16 were designed to affect the cognitive and affective domains. Due

to the inherent dangers that comes from working with electrical high voltage it is imperative that attitudes regarding safe procedures be adopted by electricians. The lessons must therefore address all types of dangerous conditions and actions. The students apply their knowledge of lessons one to 16 to complete the projects in lesson 17. Psychomotor skills are acquired by the students from the activities contained in lesson 17. A set of lesson plans was developed for the module to meet the needs of students. Each lesson contained a set of objectives, a presentation of old and new knowledge, student activities and some form of simple formal or informal assessment. By selecting this arrangement the first level objectives can be attained by the end of the module.

To show students how a main is installed, it was decided that a lesson on how to upgrade an Electrical Main from 100A to 200A would be appropriate. A copy of this lesson plan is contained in Appendix C.

Due to the present recession (1993) very little residential construction is taking place. However the changing of a main was still occurring at a frequent rate. A firm was selected that was doing main changes as part of its mandate. The master electrician of that company was willing to assist in the development of a multi-channel media presentation on the subject of "changing an electrical main".

Target Audience

The target population for whom this learning package is intended are Construction Electricity students involved with the SSVD Diploma program. Students ages range between 17 and 45 years of age. About 25% of the class are 17 or 18 years old and the balance between 19 and 45 years of age. All these students are registered in the adult sector and have different levels of education qualifications. The minimum level of education is Secondary IV high school to as high as CEGEP graduation. Students completing this course are for the most part highly motivated and hard working.

Based on past teaching experience some of the students who enrol in this program have poor reading and learning skills. These students tend to learn at a slower rate and sometimes forget what they have learned. These students learn more effectively when they see what has to be done. Since installing a service entrance requires cognitive and psychomotor skills the use of audio and visual stimuli should enhance learning. Therefore, for teaching the required installation and construction skills the use of tape-slide media will enhance learning for this particular group of learners.

This particular class of 17 students contains two students whose first language is neither English or French. Also two students have been working with electricians prior to taking this course.

Rationale for Media Selection (Lesson topic 13)

Although students will construct service entrances as part of the module, this process is not full scale due to the limitations of shop facilities and equipment. To learn the fine points of construction of a full service, students would have to work on a job site. Since this cannot be done the second choice would be to bring the project to the shop. This is done through in-class practical projects. To bring the fine details of the job tasks to the students, some form of visual presentation, that meets the cognitive needs of learners was developed. A connection between a teaching problem and solution would be established.

The production is predominately visual. Additional information is on the synchronized audio tape. The correct combination of the two media will enhance the acquisition of learning. Day and Beach as cited in Travers (1966) reviewed 10 studies which compared the relative efficiency of an audio visual presentation of information compared to auditory and visual channels alone. They found that the combined audio visual mode was superior over the auditory or the visual mode.

There are two multi-channel media that could be used, one being tape-slide the other television. MacInnes (1980) wrote a text specifically for using Video in Education. He suggested the question of choice be; "which is better for the particular job with this audience. If the information

can be broken down into small units of information then the tape-slide will be equal to a moving video presentation".

Tape-slide programs have been shown to be effective media for use in learning and helpful for developing certain kinds of knowledge. For example Bernard & Perri (1982) produced a tape-slide program that focused on four pieces of High Fidelity equipment, systematically explaining in detail which manufacturer's specifications are important to consumers and why. The difference between pre and post test scores indicated the effectiveness of the presentation.

Outline of Content (tape-slide)

The script of the tape-slide production (Appendix D) begins with the introduction of why service entrances are upgraded. The electrician then makes his recommendations to the customer and obtains permission to proceed with the upgrade. Before work can begin a work permit must be obtained. Dismantling of the old service entrance follows and parts that must be saved are kept in a secure location. The use of proper tools and safety procedures are emphasized. The old hole through the wall is enlarged. Workers on the inside of the house mount the new panel and the electrician starts the building of the outside mast and meter socket assembly. A new mast is built and made ready to receive the new wires. The work crew at the panel installs the wiring for the new branch circuit breakers. A

new electrical ground wire is also installed. The work teams then combine to install the heavy line wires needed by the 200 ampere main. A worker then completes the installation of the 200 ampere main circuit breaker. When all wiring is complete the electrician reinstalls the old meter and reconnects the service entrance to the Hydro lines. The electrician prepares the paperwork for Hydro and the board of electrical examiners. Hydro Quebec sends a work crew to change the drop wires from the pole and installs a new meter and seal. The electrical examiners do an overall inspection of the job and send any defect notices to the electrician. An itemized invoice that includes all costs are submitted to the homeowner.

The presentation emphasizes correct selection of tools, adherence to important Hydro Quebec installation regulations and use of proper safety equipment.

Instructional Strategy (Whole module)

At the start of each new lesson, the objectives are explained and the reason for requiring this knowledge is presented. Since these lessons build on previous topics the learners tend to remain interested. Homework assignments that include exercises are also assigned. These assignments are corrected in class and grades are recorded.

These students like to do practical work. By telling them about the upcoming installation projects, interest in

the module remains high. A teaching aid (Appendix E) provides the student with the necessary guidance on how to calculate the size of an electrical service. In addition students are shown how to use the Code Tables so that parts, wire size and installation components can be specified.

Instructional Strategy (Lesson 13 tape-slide)

Pre-instructional activities for those learners include stating the objectives of the lesson and explaining the need for the tape-slide. The lack of shop facilities is also mentioned. Once students understand that the knowledge they will acquire from the presentation will directly relate to their practical assignments, they hopefully will be eager to view the tape-slide. They will be able to observe the procedures followed by a team of tradesmen in accomplishing the changing of a main. The presentation will also indicate correct use of tools and safety procedures.

The tape-slide presentation is broken down into sub concepts. The choice of concept arrangement comes from the instructional analysis, discussions held with a subject expert and suggestions from an educational technologist. These sub concepts are;

- Dismantling the old main,
- Enlarging of hole through the wall,
- Mounting of new panel using new conduit and LB condulet,

- Installation of new meter socket,
- Installation of new mast,
- Wiring of new panel,
- Installation of wires in conduit and mast,
- Connection to service drop,
- Testing and branch circuit identification.

After viewing the presentation the instructor will ask if there are areas in which some ideas remain unclear. At the request of a student or if the instructor so desires some slides can be viewed again and explained a second time.

Before terminating the lesson a materials list for upgrading the 200 amp main will be distributed to each student. This will help the learners remember the different components required and their corresponding quantities. Appendix F is a copy of the materials list.

Gagne's nine phases of learning (lesson 13)

The instructor completes the first three phases of Gagne's nine phases of learning at the beginning of the lesson. The objectives of the lesson are explained to the students. A review of previously presented material is covered by class discussion and verified by the entry levels test. Through writing of performance objectives, presentation of the tape-slide and then the evaluation of the learners through the posttest, the next five phases of learning are covered. The corrected posttest is returned to

the learners. By reviewing the test with the class two of Gagne's important phases of learning are covered. These are reinforcement and cueing retrieval. The instructor provides informative feedback and assesses performance. The final phase of generalizing does not occur in lesson 13. It occurs during the activities contained in lesson 17. The students can now apply the knowledge gained in lesson 13 to actual service entrance installation projects. See Appendix C for details of lesson 13.

Chapter 3

Production Development

Slides

The module was analyzed during the months of June and July 1993. A set of lesson topics was developed and the location within the module for the topic "changing an electrical main" was decided upon. A set of lesson plans for the entire module were written. Each lesson contained its own set of objectives based on ministry requirements.

To determine the sequence of work in "changing a main", telephone conversations were held with two electricians during late July and early August. From their knowledge and experience a general list of steps was formulated. Appendix G outlines the sequence of steps to change a typical electrical main.

Five different electrical contractors were contacted to see if they had service entrance work and if they would help us to produce an educational package. All firms replied that there was little work in this area but would contact me when a job came up.

In early August Kode Electric received a job to upgrade an electrical main from 100 amps to 200 amps using an outside steel mast with an outside meter socket. This job was to become the subject of the lesson.

On August the 12th a meeting was held with Mr. Grant of Kode Electric to discuss the final job sequence procedure that was to be followed, since the details of the job were now known. A list of slides that would be needed was prepared. Appendix H contains the list of required slides for the production. For each step required, scenes were hand drawn on 3 1/2 X 5 inch cards. The cards were placed in a sequence of how the work was to be done. Sixty cards were written prior to the actual production. Appendix I contains two sample cards. As soon as the actual work date became known the photography equipment was checked and two rolls of 36 exposure Kodachrome slide film was purchased.

On the day of the job the producer met the work crew near the house where the work was to be done. This helped the people who were to be photographed become familiar with the photographer and therefore reduce any apprehension. The job commenced at 8 a.m. and ended at 2:30 p.m.. The crew ate lunch at 12:30 p.m. that lasted about 30 minutes.

As each work task came up a picture was taken and sometimes a second shot was taken as a back up. Additional shots were taken that were not in the original set of cards. Some of these shots were not discussed prior to the shoot, but were recommended by the producer or the electrician. By marking each card with a check the taking of extra slides was minimized. Both rolls of film were used on that day.

To produce text and graphic slides a home brew approach was devised. A computer program call "Print Master Plus" generated the required text. This text was printed on green coloured paper. To shoot these documents the 35 mm camera was mounted on a tripod with a X 2 lens extender attached to the 50 mm lens. This 50 mm lens became a close up lens. Natural sunlight coming into the room served as the main light source. Where applicable an electronic flash was used in lieu of the sunlight.

As with most productions, revisions were required. Changes were made in the sequencing or grouping of slides, in retaking a few specific scenes and of highlighting areas of two slides in order to better focus the learners on the subject matter.

To improve perceptual distinguishing for two slides, red circles were drawn around the areas to be highlighted. A piece of clear 35-mm slide film was inserted in the 35-mm slide holder containing the desired scene. A circle was drawn on the blank material using a fine point felt marker. The final production contained 80 slides.

Script and Audio Tape

The slides were developed and then placed in a sequence that best followed how the work was done. A preliminary script was drafted. This script was then revised due to a new sequencing of the slides and to provide additional

information so that specific topics were outlined in greater detail and clarity. As cited in Kemp & Smillie (1989) the ideas of Severn were also included in the script development. That is, "Multiple channel communication that combine words with relevant illustrations will provide the greatest gain because of the summative cue between channels". Appendix D contains the final script.

For the preliminary recording of the script a Wollensak 3M 2550 AV cassette recorder was used at the producers home. Synchronizing pulses were then added. Recording of the final script took place at the studio facilities of the Protestant School Board of Greater Montreal. Permission to use the facilities at no charge was granted since the producer taught at the board and the tape-slide would be available for education purposes.

The script read by the producer was recorded on 1/4" audio tape. Music was added to the beginning and end of the production. Three copies of the master were duplicated onto standard audio cassettes. Tape-slide synchronizing signals were added using the Wollensak 3M 2550 AV cassette machine.

Cost of Production

By avoiding studio charges and word processing costs the only hard costs were for slide film and processing. The total cost of producing the presentation amounted to $100.00.

Chapter 4

Method

Preliminary Evaluations

A preliminary evaluation took place in early September to review the slides and hand written script. After the slides were shown to Prof. Richard Schmid and Prof. Gary Boyd a discussion followed on how to improve the presentation. For the first presentation the slides for the most part followed the actual job sequence. This resulted in a choppy presentation of some of the activities. For example, the wiring of the panelboard was spread out throughout the sequence of slides. In addition, the wiring of the ground wire circuit was spread out as well. To reduce possible learner confusion it was suggested that the sequencing of the slides be altered so that the topics were covered as separate packages. Each topic would be presented as a unit and not spread throughout and mixed with other topics. The learners would observe the work in a simple clear arrangement. Other changes to the presentation were recommended. Audio script material should be added to provide links between the topics. Text slides should be included so that the learners can better focus on specific points.

Prof. Gary Boyd observed that two slides were dark. Since retakes for these scenes were difficult he suggested that circles be drawn around specific areas of the slides in order to highlight the important details within the slide.

Prof. Richard Schmid requested that a new slide be made of the scene that involved the temporary holding of the mast by a spool rack. The first slide did not clearly show the spool rack. A new slide would be taken in the shop using better lighting.

With the information gained from this preliminary evaluation the script and slides were modified. An audio tape was made of the revised script.

A second meeting held at Riverside Technology Centre in October 93 served to review the complete production with two subject experts. Abe Grant, Master electrician and Grafton Drakes an Electrotechnology teacher viewed the tape-slide production. The presentation was acceptable except for one topic. Slides concerning the coupling system between the metallic mast and the PVC conduit required more information. A revised text for the two slides were created by the three men. By the end of the session, the three subject experts agreed that the presentation met the objectives, in explaining to students the steps and important installation regulations for upgrading a 100 amp electrical main to 200 amp, if the service had originally been equipped with an outside meter socket and metallic mast.

A final meeting concerning the actual production was held at Concordia with Prof. Richard Schmid on October 22, 1993. The slides were shown with a studio produced audio tape of the latest script. Approval was given to use the presentation for further testing and evaluation with a class of construction electricity students.

Field Evaluation

Evaluation Questions

The following major questions arose from the evaluation objectives.

1. The evaluator was testing to see whether or not the students in the Construction Electricity program would learn the required intellectual skills, verbal information and be aware of the required safe working practices necessary to upgrade and install an electrical entrance service main that used a self supporting steel mast and an outside meter socket.

2. The evaluator also wanted to assess the students' comments on the questionnaire dealing with the production and content.

Rationale

The rationale for the first objective is that the evaluator wanted to have evidence that the construction students had learned the required code regulations,

practical knowledge, and safe working practices by using this tape-slide production. If this unit worked out well the evaluator an electrotechnology teacher might develop other topics as well.

The rationale for the second objective is that the evaluation questionnaire will provide useful information on the tape-slide production which can then be used to further improve the production.

Operational definitions

Mastery of the intellectual skills and verbal information as stated in the first objective will be defined as each subject scoring at least 70% correct on the posttest. The questions on the posttest will be criterion-referenced test items for lesson 13. Since more work was still to occur after this lesson the 70% grade on the posttest was deemed sufficient.

In order for the tape-slide production to be deemed effective the results of the posttest must be significantly better than the pretest.

The tape-slide treatment will be defined as an introduction to the lesson by the teacher, a viewing of the tape-slide presentation and a review of any specific slides requested by students for clarification purposes.

Instrumentation

Testing Design

The one group pretest-posttest design was used as the design for evaluation (Campbell & Stanley, 1963). This design consisted of pretesting and posttesting with a single group. The pretest and posttest were used to measure if significant differences in achievement before and after treatment took place. These differences would be taken to represent the effects of the production on the subjects. The design used is as follows:

Pretest	Treatment	Posttest
01	X	02

Limitations of the Design

This design was chosen since there are few students enroled in the English sector of construction electricity. However, the design is still used in educational research and evaluation with some success.

This design has both weakness in both internal and external validity. History, Maturation, Testing, Instrumentation, Mortality and Interaction of Selection and Maturation are different kinds of threats to internal validity.

History refers to incidents or events affecting the result which may occur during the study. The effects of history were reduced by keeping the time between 01 and 02

to a minimum (Campbell & Stanley, 1963). The time interval between the pretest and posttest was one day. Testing referred to the effect of taking a pretest on the following posttest. Maturation referred to changes in the subject during the study.

By keeping the time between pretest and posttest at a minimum the effects of history and maturation were controlled. By using questions from the pretest in part of the posttest the violation of internal validity was reduced. To reduce biasing effects or cueing of the group the posttest was administered immediately after the presentation.

Choice of Questions

The complete module was developed on the basis of defined terminal goals and objectives. In developing the module, instructional objectives were generated for each lesson. To measure changes in learning resulting from viewing the tape-slide, criterion-reference test questions were composed. The questions used in all tests were designed to gauge whether the instructional material had met the behavioral objectives.

Type of Questions

Every student in this study had to complete an entry levels test, pretest and posttest. To keep the testing time

short and to cover the required test items, the test questions were constructed using multiple choice and short answer. By using multiple choice with 4 distracters the student had only a 25% chance of guessing the correct response. The short answer section further eliminated the guessing possibilities. If a short answer was partially correct part marks were awarded.

Entry Levels Test

The systematic design of instruction by Dick and Carey (1990) requires that learners be tested to see if they had sufficient knowledge to study a lesson topic. Therefore an entry levels test was created. This test informed the instructor how well these learners were prepared for the upcoming material. The test consisted of 12 multiple choice questions worth one mark each. Appendix J is a copy of this test.

Pretest

A pretest was developed so that the effect of the treatment could be measured. This pretest helped identify some students who already had experience with the topic (Dick & Carey, 1990). The test consisted of five multiple choice questions and five questions of the short answer variety. The total marks possible were 10 and a copy of the test can be seen in Appendix K.

Posttest

To measure the intellectual skills and verbal information gained by the learners after viewing the tape-slide production, a posttest was generated. Thirty two questions were written so that the important aspects of the behavioral objectives were covered. Ten questions from the pretest were incorporated into the posttest but in random order and not necessarily using the same type of question design. The test consisted of 24 multiple choice questions, seven questions short answer type and one question that required learners to number job tasks in correct order. All questions were worth 1 point each except for the last question which had a maximum value of 4 points. Total marks possible amounted to 35 points and a copy of the test with correct answers on a separate page can be seen in Appendix L.

Production Evaluation Questionnaire

After completion of the posttest subjects were asked to complete a form that evaluated the tape-slide production. Part one of the test allowed the students to check off particular pre written comments with respect to Graphic slides, Picture quality, Script, Accuracy of information and Sound track (Green, 1986). Part two of the questionnaire used rating scales where students could select how they felt about certain statements. The form was similar to the one

developed by (Bell & Abedor, 1977). In part three of the questionnaire open ended questions were used in order to illicit any additional comments. See Appendix M for a copy of this Questionnaire.

Sample

The subject pool came from the Construction Electricity class at Riverside Technology Centre for the school year 1993-1994. All seventeen students who were in the program took part.

Procedure

On Friday, November 26, 1993 the required tape recorder and slide projector were tested. Also required examinations were duplicated at the same time. On December 2, 1993 the Entry level test and the pretest was given.

At the start of class on the following day the slide projector and tape recorder were connected together. The lesson topic was introduced and the presentation given. Some slides were reviewed at student's request. After this review the posttest was administered. Upon completion of the posttest, the students completed a production evaluation questionnaire. The lesson had been prepared by the evaluator who also produced the tape-slide production.

Data Analysis

1. Statistics were obtained from the Entry Levels test to see if the students were ready for this lesson.

2. Descriptive statistics were obtained to measure whether or not the subjects had mastered the behavioral objectives for upgrading an Electrical Service main.

3. The production evaluation questionnaire was analyzed to determine the following: (a) Graphic slides (b) Picture quality (c) Script (d) Accuracy of information (e) Sound track. Additional questions were also posed to analyze the presentation from other aspects not covered by items (a) though (e). Additional comments by the learners were reviewed.

Chapter 5

Results and Discussion

Preliminary Evaluation

The requests for changes to slides, script and audio tape as requested by Educational technologists and subject matter experts were discussed in the previous chapter. Since the class had only 17 students a one on one evaluation was not attempted in order to maintain a respectable sample.

Field Evaluation

The purpose of this study was to evaluate a tape-slide production on the subject of upgrading an electrical service main from 100 amps to 200 amps. It was developed and tested to serve as a learning instrument and possibly to develop other lessons covering other topics in Electrotechnology. The tape-slide production was to be used as part of a class lesson and to be viewed during class time. The intention of the production was to help students learn the cognitive skills needed to build actual electrical service entrances.

It was hypothesized that the presentation of this tape-slide would be an effective method of teaching. The acquisition of the required intellectual skills and verbal information would be accomplished within the classroom and the students would now be ready to practice the psychomotor

activities by building actual service entrances in the shop.

To arrive at a final decision the students were given an Entry levels test, pretest, posttest and a production evaluation questionnaire.

All the subjects were attentive and interested in viewing the production. The students knew that these results would be recorded by the teacher, but not used to determine the final grade for the module. The final grade is based on a written practical knowledge test and on the evaluation of in shop constructed service entrances.

Entry Levels Test

The test consisted of 12 multiple choice questions. Table 1 illustrates the mean and standard deviation. The minimum score was six and the maximum was 12. Eleven of the 17 students scored higher than eight points. The remaining six students scored either six or seven out of 12. The evaluator decided that no student should be prevented from partaking in the presentation. The teacher concluded that some of the students needed additional work. More repetition of the material of earlier lessons was still to occur. It was also possible that some students still required more practice to gain full mastery.

Table 1

Mean and Standard Deviation for the Entry Levels Test of a Maximum Score of 12.

Number of students	17
M	8.29
SD	1.71

Table 2

Mean and Standard Deviation for the Pretest of a Maximum Score of 10.

Number of students	17
M	2.00
SD	1.33

Table 3

Means and Standard Deviation for the Posttest of a Maximum Score of 35.

Number of students	17
M	29.44
SD	3.48

Pretest

Immediately upon the completion of the entry test the pretest was given. Table 2 illustrates the mean and standard deviation. The results were not very good. Eleven students scored two or less and only six students received greater than two but less than five point five. Only two students scored above five. The two students above five had been working with electricians prior to taking the course. The results were not surprising since most of the questions were based on information to be delivered in the tape-slide production.

Posttest

Table 3 contains the results for the mean and standard deviation of the posttest. The results were quite good. The average mark for the class was 84%. Two students who scored 63% and 67% were the only ones under the target of 70%. An analysis of the posttest was done on an item by item basis. Appendix N contains the distribution of student responses, that indicated the following. Most questions were correctly answered by the majority. Students had trouble answering questions 11, 23, 28, and 31.

For question 11 only 50% of the class knew the correct size of the ground wire. Perhaps a text graphic slide with a table of sizes would improve the result. For question 23 the same solution of an additional text-graphic slide might

be helpful. Question 28 is an area not directly part of the changing of a main. In one of the lessons within the module more instructional material is needed to explain the use of multi-pole breakers. Question 31 also requires more explanation. A graphic slide showing the screw and how it connects between the metal box and neutral block is suggested.

Comparison of means between pretest and posttest

The difference between pretest and posttest means was very noticeable. The average score was 20% for the pretest and 84% for the posttest. Both tests were constructed using criterion-reference questions covering the same lesson. The difference in means was due to the treatment. The treatment being the presentation of the tape-slide production to the students.

Validity

Content validity is reflected in the degree to which a test is a representative sampling of a segment of the behavioral domain we wish to assess (Chase, 1974). The questions on the tests have to represent the content of the program and the objectives. Subject experts reviewed the test items to ensure that the items measured the predetermined objectives.

Reliability

Another equally important requirement for any testing instrument is reliability. Reliability refers to whether the test and each item within the test consistently measures the behaviour for which it is intended. The split half method was used to measure reliability (Chase, 1974). The posttest was split into two parts. Odd numbered questions were one half of the marks and the even questions were the other. The last question (number 32) was given a value of 1 instead of 4. Each half of the test amounted to 16 marks.

For the first part the product moment correlation between two sets of scores was calculated. The value of r_h was +0.624. By using the Spearman-Brown Prophecy formula a reliability coefficient for a 32 question exam was calculated. The prophesied reliability for the total 32 item test was +0.77. The details of the formula and calculations appear in Appendix O. To ensure reliability, the students who saw the production were also the test subject.

Production Evaluation Questionnaire

Analysis of the results from the questionnaire showed that the majority of the students found that the production quality of both audio and visual were satisfactory. Seven students thought that some slides were over exposed or dark. The slides were properly exposed for the bright background,

however, some of the subject material was shaded and therefore appeared dark. The camera should have been adjusted for the shaded subject areas. Red circles were added to highlight the important items in the shaded areas.

The questions in part two which involved rating did show a variance of opinion. A copy of the questionnaire with the frequency of students responses is shown in Appendix M. Most of the responses indicated that the presentation was well received. Question six however has a wide distribution of responses. Six students felt that there was not enough repetition of important ideas. Five students were undecided and six students thought there was sufficient repetition. Perhaps these students misinterpreted the question or the students were trying to indicate the value they place upon repetition in learning new material.

The following comments came from students answering statement 14 in part 3 where they were asked to comment on their overall reaction to the presentation.

Negative comments

- There was no possibility of seeing the tools in motion.
- Although presentation okay, could have gone into a bit more detail.

Positive comments

- A good presentation of information.
- Seeing the work done helps allot.

- The student could visualize the way the procedure was done.
- It was a good learning experience.
- It is much easier to understand when we get to see what you are talking about.

For statement 15 that asks for the most interesting feature, most of the comments were positive. For example, the following statements were made;

- How the electrician was going about his work,
- Able to see myself (the student) in one of those workers' situations,
- Clarity,
- How the panel could be neatly wired,
- How the electrician was working with live wires.

In statement 16 where students suggested changes to the tape-slide, the following is a list of their interesting comments.

- You don't have to improve it.
- Some additional explanation to a few of the key words are needed.
- More audio channel information could be added to some of the slides.
- Follow up with practical demonstrations.
- Some slides could be clearer.
- Change the selection of music.
- Use tape-slide presentations for other topics.

After reviewing these comments a few changes could be made to improve the production. Some slides should be retaken with better lighting. Some additional script

material could be added where the slide appears on the screen for a short time.

The use of the tape-slide is supported by the positive responses in the evaluation questionnaire. Students responded that they enjoyed learning the topic from the productions. They seemed to express the fact that they appreciated learning the material using a different type of presentation than strictly lecture followed by discussion.

Recommendations and Conclusion

From the results gained through the evaluation process the following modifications should be done.

- Retake some of the slides that are too dark.
- Add some additional script material for some of the slides that were covered too quickly.
- Add some graphic slides to further help in selecting the ground wire size and to explain how the bonding screw is used within the combination panel.

The author found that the tape-slide medium could be used in a flexible manner so as to enhance learning. It could be shown once and then repeated. During the second showing the production could be stopped at points of importance or interest.

It is also suggested that the tape-slide be transferred to video tape (Brandt, 1991). The process is relatively simple and inexpensive. The program could then be used in

many locations and duplication costs would be less expensive than slide duplication.

The production met the needs of the behavioral objectives. The students gained cognitive skills required in upgrading an Electrical Service main from 100 amp to 200 amp using an outside meter socket. They learned about the important code regulations that govern such installations. Required paperwork that notifies other needed parties such as the Board of Electrical examiners and Hydro Quebec were also covered.

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Appendix A

MODULE 13: LOW-VOLTAGE SERVICE ENTRANCES

786-135 Duration: 75 hours

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

EXPECTED BEHAVIOUR

To demonstrate the required competency, the students must install a low-voltage service entrance in accordance with the following conditions, criteria and specifications.

CONDITIONS FOR PERFORMANCE EVALUATION

- Working alone
- With the help of one person for erecting and dismantling scaffolds
- With the help of one person for drawing conductors into conduits
- Using a residential plan and specifications
- Following instructions
- Referring to the Quebec Electrical Code and Hydro-Quebec standards
- Using the appropriate equipment, tools and material

General Performance Criteria

- Observance of health and safety rules
- Proper use of equipment and tools
- Conformity to the Quebec Electrical Code, Hydro-Quebec standards and the plan and specifications
- Clean, careful work
- Respect for environment and layout
- Observance of ergonomic principles

FIRST-LEVEL OPERATIONAL OBJECTIVE
BEHAVIOURAL OBJECTIVE

SPECIFICATIONS OF THE EXPECTED BEHAVIOUR	SPECIFIC PERFORMANCE CRITERIA
A. Interpret the plan and use the specifications.	- Correct position of components - Proper use of specifications - Adequate sketching of installation
B. Plan the installation	- Accurate calculation of the service-entrance requirements - Appropriate selection of the necessary equipment, tools and material - Accurate calculation of point of connection
C. Adopt safety measures	- Systematic observance of personal and general safety measures
D. Prepare the equipment, tools and material	- Safe handling of equipment, tools and material - proper testing and preparation
E. Install: - the distribution panel - the meter base - the mast	- Proper installation of panel - Economical use of mat'l - Proper height of base - Proper installation of mast
F. Install the conduit and draw the conductors into them.	- Proper installation of conduits - Proper technique for drawing conductors into conduits

G. Make the electrical connections and test the installation	- Proper connections at base and panel - Proper connection of grounding conductor - Installation in conformity with checklist
H. Clean up the work area.	- Clean and orderly work area

Appendix B

SECOND-LEVEL OPERATIONAL OBJECTIVES

IN ORDER TO ACHIEVE THE FIRST-LEVEL OBJECTIVE, THE STUDENTS SHOULD HAVE PREVIOUSLY ATTAINED SECOND-LEVEL OBJECTIVES, SUCH AS;

Before learning how to interpret the plan and use the specifications (A):

1. Identify the characteristics of a three-phase current.
2. Differentiate between single-phase and three-phase service entrances (residential, commercial and industrial).
3. Be familiar with the components of the various types of service entrances.
4. Identify the tables, sections, articles and definitions of the Quebec Electrical Code related to the installation of low-voltage service entrances.
5. Identify Hydro-Quebec standards regarding the installation of low-voltage service entrances.
6. Determine the main symbols and components of a plan for the installation of a low-voltage service entrance.

Before learning how to plan the installation (B):

7. Calculate service-entrance requirements.
8. List the elements that enable the electrician to calculate a point of connection.
9. Use the concepts of communication necessary for installing a service entrance.

Before learning how to prepare the equipment, tools and material (D):

10. Identify the safety rules applicable to the installation of service entrances.

Before learning how to install, the distribution panel, the meter base and the mast(E):

11. Describe the techniques for installing panels, meter bases and masts.

Before learning how to make the electrical connections and test the installation (G):

12. Describe the techniques for connecting conductors to the panel, meter base and ground.

Appendix C

Construction Electricity Module No. 786-135

Lesson No. 13 Upgrading an Electrical Service Entrance for a single family home.

Equipment required: 35-mm Kodak carousel projector
Wollensak 2550 cassette recorder
Screen
Tape-slide production

Objectives

Students will be able to write down the steps in changing an electrical main.

Students will be able to list the tools required for certain jobs.

a) Enlarging hole in wall
b) Removing knockouts from meter sockets
c) Bending PVC conduit

Students will be able to list the correct sequence for wiring a combination panelboard.

The students will be able to identify the correct safety apparel required for working on live electrical conductors.

Students will be able to describe orally or written the responsibilities of Hydro Quebec, master electrician and Board of electrical examiners in changing an electrical main.

Students will be able to select the correct information from code rules applicable to installing a 200 amp main with respect to;

a) size of wires for the line, neutral and ground.
b) the location of parts such as the mast, spool rack and meter socket.

Preassessment

Have students complete an entry levels test. The students should score at least 70%. The subject test material comes from lessons one to twelve.

Introduction

Explain why service entrances are changed.

Ask if any student has seen a service entrance changed?
Ask class what sort of standard safety equipment might be required to do work in a bungalow?
Tell class that a tape-slide production will be shown on how to change an electrical main.
Explain the need for the production. (lack of shop facilities)

Lesson Development

Review with the students the following.

What are the responsibilities of Hydro Quebec?

Explain the purpose of the Electrical Board of Examiners.

What type of safety equipment should be worn by the tradesman? (individual protection) eg gloves, safety shoes

Explain that tape-slide will now be shown and that any questions should be held until the end of the presentation.

Show the presentation.

At the end of the tape-slide ask the students if they would like to see parts of the production for a second time in order to clear up any possible misconceptions.

Do as requested or needed.

Student activity

Participate in the introduction.
Do entry levels test.
View presentation.
Participate in post tape-slide discussion.
Complete posttest.

Evaluation

The student should score at least 70% on the posttest.

Comments

The students will now be able to start work in the shop on building service entrances.

Appendix D

Script

Slide 1	Title slide	music
Slide 2	Produced by	music
Slide 3	Credit slide	music fades

I would like to thank Abe Grant of Kode Electric for providing production and technical assistance. Also to Kosta and Mitchell who were capable helpers.

Slide 4

This presentation outlines the procedure for upgrading a 100 Amp service that contained an Outside Steel Mast and an Outside Meter Socket.

Slide 5

Service entrances are changed because new appliances are added to the home. Microwave ovens and

Slide 6

Electric baseboard heaters are some examples.

Slide 7

The electrician meets with the home owner to review the present service entrance. All the circuits are now being used in this 100 Amp combination panel and this prevents further expansion. The electrician recommends that the

present installation be replaced with a 200 Amp 40 circuit combination panel using breakers.

Once the work to be done is agreed upon, the electrician estimates the wire lengths needed and prepares a material list.

Slide 8

Before changing the electrical main a work permit must be obtained from the Board of Electrical examiners located at 355 Cremazie Blvd. This document informs the Electrical Board of examiners that major work will be done that requires inspection.

Slide 9

The electrician picks up the material at the supplier and loads them into his van. At the house the material is unloaded.

Slide 10

The meter seal number is recorded, so that the data can later be added to the request for inspection and notification to Hydro Quebec.

Slide 11

The main switch is then turned off and the helpers begin the disassembly of the branch circuit wiring connected to the old panel.

Slide 12

The electrician disconnects the line and neutral wires from the mast. Rubber gloves are used since these wires are live.

Slide 13

Together with a helper the line from the pole is anchored to the building in a temporary arrangement. Ensure that the anchor can safely hold the wires since an untimely release could be fatal.

Slide 14

The top half of the FE condulet (Entrance Cap) is now removed and the bolts holding the spool rack are loosened.

Slide 15

A duplex receptacle is attached to one of the hot lines and the neutral. This receptacle provides electrical power for tools and equipment.

Slide 16

The main wires coming from the meter to the main switch are by now disconnected by the helpers working at the panel. These wires will be pulled out from the outside.

Slide 17

The meter socket seal and meter are now removed. The old seal will be left on the new meter socket.

Slide 18

The 100 Amp Meter is placed in a safe location so that it can be reinstalled later.

Slide 19 & 20

A hammer is now used to break the LB condulet.(3 sec 3 sec)

Slide 21

The wires from the LB to the main switch are pulled out.

Slide 22

All the wires in the vertical mast can now be pulled out as well.

Slide 23

The clamps holding the old mast are removed.

Slide 24

Plastic Roof Cement surrounding the old mast is chipped away.

Slide 25

The old mast can now be lowered and discarded.

Slide 26

While the electrician has been working outside a helper on the inside of the house has disconnected all the wires from the 100 Amp combination Panel board. These wires should be identified before removal, if previously identified in the old

panel. The old panel is then removed from the wall.

Slide 27

A new hole of 2 1/2" diameter is now drilled in the wall of the house. The location is the same as the old conduit.

Slide 28

A Cold Chisel is used to make final adjustments to the shape of the hole.

Slide 29

With the new LB condulet held in place the length of new PVC conduit required between the LB and the panel board is measured.

Slide 30

The 2" diam conduit is marked using a black felt marker.

Slide 31

Using a hacksaw with a 32 teeth per inch blade the conduit is easily cut.

Slide 32

PVC cement Glue is used to join the LB Condulet to the conduit.

Slide 33

A 2" PVC connector is glued to the incoming conduit by the helper.

Slide 34

The new panel is fitted over the connector and aligned in both the vertical and horizontal directions. It is then attached to the wall with four Robertson head woodscrews #10 1" long.

Slide 35

A locknut is now threaded and tightened to the connector.

Slide 36

A plastic bushing is threaded on top of the locknut.

This completes the mounting of the panelboard and the conduit through the wall. The next step is the installation of the ground wire system by the helpers.

Slide 37

A bare copper wire #3 AWG connects from the neutral bar to the cold water pipe, where it enters the house. Green tape covers the wire in the switch area. The old ground wire is also removed.

Slide 38

Using an approved connector, the other end of the bare # 3 wire connects to the cold water pipe.

Slide 39

A special bonding screw must be left in position. It connects the metal box to the neutral bar. This screw must be removed if the panel board is a SUB SERVICE. SINCE THIS IS A MAIN SERVICE SWITCH LOCATION the screw must be left in place. While the helpers are completing the ground system, the electrician works outside and installs the new mast assembly and meter socket.

Slide 40

A 2" Plastic hub is attached to the new 200 Amp meter socket.

Slide 41

Using a tape measure, the height for the meter socket is determined.

Slide 42

Holding the meter socket in place, the length of conduit needed from the LB to the bottom of the meter socket is measured. A piece of 2" PVC is cut to the required length.

Slide 43

Using lineman pliers knockouts are removed for the 2" PVC connector.

Slide 44

The parts are assembled and the holes needed for mounting the meter socket are marked using a felt

marker. The old holes cannot be used because the 100 amp socket is smaller.

Slide 45

The bottom conduit joint is now glued.

Slide 46

Four holes are drilled for the meter socket.

Slide 47

Four plastic plugs are lightly hammered into the holes. A 2 inch PVC connector is also glued to the end of the PVC conduit.

Slide 48

The meter socket is placed over the connector and screwed into place.

Slide 49

A locknut and plastic bushing are then installed.

Slide 50 (green text)

Remember, that according to the Hydro standards the meter socket should be mounted between 1.5 - 1.8 m above grade.

Slide 51

The new mast will now be installed. An approximate length above the roof can be quickly determined. The mast is held in place by the friction between the hole in the roof and the mast. In some cases the hole may have to be enlarged.

Slide 52

To locate final dimensions the hand book supplied by Hydro can be consulted.

Slide 53

This drawing is from the Hydro Quebec's low voltage service manual. All required dimensions are shown. It gives you some idea of the information available.

Slide 54

Once the mast height about the roof is decided upon the mast is temporarily locked in place using the new spool rack.

Slide 55

The steel mast that comes with the kit is 10 feet long and is not long enough to reach the meter. A special PVC adapter is used to make the conversion from the rigid steel mast to PVC. To do this a special mast connector using a set screw connects to the metallic mast. A 2" PVC adapter with an internal thread is screwed on to the 2" threaded end of the mast connector.

Slide 56

A measurement is taken for the PVC conduit needed between the bottom of the PVC adapter and the meter socket.

Slide 57

The cut piece of PVC is now heated to form a small bend. The heater looks like a hair dryer but produces much more heat.

Slide 58

The conduit is shaped so that the mast will line up with the meter socket.

Slide 59

Support clamps are now attached to the wall. For this particular job 2 clamps plus the hole in the roof serve as mast supports.

Slide 60

The electrician removes the temporarily attached spool rack and slides on a new rubber seal. He reattaches the spool rack and mounts the bottom half of the entrance cap. At the same time the helper directs a # 3 AWG bare copper conductor up the mast that will become the neutral.

Slide 61

The distance between the spool rack and top of the entrarce cap should be between 150 - 300 mm. For this job the 150 mm distance will be used.

Slide 62

The helper now pushes 2 000 AWG R90 conductors up the mast. The electrician tells the helper when

the correct amount of wire sticks out at the top of the mast.

Slide 63 (Text)

At least 750 mm of conductor is left free for connections.

Slide 64

A special clamp mounted below the spool rack now receives the #3 bare neutral wire. This will connect the metallic mast to ground as per code rules.

Slide 65

The top half of the Entrance cap is now installed.

Slide 66

Drain holes are now drilled in the bottom of the LB. This prevents moisture from entering the panel board.

Slide 67

The line wires at the bottom of the mast are cut with a hacksaw. They are stripped of insulation and connected to the top terminals in the meter socket. Allen keys are used to tighten the screws. Notice the neutral wire is taped white where it passes through the socket. The wires between the bottom terminals of the socket are now connected and the other ends are pushed through the conduit that runs through the wall.

Slide 68

The holes surrounding the wires are filled with DUX seal in the LB condulet. This prevents hot moist air in the home from going up the mast.

Slide 69

The old 100 Amp Meter is now inserted into the Meter Socket. It is locked in place and the old seal is attached. Hydro Quebec during there final installation will replace the meter and use a new seal.

While the electrician has been working outside on the mast a helper has been wiring the panel.

Slide 70

The helper first inserts the branch circuit cables into the panel. No electrical connections have as yet been made.

Slide 71

He then connects all the bare ground wires to the ground terminal locations within the panel. Note that two ground wires have yet to be installed.

Slide 72

All the white wires are then connected to the neutral bars. There are two white wires still to be connected.

Slide 73

All the branch circuit breakers are now installed and connected. Note how the wires have been arranged in an orderly neat manner. It is also evident that there are many new spare circuits available.

Slide 74

The helper now installs the 200 A main breaker and the two #000 AWG line wires. Also note that the bare neutral wire has been taped white. Taping should be done before connecting to terminal.

Slide 75

The neutral cable from the pole is now attached to the spool rack. Also the two line wires are connected.

These connections will be redone by Hydro at a later date. They will shortly come by to change the service drop from the pole to the house and to install a new 200 Amp meter in the socket. Before leaving the roof, caulking should be applied around the rubber seal to prevent roof leaks.

Slide 76

The panel covers are now installed. All the spare locations are covered for safety reasons. This is a code rule. All the circuits are then switched on and identified by completing the blank lined writing area.

Slide 77

The work area is now cleaned and tools placed in the truck.

Slide 78

The electrician completes the request for inspection form for the Electrical Board of Examiners. A separate form is sent to Hydro so that they will replace the drop from the pole and install a new meter and seal.

Slide 79

At the same time the inspection request is made an invoice is completed and submitted to the customer.

This is usually the last step.

Slide 80 The end Music

Appendix E

AMPACITY CALCULATION FORM
For Single Family Home

Step 1 - Living area Calculation Rule 8-110

Ground Floor - 100% of Outside dimensions
1st or 2nd floor - 100% of Inside dimensions
Basement - 75% of Inside dimensions

Ground Floor	_____	X	_____	=	_____	sq m.
1st Floor	_____	X	_____	=	_____	sq m.
2nd Floor	_____	X	_____	=	_____	sq m.
Basement	_____	X	_____ X 75 %	=	_____	sq m.

Total living area _____ sq m.

Basic Load (incl. lights and duplex receptacles)

1st 90 sq m of living area	= 5000	w
2nd 90 sq m or part of (1000 w)	= _____	w
3rd 90 sq m or part of (1000 w)	= _____	w
4th 90 sq m or part of (1000 w)	= _____	w

Heating with gas or oil

If less than 1500 VA	= 0	w
If greater than 1500 VA, enter full value	_____	va

Central Electric Heating

100% rating on the furnace _____ w

Electrical Baseboard Heating

1st 10 k w @ 100%	_____	w
Balance at 75%	_____	w

Single Room A/C Units

If unit < 1500 VA enter 0	_____	w
If unit > 1500 VA enter at 100% (X no. of units)	_____	w

Central A/C Systems

If unit is part of heating system enter the greater consumption between systems. Do not add both if systems interlocked _____ w

Electric Range

Up to 12 kw			6000 w
+40 % of Excess	_____	X 40%	_____ w

Other Loads

If electric range provided for;
use 25% of the rating of each appliance rated in excess of 1500 VA. Such appliances as dryers, water heaters, kiln etc.

_____	X 25%	_____ w
_____	X 25%	_____ w
_____	X 25%	_____ w

If electric range is not provided for; use 100% of each appliance rated in excess of 1500 VA up to a total of 6000 watts.
Balance at 25% of rating as above.

_____	_____ w
_____	_____ w
_____	_____ w

Total Watts from pages 1 & 2 _____ w

Total Watts / 240 V = _____ Minimum Service Ampacity Required

Standard Ampacity Selected _____

Service Drop Wire Type & Size (Table 2, 4) _____

Neutral Wire size (Table 2, 4) _____

Meter Socket Size _____

Conduit Size (Table 6, or 8, 9, 10) _____

Panelboard size & # of ckts _____

Main Service Switch Ampacity _____

Combination Panel Size (# of ckts) _____

Ground Wire Size (Table 17) _____

Notes _____

End

Appendix F

Material List for
Upgrading to 200 Amp Service

Qty	Description
1	Mast Kit 200 Amp Includes Entrance Cap Mast 10' long 2 1/2" dia Spool rack Steel Mast connector & PVC adapter Metallic roof flange & seal Two hole conduit supports
14 meters	#000 R90 copper cable - black
14 meters	#3 Bare Copper conductor
1	Ground Clamp for pipe up to 3" diameter
1	Ground Clamp 200 Amp for 3/4" Water pipe
1	40 circuit combination panel 200 Amp 120 - 240 V 1 phase
1	200 Amp 2 pole 120 - 240 V main breaker
2	40 Amp 2 pole 120 - 240 V breakers
2	30 Amp 2 pole 120 - 240 V breakers
1	20 Amp 2 pole 120 - 240 V breakers
10	15 Amp 1 pole 120 V breakers
1	200 Amp 1 phase 120 - 240 V Meter Socket
1	2" LB PVC Condulet
1	2" PVC Meter Hub
2	2" PVC Connectors
2	2" Steel Locknuts
2	2" Plastic Bushings
8	1" long #10 Robertson screws
4	Plastic Plugs
1	Dux Seal Package
	Roof caulking

Appendix G

Task sequence for changing an electrical main

Notes: Based on telephone conversations held with two electricians.

1. Pick up material and load truck.
2. Load required special tools in truck.
3. Drive to site.
4. Examine Service Entrance to be removed.
5. Turn power off at main panel.
6. Disconnect wires at service head.
7. Arrange for electric power to run electrical tools.
8. Disconnect line wires and neutral in main service switch.
9. Disconnect ground wire in main switch.
10. Break LB on outside and pull out wires from LB to main switch.
11. Pull wires out of mast.
12. Remove old mast.
13. Disconnect branch wires from panelboard.
14. Remove old panel, main switch and meter if inside.
15. Where hole in wall located drill to required new size using concrete core bit.
16. Measure thickness of wall and determine length of PVC needed from back of panelboard to LB on outside. Cut to length.
17. Glue connector on PVC pipe & attach to new panelboard.
18. Mount combination panelboard on wall.
19. Select height of meter socket and cut 2nd piece of PVC pipe then attach connector to PVC.

20. Glue PVC pipe to LB and complete mounting of meter using 4 screw and lead shields.

21. Enlarge hole in roof overhang if needed.
- Reciprocating saw suitable.

22. Place mast in hole and leave enough mast above roof to meet installation requirements.

23. Hold mast and measure for conduit between mast and meter socket.

24. Cut conduit to length.

25. Insert the metallic to PVC adapter into mast and tighten.

26. Glue assembly to PVC conduit and then glue plastic hub to conduit for attachment to meter socket.

27. Mount required support clips for mast using lag bolts 3/8" - 3" length.

28. Put on roof flange (nails & tar).

29. Install spool rack on the mast.

30. Install bottom half of F condulet.

31. Push wires up from meter socket, leave 1 m free.

32. Connect wires to meter.

33. Complete F condulet installation.

34. Connect wires from meter socket to panelboard.

35. Tape neutral wire where required.

36. Reconnect panelboard circuits.

37. Install new ground wire.

38. Install ground clamp on mast for neutral.

39. Reconnect hot wires. Use burnby connectors.

40. Put jumpers in meter socket or install old meter.

41. Drill drain hole in LB.

42. Apply dux seal in LB.

43. Prepare paper work for inspection purposes.

44. Make up invoice.

45. Pack up tools & clean up.

Appendix H

Slides required for project

Notes: The following is the list of scenes to be photographed which was made up prior to doing the job.

Truck being unloaded including materials and tools.

Picture of old panelboard area.

Turn power off at main panel.

Cut wires at entrance cap.

Attach drop wires to building.

Make arrangement for electric power needed by tools.

Slide of disconnecting ground wire.

Disconnect other wires in main switch.

Breaking LB condulet.

Pulling wires out of LB from main switch.

Pulling wires out of mast.

Taking down old mast.

Disconnecting all branch wiring from panelboard.

Drilling hole for PVC conduit to enter building (concrete core bit).

Determine length of PVC between panelboard and LB.

Cut PVC conduit to length.

Glue connector on PVC conduit and attach to pannelboard.

Select location of meter socket, mark for drilling.

Drill holes. (height 1.5 - 1.8 m)

Cut PVC conduit to length and add connector.

Glue piece between between LB and meter.

Mount meter socket using screws.

Enlarge hole to size in roof overhang (reciprocating saw).

Installing mast through roof overhang.

Hold mast and measure for required PVC conduit between mast and meter.

Cutting conduit to length.

Installing metal adapter to mast.

Mounting hub and conduit to top of meter socket & fitting into adapter.

Installing support clamps for mast (2 to 3 clamps) use 3/8" dia 3" length lag screws.

Putting on roof flange (nails and tar).

Installing spool rack (150 - 300 mm from F condulet).

Installing bottom half of F condulet.

Pushing wires up from meter socket, leave 1 m free.

Connecting wires from mast to meter socket.

Complete F condulet installation.

Connecting wires, from meter socket to panelboard.

Taping neutral wire in meter socket (white).

Install branch circuits using new connectors.

Installing new ground wire at neutral block.

Slide showing bonding screw.

Installing ground wire at water pipe.

Installing ground clamp at mast to connect to neutral.

Reinstalling old meter in socket.

Reconnecting hot drop wires using burnby connectors.

Power up system and check.

Drilling hole in LB condulet.

Apply dux seal in LB condulet.

Install old meter seal.

Preparing documentation for Hydro and inspection request.

Making up invoice.

Packing up tools and clean up of work areas.

Other Slides

Title Slide

Produced by

Thanking Slide or Slides

The End

Inspection request form

Copy of blank invoice

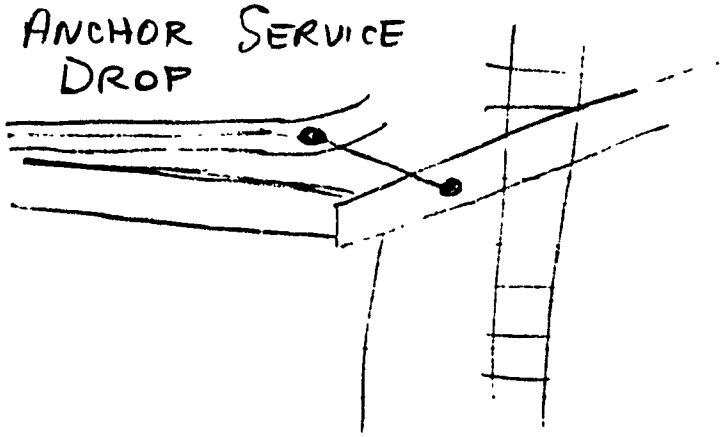
Slide of microwave

Slide of baseboard heater

Appendix I

Sample scene cards

ANCHOR SERVICE DROP



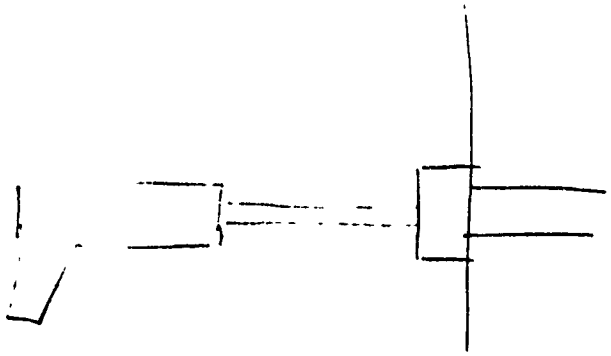
SLIDE NO. 12

TAKE AT SITE

USE X2 LENS ADAPTER

TOGETHER WITH A HELPER THE LINE FROM THE POLE IS ANCHORED TO THE BUILDING IN A TEMPORARY ARRANGEMENT. ENSURE THE ANCHOR CAN SAFELY HOLD THE WIRES SINCE AN UNTIMELY RELEASE COULD BE FATAL.

DRILL HOLE IN WALL.



SLIDE NO. 19

TAKE AT SITE

USE X2 LENS ADAPTER

A NEW HOLE OF $2\frac{1}{2}$" DIAMETER IS NOW DRILLED IN THE WALL OF THE HOUSE. THE LOCATION IS THE SAME AS THE OLD CONDUIT.

NOTE - CONCRETE CORE BIT

Appendix J

Entry Levels Test
For Upgrading Service Entrance Project

Students Name_____

Read each question and circle the best answer. Good luck.

1) The Standard Service Voltage for a single family home should be;

   (a) 120/208 Volt three phase.

   (b) 120 Volt single phase.

   (c) 240 Volt single phase.

   (d) 120/240 Volt single phase.

2) Who makes the <u>final</u> connections at the service head for a single family home?

   (a) The homeowner.

   (b) An Electrical Apprentice.

   (c) A Contractor Electrician.

   (d) A Hydro Quebec Electrician.

3) The sketch at the right represents a,

   (a) Spool Rack.

   (b) FE Condulet.

   (c) LB Condulet.

   (d) Plastic Bushing.

4) When a hot water tank is connected to a panelboard, what type of breaker is required?

   (a) 15 Amp 120V 1 pole

   (b) 20 Amp 120V 1 pole

   (c) 30 Amp 600V 1 pole

   (d) 20 Amp 240V 2 pole

5) The service drop wire crossing a public roadway must be at least _____ above the road.

(a) 5.5 meters

(b) 5.0 meters

(c) 4.0 meters

(d) 3.5 meters

6) A combination Panelboard combines a,

(a) Meter Socket and Main Switch.

(b) Meter and fuses.

(c) Main Breaker and Branch Circuit Breakers.

(d) Current Transformer and Meter Socket.

7) The maximum number of consumer services that can be connected to one supply service is _____.

(a) 5

(b) 4

(c) 3

(d) 2

8) A 12 KW stove is to be connected to a panel. For service entrance load calculations what is the demand factor?

(a) 25%

(b) 40%

(c) 50%

(d) 100%

9) When an open neutral defect occurs it is most often found,

(a) in the panelboard.

(b) in the ground circuit.

(c) in the Hydro power meter movement.

(d) at the entrance cap.

10) Which one of the following conduit cannot be used to install main service conductors?

(a) Rigid Metallic Conduit.

(b) Electrical Metallic Conduit.

(c) Fibreduct.

(d) PVC Conduit.

11) When a service entrance requires a separate ground rod, the rod dimensions if made of steel are,

(a) 1/4" dia X 3 meters long.

(b) 5/8" dia X 3 meters long.

(c) 1/2" dia X 2 1/2 meters long.

(d) 3/4" dia X 2 meters long.

12) Which of the following meters are no longer used?

(a) 60 Amp 120/240 Volt single phase

(b) 100 Amp 120/240 Volt single phase

(c) 100 Amp 120/208 Volt three phase

(d) 200 Amp 120/240 Volt single phase

Total marks 12

Appendix K

Pretest for Upgrading a 100 Amp Service to 200 Amp

Name_____

Part 1

Read each question carefully and circle the best answer.

1) Before changing an electrical main the electrician must obtain a/an;

   (a) Inspection report

   (b) New meter seal

   (c) Work permit

   (d) Hydro Quebec qualification certificate

2) What type of tool is used to dismantle the LB condulet?

   (a) Robertson Screwdriver-Yellow

   (b) Westcot wrench

   (c) Cold chisel

   (d) Hammer

3) What size of PVC conduit is used when installing a 200 Amp main?

   (a) 3/4" dia.

   (b) 1-1/4" dia.

   (c) 1-1/2" dia.

   (d) 2" dia.

4) What colour tape should be used in covering the bare copper wire that runs from the panel to the cold water pipe?

   (a) Black

   (b) Red

   (c) Green

   (d) White

5) Name the component that is screwed to the top of a new 200 Amp meter socket?

   (a) Plastic Hub

   (b) Plastic locknut

   (c) PVC connector

   (d) LB condulet

Part 2

Read each question and answer on the line provided.

6) The device that connects the neutral bars to the metal panel box is called a/an;

_____

7) Name the tool that is commonly used to remove knockouts from a new meter socket.

_____

8) What is the standard length of the steel mast that comes with a mast kit?

_____feet.

9) What type and size of main circuit breaker is used in a 200 Amp panel?

_____

10) What type of material is placed in a LB condulet to prevent moisture from going up the mast?

_____

Total Marks 10

Appendix L

Posttest
Upgrading a 100 Amp Service to 200 Amp

Name_____

Part 1

Read each question carefully and circle the best answer.

1) Service entrances are increased in ampacity size because;

   (a) circuit breakers keep tripping for unknown reasons.

   (b) Hydro Quebec makes a recommendation.

   (c) some people have increased their service entrance size.

   (d) new circuits are required within the home that require heavy current.

2) Before changing an electrical main the electrician must obtain a/an;

   (a) Inspection report.

   (b) New meter seal.

   (c) Work permit.

   (d) Hydro Quebec qualification certificate.

3) To protect the electrician while disconnecting the lines at the service head;

   (a) Non insulated steel cutters are used.

   (b) Rubber gloves are worn by the tradesmen.

   (c) The electrician dries the area around the mast.

   (d) Arrange for Hydro to turn off the power.

4) When the meter seal is removed from the old meter socket, it is,

   (a) kept by the electrician to be reinstalled.

   (b) thrown away.

   (c) sent to Hydro Quebec.

   (d) kept by electrician for record keeping purposes.

5) What is the standard length of rigid steel conduit that comes with the 200 Amp mast kit?

   (a) 8 feet

   (b) 10 feet

   (c) 14 feet

   (d) 20 feet

6) Why does the electrician connect a duplex receptacle to the service drop wires coming from the pole?

   (a) So that the customers fridge is kept running.

   (b) So that the alarm system be kept operative.

   (c) So that the electrical appliances are not damaged.

   (d) So that electrical tools required during installation have a source of power.

7) Which one of the following tools is used to dismantle the LB condulet?

   (a) Hacksaw

   (b) Adjustable wrench

   (c) Cold chisel

   (d) Hammer

8) Which tool was used to make final shape adjustments to the hole drilled through the wall?

   (a) Hacksaw

   (b) Pipe wrench

   (c) Hammer & Cold chisel

   (d) File

9) Within the panel the main ground wire is covered with tape. What should the tape colour be?

   (a) Black

   (b) Green

   (c) Red

   (d) White

10) When the new panel was slipped over the 2" PVC connector, which components were then installed on the connector?

   (a) Set screw and locknut

   (b) Locknut and metallic bushing

   (c) Metallic locknut and plastic bushing

   (d) Plastic locknut and plastic bushing

11) What size and type of wire is used to connect the neutral bar to the cold water pipe for a 200 Amp electrical entrance?

   (a) #3 AWG stranded copper wire

   (b) #3 AWG stranded aluminum wire

   (c) #6 AWG solid copper wire

   (d) #8 AWG stranded copper wire

12) The bare wire going through the meter socket has to be taped. What tape colour should be used?

(a) Black

(b) Blue

(c) White

(d) Green

13) To remove knockouts in a new meter socket what is the recommended tool?

(a) A heavy hammer

(b) Linemen pliers

(c) Red Robertson screwdriver

(d) Wide cold chisel

14) Name the component that is screwed to the top of the new 200 Amp meter socket?

(a) Plastic Hub

(b) FE condulet

(c) LB condulet

(d) PVC 1 1/2" dia. connector

15) When installing the new meter socket how many support holes should be drilled?

(a) 4

(b) 3

(c) 2

(d) 1

16) The meter socket should be located between

(a) 1.0m to 1.5m above grade

(b) 1.2m to 1.6m above grade

(c) 1.5m to 1.8m above grade

(d) 1.8m to 2.5m above grade

17) To temporarily hold the new mast in place what should be the holding device?

(a) A 2" entrance cap

(b) An 1-1/2" diameter U Clamp

(c) Two 2" diameter locknuts

(d) A 2" spool rack

18) When installing a service mast which text provides the required dimensional data for use in Quebec?

(a) The handbook supplied by Hydro Quebec

(b) The Canadian Electrical Code

(c) The Quebec Electrical Code

(d) Electrical Code Simplified - Ontario

19) What should be the minimum number of support points for a standard steel mast, between the entrance cap and the top of the meter socket?

(a) 4

(b) 3

(c) 2

(d) 1

20) Why are drain holes drilled in the bottom of the LB condulet?

(a) To prevent moisture from collecting in the bottom of the mast.

(b) To allow for the escape of heat.

(c) Permits cold air to enter the mast and therefore cool the service entrance wires by convection.

(d) None of the above.

21) Which type of tool is used to cut the #000 conductors?

(a) An electric jig saw

(b) A metallic key hole saw

(c) A hacksaw with a 16 teeth per inch blade

(d) A hacksaw with a 32 teeth per inch blade

22) What diameter of PVC conduit is used between the LB condulet and the panelboard for the 200 Amp service?

(a) 1-1/4" dia.

(b) 2" dia.

(c) 3" dia.

(d) 4" dia.

23) How many circuits are available in the new 200 Amp panel?

(a) 16

(b) 20

(c) 24

(d) 40

24) What type and size of circuit breaker is used with a 200 Amp electrical main that uses #000 conductors in the mast?

(a) 150 Amp. 3 pole breaker

(b) 150 Amp. 2 pole breaker

(c) 200 Amp. 1 pole breaker

(d) 200 Amp. 2 pole breaker

Total Marks 24

PART 2

Answer the following questions in the space provided.

25) Why is it important that the service drop wires from the pole to the house be securely anchored to the building while the new mast is installed?

_____

_____

26) Who completes the form that informs Hydro Quebec that a new drop and new meter seal are to be installed?

_____

_____

27) Name the material used in an LB condulet to prevent hot moist air in the home from going up the mast?

_____

28) Explain why 2 pole breakers are used to control a 240 Volt clothes dryer.

_____

_____

_____

29) To meet electrical code wire identification requirements, what should be done to the #3 bare conductor that enters the panel board from the service mast.

---

30) What should be done in order to prevent possible roof leaks from the rubber seal installed around the mast?

---

31) Name the part that electrically connects the neutral bars to the metal service entrance box?

Total Marks 7

PART 3

32)
The following steps are used to wire the branch circuit area of a combination panelboard. They are not in order. Place them in order by entering numbers in the spaces provided.

_____ The bare ground wires from each branch circuit is connected to ground terminal locations.

_____ Using new connectors the branch circuit cables are inserted into the panel.

_____ The branch circuit breakers are mounted and the hot wires are connected.

_____ White wires from the branch circuit cables are connected to the neutral bars.

Total Marks 35

The End

Correct Answers for Posttest

1. D
2. C
3. B
4. A
5. B
6. D
7. D
8. C
9. B
10. C
11. A
12. C
13. B
14. A
15. A
16. C
17. D
18. A
19. B
20. A
21. D
22. B
23. D
24. D

25. To prevent live drop wires from falling and injuring people.
26. The master electrician.
27. DUX seal (Putty like substance).
28. So that all hot wires are disconnected at the same time.
29. Taped white.
30. Use caulking
31. Bonding screw
32. Correct sequence is 2, 1, 4, 3.

Appendix M

Note: COPY OF EVALUATION QUESTIONNAIRE WITH RECORD OF STUDENT RESPONSES. SOME LINES DO NOT ADD UP TO 17 DUE TO NO RESPONSE FROM SOME STUDENTS.

Production Evaluation Questionnaire for

Upgrading a 100 Amp Service Entrance to 200 Amp

Please evaluate the tape-slide presentation as accurately as possible. Remember, you are our prime source of information regarding what needs to be revised.

Part 1

Place a check mark in the space that best describes your opinion. No more than one check mark per line.

GRAPHIC SLIDES:

Slides with text: 4 excel 13 good 0 needs work 0 poor

PICTURE QUALITY:

Exposure: 8 excel 7 some overexposed 0 some underexposed

Visual Sequencing: 10 excel 6 satisfactory 0 poor

Variety of shots: 12 excel 5 satisfactory 0 poor

Visual impact: 13 excel 4 satisfactory 0 poor

SCRIPT:

Pace: 2 too fast 15 perfect 0 too slow

Vocabulary: 3 complex 14 perfect 0 too simple

Flow: 0 mixed up 4 some confusion 13 very logical

ACCURACY OF INFORMATION:

12 very good 4 fair 0 inaccurate; needs work

SOUND TRACK:

Sound quality: 4 excel 13 good 0 poor

Volume level: 1 too low 16 correct 0 too high

PART 2

Comment on the following statements by circling the appropriate letters. Follow the key in making your selection.

Key:
SA = strongly agree
A = agree
U = uncertain
D = disagree
SD = strongly disagree

1. I had sufficient information to prepare me for this presentation.

   SA = 2 A = 13 U = 2 D = 0 SD = 0

2. I was often unsure of what, exactly, I was supposed to be learning.

   SA = 0 A = 4 U = 2 D = 7 SD = 4

3. Listening to the tapes and watching the slides was often boring.

   SA = 0 A = 0 U = 1 D = 16 SD = 0

4. This presentation was very well organized. The concepts were highly related to each other.

   SA = 4 A = 13 U = 0 D = 0 SD = 0

5. There was too much information in this presentation.

   SA = 1 A = 0 U = 3 D = 9 SD = 4

6. There was not enough repetition of important ideas.

   SA = 0 A = 6 U = 5 D = 5 SD = 1

7. Often the tape and slides seem unrelated to each other.

   SA = 0 A = 0 U = 0 D = 14 SD = 3

8. The vocabulary used contained many unfamiliar words. I often did not understand what was going on.

   SA = 1 A = 1 U = 1 D = 9 SD = 5

9. The posttest questions did a good job of testing my knowledge of the main points in the presentation.

   SA = 6 A = 11 U = 0 D = 0 SD = 0

10. At the end of the presentation I was still uncertain about a lot of things and had to guess on many of the posttest questions.

    SA = 1 A = 3 U = 1 D = 11 SD = 1

11. I believe I learned a lot, considering the time spent viewing this presentation.

    SA = 5 A = 10 U = 1 D = 1 SD = 0

12. The objectives of the presentation were of great interest to me personally.

    SA = 5 A = 12 U = 0 D = 0 SD = 0

13. As an aid to learning would you like to view the tape-slide presentation again?

    SA = 6 A = 7 U = 2 D = 2 SD = 0

PART 3

14. Please summarize in one sentence your overall reaction to this presentation.

15. In one sentence, state what you believe to be the best or most interesting feature of this presentation.

16. Write below any suggestions or changes that you believe will improve the tape-slide production.

Thank you

Appendix N

Posttest Analysis

Note. The following is a distribution of the answers selected by the 17 students for the first 24 questions of the posttest. The number underlined represents the correct response.

Question	A	B	C	D
1.	0	0	1	<u>16</u>
2.	1	0	<u>16</u>	0
3.	0	<u>17</u>	0	0
4.	<u>13</u>	0	2	2
5.	0	<u>15</u>	2	0
6.	0	0	0	<u>17</u>
7.	0	2	0	<u>15</u>
8.	0	0	<u>17</u>	0
9.	0	<u>17</u>	0	0
10.	1	1	<u>15</u>	1
11.	<u>8</u>	0	5	4
12.	0	0	<u>17</u>	0
13.	0	<u>16</u>	0	1
14.	<u>12</u>	0	1	4
15.	<u>17</u>	0	0	0
16.	0	0	<u>17</u>	0
17.	0	6	1	<u>10</u>
18.	<u>15</u>	0	2	0
19.	1	<u>14</u>	2	0
20.	<u>15</u>	1	0	1
21.	1	1	3	<u>12</u>
22.	1	<u>15</u>	1	0
23.	0	0	7	<u>9</u>
24.	0	0	4	<u>13</u>

Note: For questions 25 through 32 part marks were given. Therefore the distribution is broken down into Correct response, Partial correct response and Incorrect response.

Question No.	Correct response	Partial correct response	Incorrect response
25.	17	0	0
26.	16	0	1
27.	9	4	4
28.	5	4	8
29.	11	4	2
30.	14	1	2
31.	5	4	8
32.	14	3	0

The End

Appendix O

NOTE: PRODUCT MOMENT CORRELATION BASED ON THE SPLITTING OF THE POSTTEST INTO TWO EQUAL PARTS.

Person	(X)	(Y)	X^2	Y^2	XY
Harlev	10.5	14.0	110.25	196.00	147.00
Blackburn	13.0	12.5	169.00	156.25	162.50
Bailey	14.0	13.0	196.00	182.25	189.00
Rotariu	12.5	15.0	156.25	225.00	187.50
DeCarlo	8.0	12.5	64.00	156.25	100.00
Arvanitos	10.5	14.0	110.25	196.00	147.00
Dixon	14.0	14.5	196.00	210.25	203.00
Argyrou	14.0	14.0	196.00	196.00	196.00
Tsoupakis	12.0	11.0	144.00	121.00	132.00
Rowe	15.0	15.0	225.00	225.00	225.00
Green	15.0	16.0	225.00	256.00	240.00
Sweetman	16.0	16.0	256.00	256.00	256.00
Iamello	15.0	15.5	225.00	240.25	232.50
Ransom	13.5	14.5	182.25	210.25	195.75
Gariba	10.0	9.0	100.00	81.00	90.00
Brusilo	10.0	14.0	100.00	196.00	140.00
Fairse.	12.0	14.0	144.00	196.00	168.00
n=17	215	235	2799	3299.5	3011.25

$$r_{xy} = \frac{\Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{n}}{\sqrt{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}\ \sqrt{\Sigma Y^2 - \frac{(\Sigma Y)^2}{n}}}$$

$$= \frac{3011.25 - \frac{(215)(235)}{17}}{\sqrt{2799 - \frac{(215)^2}{17}}\ \sqrt{3299.5 - \frac{(235)^2}{17}}} = +.624$$

Spearman-Brown prophecy formula

$$r = \frac{2r}{1 + r} = \frac{2 \times .624}{1 + .624} = +.77$$