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The soundboard program: A case study investigating the design, creation and evaluation of an interactive computer-based training program.

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THE SOUNDBOARD PROGRAM:

A CASE STUDY INVESTIGATING THE DESIGN, CREATION AND EVALUATION OF AN INTERACTIVE COMPUTER-BASED TRAINING PROGRAM

by

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ABSTRACT

The world's knowledge base grows exponentially on a daily basis. Businesses and schools are obligated to provide the latest methodologies and information to their respective fields of expertise. However, shrinking fixed resources such as laboratory space and the scarcity of funds negatively pressure the goals of providing these latest innovations to learners. The Communication Studies Department at the University of Windsor presently experiences these problems.

The researcher of this thesis authored an interactive computer-based training program to address these concerns. The program teaches signal routing concepts and the proper setting of line levels for equipment found in one of the University's recording studios. Graphics, animations and text were used to create the program. Smith and Ragan's (1993) Instructional Design Process Model guided the researcher from the front-end analysis of the problems, to the design and creation of the *soundboard program*. The use and application of instructional design theories and research into designing messages for the computer are also discussed. An evaluation was conducted to see whether the instruction teaches. Twenty-nine students with no prior knowledge of audio production evaluated the program. They were tested two days later on signal routing and setting line levels. A combined average of 43% was recorded. The *soundboard program* succeeds in teaching tasks. However, participants who had some guidance by a teaching assistant fared better than participants who used the program on their own.

DEDICATION

To my parents Violette and Gerhard for nurturing my love of learning.

To my wife Christy for showing me the strength of the human spirit.

To my friend Sam Conti for proving attitudes can be changed by example, through discourse, and with friendship.

This work is dedicated to these four people who were instrumental in my search for a path in life that would fulfill both my personal goal for growth and my enjoyment in helping others. I hope to follow in your footsteps.

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I would like to thank Don Snider, manager of the Division of Instructional Development's 'Design, Development & Research,' who by all rights shares a credit for the development of the *soundboard program*. He is referred to throughout this study as D.I.D.'s 'expert.' When I get the chance to help someone with their project, I hope I can afford the same amount of time, patience, and interest that you gave to me.

I would also like to thank my committee members, Richard, Kai, and Veronika for trusting me with this endeavor; for motivating me when I felt overwhelmed; for challenging me in my studies; for supporting me when I fell down.

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CHAPTER ONE
Introduction

The rapid advancement of technology, innovative research and creative thinking exponentially enlarge the world's knowledge base. At the same time, an environment of shrinking resources challenges businesses and schools striving to incorporate and deliver the latest methodologies and information to their fields of expertise. Fiscal responsibility, as demanded by governments and shareholders alike, exerts pressure to train students and employees at the lowest cost possible. Adding to this pressure is the increase in classroom enrollment and the limitations imposed by fixed resources such as a laboratory space and equipment. This not only decreases students' availability to these resources; it also increases the likelihood of equipment failure due to overuse. One coping strategy is to apply enrollment restrictions to ensure proper training and supervision. Other equipment-intensive programs wishing not restrict registration consequently experience the strain of overcrowded labs.

Equipment-intensive courses are not only demanding on the physical elements of laboratories. Qualified personnel are also needed to deliver effective instruction and to evaluate learner performance. Again, the lack of time limits teachers' abilities to perform these basic functions as well as constrains their capacity to provide one-on-one counseling. This lack of time, due to shortages in equipment, space, and qualified teachers, has serious implications; the most serious of which may be the degradation in the quality of instruction. A possible solution, although not a remedy, may be the use of computer based instruction to ease these pressures.

Multimedia and Computers:

The computer has an advantage over other media when it comes to presenting instruction:

- It is a reliable and cost-efficient way to test, score, and keep records for a course (Crosbie and Kelly, 1993);
- It can be programmed to adjust to the needs of the learners and be made to react like a human (Smith and Ragan, 1993);
- Computers can be highly interactive depending on the programming by giving learners feedback on their performance (Jonassen, 1985);
- It can present information in a number of ways including motion picture, graphics, and sound (Smith and Ragan, 1993);
- Computers can adapt the instructional material to the learner, which is positive when individualized instruction is desired (Smith and Ragan, 1993).

Print instruction costs less than computer-based training programs (CBT), but it lacks certain qualities (Smith and Ragan, 1993). Print does not interact with the learner to the same degree as a CBT program. Print can support graphics, but it must rely on the student's ability to imagine the outcome of movement. For example, a book on auto mechanics may rely on arrows, text, and pointers to describe how to remove a carburetor, whereas a CBT program can demonstrate it. Print also does not support sound and cannot simulate reality.

Video effectively demonstrates procedures and has the ability to compress and expand time (fast and slow motion). Video can also zoom in for enlarged close-ups. Its weaknesses lie in its inability to support interactivity and its linearity in presenting information. Although cheaper to produce than a CBT program, video is difficult and awkward to modify by individual learners because of this characteristic (Smith and Ragan, 1993).

A computer can incorporate all of the advantages of print and video and do more. Its fluidity allows a computer program to be easily modifiable whereas the other two media are fixed within themselves; a video would have to be re-shot and re-edited and a bound book would have to be reprinted in its entirety to include new information. Computers also allow the flexibility to retain and analyze the progress of its users so that the instructor can modify future sequencing. Its most powerful strength lies within its ability to simulate reality thereby negating the need to purchase expensive equipment, build more labs, or build larger labs (Smith and Ragan, 1993).

The Study

The purpose of the thesis is to research, design and create a multimedia teaching unit for a course offered by the University of Windsor's Communication Studies Department. Currently, this Department exhibits many of the previously mentioned problems and might benefit from computer-based instruction (CBI). These benefits accrue potentially both to the teacher and to the learner. First, it allows the learner to practice a developing skill without the consequences of being in the actual environment. Second, the learner can access this information at any time and from any distance if an Internet server offers the program. Third, teachers can better use their time to assist students with problems that cannot be covered by the computer's standardized instruction. In response to these potential benefits I will ask:

- Can the computer virtually re-create an environment in which the learner will be able to practice and strengthen skills?
- Are these skills transferable from the virtual environment to the real environment?
- Do students benefit from and enjoy this type of learning?

I use Smith and Ragan's (1993) *Instructional Design Process Model.* It comprises three parts, which systematically guides the instructional designer through the stages of designing instruction. Theories of instructional design and prescriptions taken from research into the design of the computer-learner interface further direct the creation of the instructional unit.

The Instructional Unit

The University of Windsor's Communication Studies department offers a course in sound production at the undergraduate level. The course traditionally has a full class enrollment of 36 students who share three sound studios located at the University's Division for Instructional Development (D.I.D.). Students are expected to learn skills by attending small group labs and independently producing projects. These studios are not exclusive to these students, but are also open to students in television production, film production, music, fine arts, and anyone in the University with an interest in producing audio.

D.I.D.'s studios consist of two small recording rooms and one larger multi-tracking room. The smaller rooms serve as an introduction to basic audio production before multi-tracking and other higher order concepts are developed by the learners. The labs are taught by teaching assistants (TAs) who have demonstrated a competence in sound production and have previously passed the course.

The multi-tracking room, or 8-track studio, poses the most problems. Students need hours of supervision and reinforcement for the simplest of tasks. To compound this problem, TA supervision is inconsistent with TAs some passing on bad habits acquired from previous TAs. I believe that if this course were to use a standardized instructional unit, these TAs can better be utilized by fostering within their students the esthetic qualities of sound production.

Two areas need a standard method of instruction. They are setting line levels and signal routing. Setting the line levels involves calibrating the equipment found in the 8-track room so that equipment receive and send signal at a predetermined strength. Failing to properly do so will introduce noise and/or distortion to a recording, ruining a student's project. Signal routing involves receiving a signal from a one source and sending it to recorder. Both these procedures need the 8-track studio's soundboard.

I have created an instructional unit using *Asymetrix Toolbook*'s multimedia authoring software to address space and time problems. Specifically, I have animated the multi-tracking studio's soundboard and created practice exercises for students to practice these procedures. I believe that this interactive instructional unit will enable the student to master these two problem areas without tying up studio time.

A formative evaluation was conducted after the design of the *soundboard program*. Experts reviewed the content and twenty-six volunteers participated in this phase of the instructional design process model. The purpose was to uncover pedagogically unsound material, design flaws, and to validate the learner using the program.

This study follows the following format. Chapter two explains the *Instructional Design Process Model* (IDPM), theories of instructional design, and research into the design of courseware. Chapter three describes the analysis I did prior to designing the instructional unit and discusses the implications for the program's overall design. Chapter four exemplifies the use of instructional design theories for this program and follows the design strategy supplied by the IDPM. Chapter five illustrates the *soundboard program* on a page-per-page basis and looks at *Toolbook* as a multimedia-authoring program. Chapter six examines the evaluation method I used for this study. Chapter seven reveals the data yielded from the evaluation. Chapter eight discusses the data and their possible implications. Chapter nine concludes this study by suggesting further research and exploring some of my thoughts about the instructional design process.

CHAPTER TWO
Instructional Design Theories and Models

Rationale for using Theory in the Design of Instruction

Why use theory in a field that is applied and decision oriented? Much like the production of a film, experience, a good creative sense, and luck can bring about effective instruction. However, the design of instruction involves more than creating an esthetically pleasing unit. An instructional product's purpose is to teach, and if it fails it has no value (Merrill, 1997).

Unlike the creation of entertainment or art, instruction involves the direction of learning activities and the guidance to appropriate knowledge for learners to rehearse, encode, and process information (Merrill, 1997). This systematic approach needs a basis to achieve these objectives. This basis for creating effective instruction includes instructional design models and theories and message design principles.

Theory is like a set of blueprints, which the instructional designer uses to prescribe actions that will lead to certain results. Grounded in research that explains why certain prescriptions work, theories and models shape the direction of the instructional design and allow the designer to justify their decisions (Smith and Ragan, 1993). Theory can be defined as an organized set of statements that allow the explanation, prediction and control of events (Smith and Ragan, 1993) This chapter investigates the models, theories, and design principles that were used to create the *soundboard program*.

The Instructional Design Process Model

The instructional design process answers three questions (Mager, 1984):

- What are the objectives of the instruction?
- What instructional strategy will be used and on what medium?
- How will the instructional designers know how to test and how to revise the instructional materials accordingly?

These three questions can be rephrased into the steps an instructional designer takes during the development of instruction (Smith and Ragan, 1993, p.5):

- Perform an instructional analysis to determine the objectives.
- Develop an instructional strategy to determine the strategy and the delivery of the instruction.
- Develop and conduct an evaluation to uncover any ambiguities within the instruction and to discover its effectiveness

These three steps are the foundation to the Instructional Design Process Model (IDPM) developed by Smith and Ragan. They parallel the steps that interactive courseware developers and media producers call storyboarding. A typical storyboard contains the general instructional treatments given to lessons in the course and is the key design document that a production team uses as a base for developing any program (Bunch, 1991, Orr, Golas, & Yao, 1994, Higgins, 1995).

I chose the IDPM because of its comprehensiveness in outlining instruction. The Interactive Courseware strategy (ICW) proposed by Orr et al.(1994) focuses primarily on the design of the program itself, assuming target audience research and instructional development have been done. Overbaugh's (1994) guidelines for computer-based instruction development (CBID) concern itself only with management and organizational strategies. Both ICW strategies and CBID guidelines were used to enhance the IDPM when it was found that the former two could explain an event better.

Analysis

The analysis stage of instructional development analyzes three basic components: the instructional context, the prospective learners and the learning task (Smith and Ragan, 1993). When analyzing the instructional or learning context, the designer uncovers the characteristics of the environment in which the instruction will be used and the substantiation of a need for instruction in a certain content area (Smith and Ragan, 1993). This type of evaluation, commonly called a needs assessment, typically asks:

- Are there learning goals not being met by the students?

  If learning goals, as stated by a curriculum, a teacher, or a training institute's mandate are not being reached by an acceptable margin, then these goals are possibilities for the development of instruction (Smith and Ragan, 1993)

- Is the existing instruction being delivered efficiently?

  Sometimes learning goals are met but through an inordinate consumption of time and other resources. Inefficient instruction indicates a possible need for an alternate form of delivery or revision (Smith and Ragan, 1993)

- Is the instruction impeding the motivation and interest of learners?

  The needs assessment investigates the source of the impediment to avoid a reoccurrence in the revised instruction (Smith and Ragan, 1993).

- Should new learning goals be added?

  On the occasion that new equipment, new responsibilities to a job description, or new teaching philosophies are implemented, new learning goals are added (Smith and Ragan, 1993).

The analysis describes three areas of the learning context: the learning environment, the learners, and the learning tasks.

Learning Environment Analysis

This phase of the analysis describes the learning system in which the instruction takes place. The examination of this environment reveals all the factors that interact with learning. The analysis allows the instructional designer to ensure that the instruction will be effective in the environment (Smith and Ragan, 1993). Some environmental questions that help reveal the make-up of the instructional milieu.

What are the characteristics of the teachers and trainers who will be using the material?

> The purpose of this step is to reveal interests and preferences of the teacher and to see how they perceive their roles. It is also useful to discover whether they are amenable to having instruction delivered by media and other nontraditional methods (Smith and Ragan, 1993).
> Another area of importance is to ascertain the level of experience the trainers have with the content, learners, and teaching in general. The more inexperienced teacher may benefit from structure and organization within the instructional material (Smith and Ragan, 1993).

Can the newly developed instruction fit into existing curricula?

> Materials being developed should conform to existing teaching practices and philosophies in order to ensure compatibility. There may be the occasion where an alternate method may be more appropriate and used, however, the designer should be aware that this is being done (Smith and Ragan, 1993).

Describe the media hardware and their configurations that are available in the learning environment.

> Smith and Ragan (1993) note that one obstacle to planning mediated instruction is the availability of media hardware. Designers should record what is available to them and should not assume that the hardware that they are accustomed to working with will be common within the learning environment they are designing for (Smith and Ragan, 1993).

What are the characteristics of the school or organization in which the instruction will take place?

> Not considering a school or organization's mission statement and belief structure may risk having an instructional program that cannot be implemented. The designer should find out who the primary decision-makers are and how the establishment's belief system is integrated into its organizational structure (Smith and Ragan, 1993).

In answering these questions, the designer observes how factors interact. The learning environment should be considered a system in which various elements connect and affect the outcome of learning. A deconstruction of the learning environment in helps to create effective instruction (Smith and Ragan, 1993).

Learner Analysis

It is critical to produce instruction with the learner in mind rather than centering the design solely on content. An emphasis solely on the content and using examples and instructional techniques that work well for that designer, may not be effective with the target audience. By taking into account the learners' diversities and commonalties, the instruction can be made more effective and appropriate (Smith and Ragan, 1993).

Figure 2.1: *Four categories of learning characteristics* (Smith and Ragan, 1993, p.45)

	SIMILARITIES	DIFFERENCES
STABLE	• Sensory capacities • Information Processing • Types and Conditions of learning	• Intelligent Quotient • Cognitive styles • Psychosocial traits • Gender, Ethnicity, and Racial Group

CHANGING	Development Processes
	• Intellectual
	• Language
	• Psychosocial
	• Moral
		• Developmental State
		• Prior Learning
		  • General
		  • specific

Although learners possess a multitude of unique characteristics, it would be counter-productive to create instruction at that singular level. Consequently, the designer investigates the target audience as a whole. Two general conditions are investigated in analyzing learners: similarities among people and the differences between them. Two additional variables of stability and change complete the matrix shown in Figure 2.1 to make four categories that assist the designer when applying instructional treatments (Smith and Ragan, 1993).

The changing/stable, similarities/differences matrix of learner analysis goes beyond the purpose of providing a general representation of the target audience. Implemented to its fullest, this matrix's rigor would slow the instructional design process. Its inclusion provides the background and purpose to Smith and Ragan's (1993) "Outline of Learner Characteristics."

Outline of Learner Characteristics

Smith and Ragan have recategorized the major characteristics useful to learner analysis from the changing/ stable, similarities/differences system. While this system is useful for the conceptualization of learners, the system included in the *Instructional Design Process model* is easier for analysis. Depending on the learning task, some of these characteristics may not be relevant (Smith and Ragan, 1993).

Cognitive Characteristics:

- General aptitudes
- Specific aptitudes
- Developmental level or Piaget's levels of cognitive development
- Language development level
- Reading level

Cognitive Characteristics (*continued*):

- Level of visual literacy and the ability to glean information from graphics
- Cognitive processing styles
- Cognitive and learning strategies
- General world knowledge
- Specific content knowledge

Psychosocial Characteristics:

- Interests
- Motivations
- Motivations to learn
- Attitude toward subject matter
- Attitude toward learning
- Academic self-concept
- Anxiety level
- Beliefs
- Locus of control
- Relationship to peers
- Feeling towards authority
- Tendencies toward cooperation and competition
- Moral development
- Socioeconomic background
- Racial/ethnic background and affiliations
- Job position, rank
- Role models

Physiological Characteristics

- Sensory perception (visual, auditory, etc.)
- General health which could influence the tendency towards fatigue, among other things
- Age

Instructional designers have a number of possible methods for determining these characteristics. Information gathering can be conducted from an interview, to an in-class observation, to a questionnaire. Designers should also use several different sources in describing diversities and similarities in order to avoid stereotyping (Smith and Ragan, 1993)

Implications of Learner Characteristics for Design

As part of the learner analysis, the instructional designer should conclude by stating which learner characteristics affect the instructional strategy. These instructional techniques show how the instruction will adjust to the learner characteristics. They include but are not limited to the following list (Smith and Ragan, 1993).

- Speed of presentation
- Number of successful experiences learners should have in practice
- Types of statements relating to the relevancy of the instruction
- Techniques for gaining and focusing attention
- Context of examples
- Amount of structure and organization
- Medium/media of instruction
- Level of learner control
- Type of feedback
- Vocabulary and terminology
- Size of instructional chunks
- Amount and types of reinforcement
- Amount of learning guidance, cues, and prompts provided.

Learning Task Analysis

At the conclusion of a needs statement, a list of gap statements reflects what learners currently cannot do. These statements reflect the gap between what learners should be able to do and what they are able to do within the identified instructional goals (Smith and Ragan, 1993). The task analysis transforms these gaps into learning tasks, which are then used in the design of the instruction. The steps to performing a learning task analysis with their definitions and purpose are:

1. Write an instructional goal.

   Instructional goals report what learners should be able to do at the end of the instruction. They are a conversion of gap statements into a clear description of goals. Performance-based terms are used to describe these goals in order to have a clear idea of what needs to be learned. These statements are general in nature and do not include the preciseness of an instructional objective, which will be discussed in information processing (Smith and Ragan, 1993).

- *Example*: When given a car that does not start, the learner will be able to identify the problem and will be able to repair it.

2. Determine the types of learning of the goal.

Once the instructional goal has been written, the designer needs to identify the type of learning outcome the goal represents. Gagné (1977) divides learning outcomes into five categories which include most learning objectives (Aronson and Briggs, 1983, Smith and Ragan, 1993). A brief description of each category follows:

Verbal information or declarative knowledge objectives require the learner to recall in verbatim, paraphrased, or summarized form facts, lists, names, or other similarly structured information. These objectives do not require the learner to apply the information, but only recall it (Aronson and Briggs, 1983). Learning a poem by heart is an example of a verbal information objective

Intellectual skills are the predominant objectives in most learning situations and are typified by the application of rules to an unencountered example. It differs from verbal information in that it is "knowing how" instead of "knowing that"(Aronson and Briggs, 1983). These skills are further divided into subcategories:

- Discriminations involve the differentiation between two stimuli (Smith and Ragan, 1993, Aronson and Briggs, 1983).

- Concepts involve the ability to classify and respond to things as members of a group. Concrete concepts define objects by their physical characteristics, whereas defined concepts describe objects by their meaning (Smith and Ragan, 1993, Aronson and Briggs, 1983).

- Rules and principles govern the way one reacts to problem or an outcome. Much of the instruction in math and the sciences is filled with rule and principle outcomes. There are two categories or rules. Relational rules are if-then statements that help predict and explain circumstances in an environment. Procedural rules explain which steps should be taken in order to complete a given task (Smith and Ragan, 1993, Salisbury et al., 1985, Aronson and Briggs, 1983).

- Higher-order rule learning or problem solving involves the selection of a number of relational or procedural rules to solve a previously unencountered problem (Smith and Ragan, 1993, Aronson and Briggs, 1983).

Cognitive strategies or learning strategies can be defined as "learning how to learn," and are used by students to manage their own learning. The use of mnemonics to learn the periodic table is one example of this. Although rarely taught, cognitive strategies transcend content and fields of study, and should be included in the instructional content to help with learning (Aronson and Briggs, 1983).

Attitudes are mental states that influence a learner to behave a certain way. The way in which the instruction is designed will generate attitudes about the content being learned. If, for example, an instructional computer program neglects to provide adequate feedback and does not adapt to the learner's proficiency level, it is possible s/he may develop a negative towards computer training in general (Aronson and Briggs, 1983).

Psychomotor skills are coordinated, smooth, and precisely timed muscular actions. Although physical in nature, psychomotor skills rely on procedural rules that organize the sequence of events. Instruction can teach these rules, however, psychomotor skills must be practiced to be learned (Aronson and Briggs 1983)

Once a goal's learning types are defined, the deconstruction of that goal reveals the content needed for the instruction. Its purpose is to ensure the student gets every opportunity to learn all that is needed to achieve the goal and to identify prerequisite skills and knowledge the students must acquire. The goal analysis comprises of two stages: a) an information processing analysis as described in stage #3 and b) the prerequisite analysis of the identified steps in stage #3 as described in stage #4 (Smith and Ragan, 1993).

3. Conduct an information processing analysis of the goal(s).

This instructional design process analysis describes the sequential and mental processes the learner might go through in completing the goal's task. Smith and Ragan (1993) offer these methods:

- Read and gather as much information as possible of the task implied by the goal.
- Observe individuals doing the task and write down their procedures. It may be useful to ask them how and why they make the decisions they make. Another variation would be to have them write down the task as if they were performing it.
- Videotape an expert doing the task, write down the steps and ask questions aimed at trying to uncover the unobservable cognitive knowledge influencing the expert's behaviour.
- Confirm the analysis with experts and have them do the tasks implied by the goal (p.72-73).

An example of an information-processing analysis of the goal stated in stage #1 may be:

- Locate the gas gauge to determine whether the car has run out of fuel.
- Locate the battery and run a test to see whether it is charged.
- Locate and diagnose the starter to see whether it works.

4. Conduct a prerequisite analysis and determine the type of learning necessary for the prerequisites.

Once the goal has been deconstructed into information-processing tasks, the designer asks: "What must the learner know or be able to do to achieve this step?" The information is listed in a hierarchical fashion where the first skill is a prerequisite to the following skills. This allows the designer to determine where a student's entry level may be required (Smith and Ragan, 1993). An illustration of possible prerequisite skills of the example: "Locate the gas gauge to determine whether the car has run out of fuel" follows:

- Know that the gas gauge needs electricity to be functional
- Be able to turn on the car
- Know how to read a gas gauge

5. Write performance objectives for the instruction.

Once the prerequisite skills from both stages #3 and #4 are identified, they are transformed into performance objectives. Smith and Ragan (1993) describe a performance objective as "a statement that tells what learners should be able to do when they have completed a segment of the instruction. What learners "do" must be observable so learners know that they have learned and what they have learned " (p.91). Performance objectives provide focus and guidance in selecting content and in how the student should be evaluated. They also help students focus their efforts and conduct assessments of their own learning (Smith and Ragan, 1993).

Performance objectives have three components to them. The **Terminal behaviour** describes what the learner must demonstrate to show s/he has learned. The **conditions of demonstration** describe the tools or information learners will manipulate; this statement is at the beginning of the performance objective. The **performance standards** indicate the goal at which the student must achieve (Smith and Ragan, 1993). Following shows a performance objective for the goal expressed in stage #1:

- Given a car that does not run, identify and fix the problem. You have fifteen-minutes to complete this task.

Once all three stages of the instructional analysis are complete, the designer has the tools needed to create the instruction. The learning environment analysis and the needs assessment ensures the instruction is required and will be compatible with the existing hardware and teaching philosophies of the learning milieu. The learner analysis ensures the instruction will address the needs and learning abilities of the student. The task analysis gives the designer an exact description of what needs to be learned. After these three stages of analyses are finished the designer's task centers on organizing the instruction's strategy (Smith and Ragan, 1993).

Instructional Strategy

This part of the Instructional Design Process Model contains the prescriptions and strategies for creating the instruction. The needs assessment described in the analysis stage determines how it will be developed and presented. Three distinct parts comprise the IDP Model's strategy: Organizational strategy, delivery strategy, and management strategy (Smith and Ragan, 1993).

Organizational strategy refers to what content will be presented, how the content will be presented, and in what sequence the content will be presented. The delivery strategy deals with what medium the instruction uses and how learners will be grouped. Management strategy concerns with scheduling and allocation of resources once the previous two strategies have been defined. Depending on the demands of the instruction, these three strategies can be outlined at the macro level (*e.g.* the course or curriculum) or the micro level (*e.g.* a lesson) (Smith and Ragan, 1993).

Organizational Strategy

The prevailing decisions in organizational strategy are as noted by Smith and Ragan (1993): "What content should be presented? How should this content be presented? What sequence should the instruction follow?" (p.139). The instructional designer uses organizational strategies, which are grounded in cognitive and instructional research, to facilitate the learning and retention of new material by the student. Depending on the learning objective, these organizational strategies may vary. Some general characteristics of a typical organizational strategy follow this pattern: The introduction, the body, the conclusion, and the assessment (Smith and Ragan, 1993).

Many instructional design theories can be used to promote learning within the organizational strategy. For the purpose of this thesis, I have used principles from different theories to convey the information and to enhance the retention of the material. The authors of the Instructional Design Process model use a version of Gagné's (1977) "nine events of instruction" to illustrate this pattern. Overbaugh's (1994) research into guidelines for the development of computer-based instruction also uses a form of Gagné-Briggs (1983) events as a basis for lesson design. Both are used to complement the description of the Gagné'-Briggs' theory of instructional design.

Generative and Supplantive Strategies

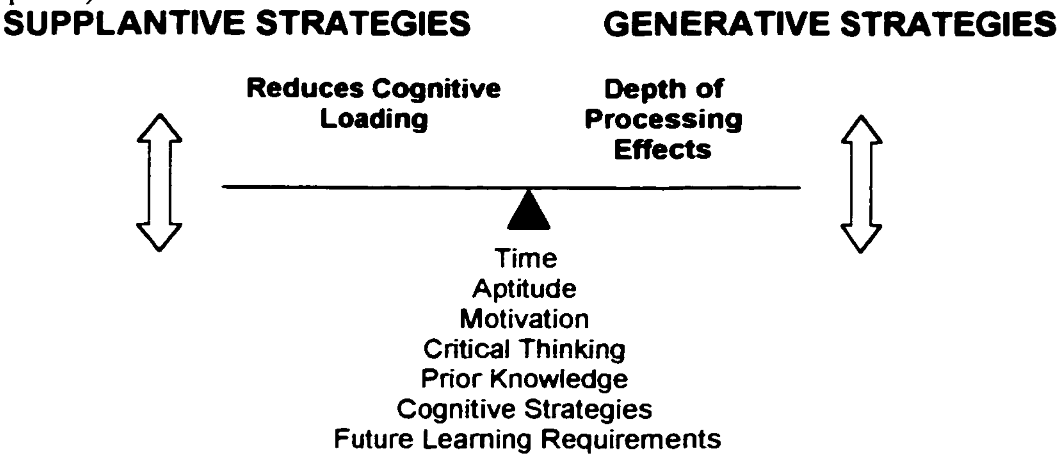
In meeting instructional prescriptions, one must also decide how the student will access and process the information. Two approaches can be taken: generative and supplantive. A strategy based on the generative approach allows the learners to construct their own inferences from the learning material. Students control the majority of the information processing by controlling the events of instruction themselves. Allowing the student to generate associations between new information and prior learning enhances learning and improves comprehension. Studies have shown this greater depth in processing information supports better learning and brings about better analytical skills (Smith and Ragan, 1993).

The generative approach, however, can cognitively overload the learner to the point of emotional frustration. It also takes more time. The success of this generative approach depends on the learner's prior knowledge. If the target population does not have the requisite prior knowledge, a supplantive strategy may better suit the organizational needs of the instruction than a generative strategy (Smith and Ragan, 1993).

Supplantive strategies explicitly and overtly provide many of the instructional events thereby conserving learners' cognitive capacity for acquiring skills. By limiting the amount of responsibility students have for structuring the learning situation, learning outcomes are more focused and predictable. A supplantive approach is more efficient than a generative one and can result in more material being learned in a shorter period of time (Smith and Ragan, 1993).

Although useful for learners with little prior knowledge, instructional materials created with this approach use fewer mental processes, which subsequently produces less complete learning. Supplantive instruction can also be perceived as contrived, leaving the learner feeling less challenged and less motivated. The instructional designer must weigh these two competing approaches to produce instruction that best suits the learners and their learning environment (Smith and Ragan, 1993).

Figure 2.2: *The balance of generative and supplantive strategies* (Smith and Ragan, 1993, p.153)



When trying to balance the two strategies, Smith and Ragan (1993) note the designer must consider two competing demands:

- The need to require sufficient mental effort to lead toward learning.
- The need to support learner's processing sufficiently in a way that does not overload their working memory (p.153).

Figure 2.2 illustrates the factors within the learner, the learning context, and the learning task which suggest which strategy should be used. If, for instance, a learner's prior knowledge of the subject is high, then a generative strategy may be more effective. If the time line for mastering a particular skill is critical, a supplantive strategy may be more effective (Smith and Ragan, 1993).

Delivery Strategy

Decisions within this strategy set involve determining the appropriate medium of instruction and determining the grouping strategies. These selections can remain the same throughout an instructional episode or vary from event to event. For example, the instructional designer may present material with videotape and an instructor to a large audience. Following the common lecture, the learners split up into small groups and work with printed instruction (Smith and Ragan, 1993).

Media Selection:

Smith and Ragan (1993) define an instructional medium as "the physical means by which the instructional message is communicated" (p.344). This definition includes teachers, computers, print materials, and television among other media. To avoid using "technology as a solution looking for a problem," instructional designers contemplate the use of media after first examining the needs of the instructional situation (ibid. p.344).

No instructional medium is superior to another regardless of learning task, learner traits, symbolic elements, curriculum content, and setting. However, media attribute theory attests some instructional media may be more appropriate than others because they support specific cognitive processes within learners. This theory holds that humans and media employ symbols to represent, store, and manipulate information and that some of the symbols used in cognition are taken from symbols used by media. The closer a mediated symbol matches a learner's mental representation of the skill required to do an instructional task, the less effort the learning will require.

The designer must then examine a medium's attributes when considering the delivery strategy. Some media facilitate learning more than others do depending on the instructional situation and learner characteristics. Smith and Ragan (1993) list some factors that determine the selection of media:

1. The learning task along with the instructional conditions that facilitate the learning of that task.
2. The characteristics of the learners.
3. The learning context and other practical matters that influence the appropriateness of the medium.
4. What each potential medium can and cannot do with regard to the prior three factors.

Media Attributes:

Following are brief descriptions of characteristics of three popular instructional media to exemplify their attributes:

- Computers are most like people in that they can be programmed to adjust to the needs of the learner, analyze the learner's problems, and give feedback. Their flexibility allows them to hold a great deal of information and manipulate this information quickly without making mistakes. Computers can be highly interactive, responding to the student in a relatively individualized manner. Computers can retain and analyze student performance to adapt future instruction to the learner. They can support many other media such as print, audio, and visuals. Computers can also allow exact duplication of instruction at remote sites. Depending on the degree of programming required, a computer based training program varies in cost. (Smith and Ragan, 1993).

- The popularity of print is second only to a teacher as an instructional medium. This portable medium can support individualized instruction and can be produced to give a fair degree of interactivity. It can provide random access to information by use of page numbers and table of contents. Print is relatively easy to produce and can be made to include high-quality illustrations and graphics (Smith and Ragan, 1993).
- People, or teachers, are the most interactive, adaptable and flexible of all instructional media. Teachers are also the only instructional medium that possess and reflect empathy, which for certain learning tasks such as attitudes is most valuable. However, people are very expensive to train and employ when compared to other instructional media, and they also cannot do the same teaching task in the same manner twice (Smith and Ragan, 1993).

Management Strategies

Management strategies direct the arrangement of organizational and delivery strategies. They also guide the scheduling of instructional events and the mechanisms for the delivery of these events. On the micro level, a management strategy suggests to the teacher when to give information and when to move onto another segment of the lesson. A teacher preparing for a class is one example of this strategy. The instructional designer's role can include the development of a teaching guide to assist with management decisions (Smith and Ragan, 1993).

The macro level of management strategy reflects the system in which the instruction is taking place. These strategies are often incorporated into models that can be used by other training institutions. The Individually Prescribed Instruction System is one example that includes a diagnosis of student's prior learning, placement of students into curriculum entry points, the use of pre-tests and post-tests, and student assessment test (Smith and Ragan, 1993). Although management strategies are not a prime focus of this thesis, their relevance to the design of instruction remains important.

Summary of the Strategy Section

The IDP model systematically guides the instructional designer in the formation of organizational, delivery, and management strategies. Without this direction, media and technology would have little impact and effect on the learner. The organizational strategy embodies the content of the instruction. Theories of instructional design and the use of supplantive/generative strategy ensure the subject matter will best satisfy students' learning needs. The delivery strategy reflects the importance of considering a medium's attributes before considering how the instruction will be conveyed. It is best to consider and match a medium's attributes to the needs of the learning task, the characteristics of learners, and the learning context. Management strategies orchestrate the complex interrelationships of delivery and organizational strategies. On the micro level, it gives the instructor direction for presentation. On the macro level, management strategies can be used to control curricula.

Evaluating Instruction

The effectiveness of instruction can be established by an evaluation of that instruction. An evaluation has several components, the most important of which is the evaluation of what the student learns (Castellan, 1993). Two key phases complete the evaluation stage for the IDP model: the formative evaluation and the summative evaluation. Both of these provide a set of criteria that are used to address whether the instruction reaches the goals set in the analysis and strategy portions of the design.

Formative Evaluation Overview

A formative evaluation uncovers any design weaknesses and pedagogically unsound material within the instruction. Formative evaluations are done when the instruction is being created while interpretations of the instructional goals are still incomplete. The designer tries out the learning material with representative members of the target audience and experts to discover these inconsistencies. The advantages to conducting a formative evaluation include saving time and money by avoiding costly rewrites during the actual implementation of the instruction (Smith and Ragan, 1993)

Four stages make up the formative evaluation process: a) design reviews, b) expert reviews, c) learner validation, and d) ongoing evaluation.

Design reviews

The design review stage of the evaluation re-examines many of the conditions revealed in the analysis stage described earlier.

- Goals are reviewed to confirm that there is an instructional need and that these goals parallel stakeholders' expectations (Smith and Ragan, 1993, p.389)
- The environment and learner analyses are reviewed to confirm their adequacy and relevance to the instruction (ibid. p.389).
- Assessment specifications and their test blueprints are evaluated to ensure validity, reliability and practicality of the instruction. It is also done to secure the knowledge that an adequate sample of the content's domain will be taught (ibid. p.390).

Expert Reviews

Once a draft of the instruction has been created, it is submitted to content experts for review of the content. The purpose, as Smith and Ragan (1993) note, is to answer the following questions:

- Is the content accurate and up-to-date?
- Does the content present a consistent perspective?
- Is the pedagogical approach consistent with current instructional theory in the content?
- Are examples, practice exercises, and feedback realistic and accurate?
- Is the instruction appropriate for the target audience?
- Are the instructional strategies consistent with principles of instructional theory? (p.390).

Castellan's (1993) *strategic evaluation* of computer-based training software complements this list by asking: "Is the use of software appropriate to the concepts being learned?" (p.235) Sometimes a designer will produce computer-based instruction as a programming exercise when the concept could have been better presented by another medium (Castellan, 1993). This question mirrors Smith and Ragan's (1993) assertion that some designers look at "technology as a solution looking for a problem" (p.344). By submitting a draft to an expert, one may find a more appropriate medium to convey the information.

Learner Validation

After having the content reviewed by an expert, the instructional designer submits the materials to a few members of the target audience. These one-on-one evaluations determine and rectify any gross problems in the instruction. Typographical errors, unclear sentences, faulty directions, inappropriate examples and poor graphical representations are a few of the many mistakes that can pass the expert review stage. The instructional designer attempts to answer the following questions during the one-on-one evaluation (Smith and Ragan, 1993):

- Do the learners understand the instruction?
- Do learners know what to do during the practice and tests?
- Can learners interpret graphics in the text?
- Can learners read all of the textual material?

With reference to computer based learning, one could add the question whether the technology encourages exploration, testing, and application of ideas and concepts. Castellan (1993) suggests a learning environment is barren if it only encompasses the particular concept to be learned. The technology should enable the learner to explore these concepts and manipulate them to create new associations to both abstract and real situations (Castellan, 1993).

Although this goal could fit well with generatively designed instructional materials, one should be cautious of it. The primary goals raised in the analysis phase should be attended to and accomplished first. If the designer encounters any positive secondary effects within both the formative and the summative evaluations, it should be noted for future study.

Group Evaluations

Small group evaluations and field trials finalize the formative evaluation process. These are conducted to see how the instruction teaches without the intervention of the designer.

Summative Evaluation Overview

The purpose of the summative evaluation is to collect, analyze, and summarize data to determine whether the instruction is effective, appealing, and efficient to the learner. Traditionally, the summative evaluation is the document given to stakeholders so that they can make a judgement on the continued use of the instruction. These evaluations usually occur after the instruction has been implemented into the targeted learning environment (Smith and Ragan, 1993, Ransdell, 1993). Castellan (1993) and Smith and Ragan (1993) advise that this evaluation should be conducted two years after the introduction of the instruction. The reason is to allow a year for management and teachers alike to become accustomed to the instruction.

A summative evaluation attempts to reveal if the instruction has adequately solved the problems uncovered during the needs assessment. It also evaluates whether the instructional material itself fits this criterion; one could have the proper instructional solution and still have problems because of poor delivery choices. Summative evaluations express these as performance standards in percentages and comparisons (Castellan, 1993, Smith and Ragan, 1993).

For example:

- 48% of students understood the concept of noise after using the computer program, compared to 36% reading only a photocopy of the same concept.

Usually, the comparisons are between the effects of the existing instructional program and those of the newly designed one. When comparing several programs, the evaluation should refer to the goals stated in the needs assessment and state which of the programs best solve the problems. The following are questions raised by Smith and Ragan (1993), which specify whether problems identified in the analysis have been solved:

- Do learners achieve the objectives of the instruction?
- How do learners feel about the instruction?
- What are the costs of the instruction?
- How much time does it take for learners to complete the instruction?
- Is the instruction implemented as it was designed?
- What unexpected outcomes result from the instruction? (p.390)

Two final questions can be added from Castellan's (1993) *strategic evaluation* for computer-based training software. The first asks if the instructional software or technology can be integrated into the course easily. This is important in that both students and teachers should view technology as integral to the course and not as an option; it should also be noted that adding instructional technology to a syllabus adds time that students must spend in the course. Terminologies and references used by both the instructor and the computer program should agree (Castellan, 1993).

The second question asks whether the instruction can be cyclically improved. Evaluations should be built into the instruction so that they can measure effects and outcomes before, during, and after its introduction in a course. If the instructional program appears less effective than desired, these ongoing evaluations could help reveal whether the problem lies with the technology, the students, or the manner in which it was integrated into the course (Castellan, 1993).

Objectivism or Subjectivism?

Two modes of inquiry can be used in a summative evaluation. The objective approach depends upon empiricism, which answers questions based on observation and data. An advantage of the objective evaluation is the possibility of replicating results. Trained individuals, given the same questions and methodology, will be able to collect similar data and draw similar conclusions. This scientific method of evaluation employs setting hypotheses, designing an experiment to control variables, collecting data, and drawing conclusions from that data (Smith and Ragan, 1993, Ransdell, 1993). As Smith and Ragan (1993) note "objective evaluations are goal based, focused on determining the degree to which the goals of the instructional program have been obtained" (p.409). A limitation of this approach stems from its focus on goals of the program. Because it uses designs to control external variables, they examine only a limited number of factors thereby ignoring effects that come from unanticipated sources (Smith and Ragan, 1993).

Subjective evaluations use qualitative methods such as observation and interviews to examine the instructional context. This evaluation differs from the objective approach, as it does not evolve from the program's goals. The reason is evaluators do not wish to be predisposed by this information and wish only to describe the program and effects, as they perceive it. The advantage to this approach is that unexpected results are more likely to be noticed. The limitations include the inability to replicate the results and the possibility of bias influencing the results (Smith and Ragan, 1993).

Summary of the Instructional Design Process Model

The Instructional Design Process model provides the instructional designer with a systematic method to producing instruction. The analysis deconstructs the learning environment, the learning tasks, and the target population for the instruction to ensure that the instruction will be usable by the learner in the appropriate learning environment.

The organizational strategy guides the production of the instruction. Theories of instructional design dictate the sequencing of instructional events and ensure learning tasks will be mastered. Delivery strategies ensure an appropriate instructional medium will be selected based on the matching of its attributes with the learners' attributes. The management strategy coordinates the previous two to ensure that the instruction is organized and well presented.

The evaluation comprises of two parts. The formative evaluation uncovers any gross errors within the instruction such as misinformation and faulty sequencing of procedures. This evaluation is typically conducted with content experts, through one-on-one interviews, and small groups. The summative evaluation asks whether the instruction has satisfactorily achieved the goals set out in the analysis. The summative evaluation can be approached in two ways. The objective approach uses the scientific method such as controlled experiments in the collection and analysis of data. The subjective approach uses qualitative methods such as observation to collect and analyze data. Properly implemented, the IDP model will yield instruction that is useable to the given situation.

Instructional Design Theories

Within the *Instructional Design Process Model*, organizational strategy referred to the selection of content and its sequencing. This part of the IDP model was intentionally left undetermined in order to present principles from instructional design and message design theories. Although Smith and Ragan (1993) do provide a systematic method for organizational strategy, it is directly related to the Gagné-Briggs model. The IDP model also strives to be generic so that it can be applied to many situations. For this reason, the following principles and prescriptions will provide a base for designing computer-based instruction.

Principles taken from the Gagné-Briggs theory of Instructional Design

Overbaugh (1994) and the authors of the IDP model use part of the Gagné-Briggs model of instructional design as a basis for planning instruction through the application of instructional events. An instructional event is part of a system that describes the external functions of a learning situation. The designer's function is to plan instruction that ensures these nine events are used to satisfy the necessary conditions of learning (Aronson and Briggs, 1983). These events also facilitate the five different types of learning described in the IDP model's *Learning Task Analysis* (Salisbury et al. 1985). Briefly they are verbal information, intellectual skills, cognitive strategies, psychomotor skills, and attitudes. The events described in Table 2.1 apply to computer-based learning.

Table 2.1: *Nine instructional events* (Aronson and Briggs, 1983, p.90)

1. Gaining attention
2. Informing the learner of Objectives
3. Stimulating recall of prerequisite learning
4. Presenting the stimulus material
5. Providing Guidance
6. Eliciting the performance
7. Providing feedback about performance correctness
8. Assessing the performance
9. Enhancing Retention and transfer

Gaining Attention

Gaining a student's attention makes the learner aware of the lesson's purpose (Overbaugh, 1994). For computer-assisted instruction, Overbaugh (1994) suggests that attention can be gained using a screen title or description of a situation. Attention gaining is also useful to indicate to the student the importance of the upcoming lesson. This makes the attention-gaining information relevant to the learner by raising motivation (Keller, 1987). Another useful presentation strategy within this event is to introduce explicit directions for using the program (Overbaugh, 1994).

Informing Learners of Objectives

Telling students what they are about to learn seems to facilitate learning (Smith and Ragan, 1993). It also enables the learner to anticipate when they have achieved the lesson's learning objective (Aronson and Briggs, 1983). Overbaugh (1994) renames this event as "Orienting Activities" which includes information relating to the student's present knowledge in the form of pre-questions, expectations for success, and advanced organizers. Presenting orienting activities before the start of the computer lesson will also reduce user anxiety about the program, and will allow learners to judge whether the goals are obtainable and worth working toward (Overbaugh, 1994). Overbaugh cautions that in some instances, orienting activities can be superfluous to the motivated student. Although it has been argued that orienting activities will not harm the learning process, an option to bypass this event should be included in the program (Overbaugh, 1994).

Stimulating Recall of Prerequisite Learning

For a new concept to be learned, it is necessary for previously learned prerequisite skills to be recalled (Overbaugh, 1994, Aronson and Briggs, 1983). These prerequisites encompass skills or knowledge the student already knows and serve as a beginning to the instruction. This event is accomplished by simply reminding students of previously encountered material or by formally reviewing prior learning (Aronson & Briggs, 1983).

Overbaugh (1994) expands this event to include the supply of missing prerequisites. The reason is a common failure to accurately pinpoint the correct starting state of learners. This is often compounded when designing computer-assisted instruction for audiences whose needs are only estimated. Computers are uniquely suited to solve this problem in that the instruction can be programmed to meet differing needs by containing a "usable learning hierarchy." In other words, an option should be included within the program to select the appropriate starting point based on some sort of starting state assessment provided by the teacher, student, or the more advanced computer-training program (Overbaugh, 1994). Given that a student is missing a prerequisite knowledge or skill, the computer should direct the student to the pertinent information.

Presenting Stimulus Material

Depending on the learning outcome, stimulus material can be presented in a number of ways. It may come in the form of a verbal statement, example, or demonstration (Aronson and Briggs, 1983). Presenting information in this manner allows the learner to form a generality by which they can build upon. This form of presenting material is called an expository sequence (Smith and Ragan, 1993).

In comparison, a discovery sequence encourages learners to find the principle or rule that is operating. For example, three numbers can be presented and the student must find the common denominator for each. Although this method of presenting information is less efficient, some researchers believe learning is more complete with this approach (Smith and Ragan, 1993).

Overbaugh (1994) notes that presenting stimuli for computer-assisted learning should also include technical considerations. The appearance of text and graphics, the use of colour, and computer screen layout are discussed later in this chapter. However, Overbaugh (1994) frequently repeats the recommendation to keep things simple for both the instruction's pedagogical and technical characteristics.

Providing Learning Guidance

The function of this event is to help the learner acquire the capabilities specified in the objectives listed in event #2 (Aronson and Briggs, 1993). This is done by re-focusing attention and by employing learning strategies (Smith and Ragan, 1993, Overbaugh, 1994). Although attention is gained at the beginning of the instruction, it should be continually refocused throughout. Pointing out the distinctive attributes of the lesson may ensure students attend to it. For courseware development, pertinent textual information can be underlined, bulleted, or hyperlinked to other sources (Smith and Ragan, 1993).

Employing learning strategies allows the learner to take charge of the instruction. Three basic instructional strategies can accomplish this goal, elaboration, inquiry learning, and discovery learning. Of the three, elaboration requires the student to do the least cognitive processing, whereas discovery learning is the most complete learning experience (Overbaugh, 1994). An instructional sequence based on elaboration strategy teaches by initially presenting the most basic and fundamental aspect of a concept and moving it progressively towards the more complex aspects of that idea.

Discovery learning arguably gives the most complete learning experience by directing students through a complex process of building a knowledge base by which a hypothesis can be proved or refuted. However, discovery learning is rarely integrated within curricula because of time constraints and management requirements (Landa, 1983).

Inquiry learning poses questions and promotes question generation by students. This is said to increase curiosity, which encourages learning (Keller, 1983, Overbaugh, 1994). Inquiry-based learning is particularly suited for computer-based learning, especially in conjunction with elaboration strategies. Although research suggests that if all three strategies are used learning will be more effective, discovery learning is often left out because of the aforementioned problems (Overbaugh, 1994).

Eliciting the Performance

To determine whether a student has internally processed and acquired a skill, it is important to have the learner demonstrate the ability. It is also important that the learner's response matches that specified in the objective to ensure the learner is practicing the newly acquired skill correctly (Aronson and Briggs, 1983). This event does not focus on evaluating and grading the student. However, assessments by the computer, teacher, or student during this learning event can be made to see whether remediation is needed if learning appears to be delayed (Smith and Ragan, 1993).

Practice activities should be performed in conditions that closely resemble the computer-replicated environment. Students should also strive to perform these activities within a time frame that is acceptable within this environment. Merrill (1983) recommends a time allowance to answer questions; rote recall should have no time delay whereas higher level tasks have some time to achieve the objective. These performance demands, however, should be within the student's limits to achieve "achievement-striving behaviour" (Keller, 1983). The instructional designer should accept a lower achievement standard at the early stages of the learning process (Keller, 1983).

Providing Feedback and Performance Correctness

The instructional event of providing feedback and performance correctness is crucial. It should be informative and direct learners to what is required to master the learning objectives in a positive manner (Aronson and Briggs, 1983, Overbaugh, 1994). Immediate feedback is more effective than delayed feedback because it motivates students to maintain the quantity of responses (Keller, 1983,). Four types of feedback for computer-assisted instruction are useful and are ordered from least useful to most useful for learning enhancement: yes/no, correct answer feedback, explanatory and bug-related (Overbaugh, 1994).

The simple yes/no may be useful for rote-recall but does not enhance motivation or achievement. Because simple positive comments does not produce higher levels of motivation, this type of feedback should be avoided (Merrill, 1983, Overbaugh, 1994).

Correct answer confirms a response to the learner and is the most frequently used type of feedback. Because there is little effort to include the correct answer with a yes/no response, this type of feedback should be the minimum level used in computer-assisted learning (Overbaugh, 1994).

Explanatory feedback is appropriate for intellectual skill development because it identifies errors, provides guidance, and gives approval for correct responses. Providing guidance also increases motivation by increasing the learner's satisfaction by attributing success in the task to the learner (Keller, 1983, Merrill, 1983, Overbaugh, 1994).

Enhancing Retention and Transfer

Aronson and Briggs (1983) state that "instructional designers cannot assume that learners will be able to transfer learning from one situation to another. [As] such, retention and transfer should be included as part of the instruction" (p.92). Varied practice, reviews, and synthesizers accomplish this task.

Varied practice should emphasize the practicality of the learned skill or concept (Salisbury, 1988). Students should also be encouraged to practice in between presentations to enhance retention. Review enhances retention especially for concrete information, verbal information and rule learning (Overbaugh, 1994). An effective review strategy should include a precise statement of each idea, fact, or procedure, typical and easy to remember reference examples, and evidence from self-test items for each idea (Overbaugh, 1994).

Summary of Gagné-Briggs

I felt it important to include the original nine instructional by Gagné-Briggs (Aronson and Briggs1983) because many instructional design authors have used and modified it. For example, Overbaugh (1994) suggests event #9 (*enhancing retention and transfer*) should proceed event #5 (*providing learner guidance*). Smith and Ragan (1993) deconstruct many of the events and expand them to a total of fifteen. Although these authors legitimate their conclusions for alteration, the significance and clarity provided by the original model keeps this part of the instructional design process simple. The designer should be able to conclude when change and expansion of these events are necessary to meet the needs of the learner.

Design Principles based on Gropper's Behavioral Approach

Gropper's (1983) behavioral approach to instructional design can be used as a model for directing prescriptions to programmed instruction. Although it will not be used in its entirety, I have chosen to include principles to describe components by which the designer can use to create practice materials for instruction. These supplement instructional events #6 and #7 of the Gagné-Briggs theory in which students demonstrate the skills taught by the instruction.

Behaviorism concerns itself with learning factors that are external to the learner. The instructional designer using this approach is interested in predicting and controlling behavior through reinforcement. In this approach the teacher presents the learner with a stimulus and a response is made, and then reinforced. When the stimulus is presented repeatedly and the correct response is made, the response is said to be under control of that stimulus and learning is thus completed. Predictably, the same response will be made upon any later presentation of it. An established stimulus control depends upon two conditions: active practice of the correct response and the reinforcement of the response following practice (Gropper, 1983, Salisbury et. al, 1985).

The preconditions to establishing stimulus control can be described by the following four levels of skill acquisition: Discrimination, generalization, association and chains. Discrimination is the ability to tell one stimulus apart from another. Gropper (1983) identifies this skill as fundamental when learning and suggests that learning to discriminate between two stimuli be facilitated by differential reinforcement. For example, in teaching audio recording, a student needs to be able to discriminate between noise and distortion. The appropriate response to rectifying noise is to increase the signal's level whereas to rectify distortion, the level needs to be decreased (Gropper, 1983).

Generalization occurs when a class of stimuli requires the same controlled response from the learner. Any stimulus belonging to a class has to be recognized as being similar to that class and they all have to be seen as appropriate occasions for demonstrating the same response. Thus when the audio recording student is able to identify signal originating from either the soundboard, tape, microphone, and signal processor as noisy, s/he has generalized the concept of noise (Gropper, 1983).

Association is the third precondition to stimulus control. This happens when the learner who has generalized a concept can associate an appropriate corresponding response to that concept. With the previous example, the audio recording student will increase the signal's gain from the source to rectify the noise problem (Gropper, 1983).

Discrimination, generalization, and association are the three skills needed for making a stimulus-response (S-R) unit. Chains of linked S-R units structure most learning tasks. For learning to occur, active practice with reinforcement of the correct response to each stimulus is necessary. Successful performance of any activity can not occur unless the student has learned all S-R units and has integrated them into a complete chain (Gropper, 1983).

Techniques such as incrementing, shaping and fading are used to help the learner master an activity's S-R associations and to integrate them into a complete chain. Two types of stimuli help the learner master the learning task: the criterion stimulus and the cue. The criterion stimulus is the concept, object, or signal that gains control of a desired response by the time the learning is complete. A stimulus does not possess control over this prior to learning (Gropper, 1983).

The cue is a non-criterion stimulus that possesses some control over responses that have to be learned. Gropper (1983) notes that "cues are used to elicit practice of responses in the presence of the relevant criterion stimuli" (p.110). With continued practice, control is ultimately transferred from the cues to the criterion stimuli. Oral instructions, printed hints, and suggestions from a computerized lesson can serve as cues. At the point that the learner no longer needs cues, the criterion stimulus has achieved stimulus control (Gropper, 1983).

Complex behaviors made of many S-R units may require an incremental approach. This step-by-step process teaches each unit of the desired behavior separately or in small distinct groups. When mastered, more units or groups are added to and integrated with the previous S-R unit (Gropper, 1983).

Shaping is the process of taking a student from a partial and incomplete performance to one that meets the criterion standard. This is accomplished through a series of approximations of the desired behavior. The learner fine-tunes the desired behavior with practice until mastery of that skill has been attained (Gropper, 1983).

Fading is the final technique to helping the student master the desired skill or behavior. During the incrementing and shaping stages of learning and practicing, cues provide guidance to elicit the correct responses. To prepare for real-world situations, cues must be made weaker. Fading and weakening cues thus strengthens the responses being practiced. When cues are no longer necessary, the learner will have learned the task and thus formed a chain (Gropper, 1983).

Waldrop's (1984) research on using behaviouristic principles for the development of computer-assisted instruction warns of misapplying reinforcement principles that may lead to ineffective instruction. The failure to plan for the reinforcement of responses through the systematic application of instructional design principles can seriously impair the effectiveness of the learning program. Feedback is one reinforcement strategy that is well suited for the CAI environment (Waldrop, 1984).

Some suggestions helpful for authoring computerized feedback during the incrementing and shaping stages can be summarized as follows:

1. In the event of a correct response, the feedback should explain why the response is accurate. Sometimes learners are lucky with their answers. It is also a good time to reinforce the behavior (Waldrop, 1984).

2. In the event of an incorrect response, feedback should state why the response was incorrect. The learner should then be given the correct response, or better yet, be given cues and a chance to redo the question (Waldrop, 1984).

3. There are many ways to say, "you're correct." In diversifying the feedback, the learner's tendency to ignore repetitive feedback boxes is alleviated by maintaining learner interest in the unexpected (Waldrop, 1984).

The Behaviorist theory is a collection of general principles and concepts that govern the acquisition of a skill. Some of these principles fit well within the practice portion of the nine instructional events developed by Gagné- Briggs. Techniques such as incrementing, shaping, and fading with the use of cues, help the instructional designer plan these events. Research has also shown that behavior reinforcement strategies for computer-assisted instruction are effective when providing feedback. All feedback should specify why answers are correct or incorrect to reinforce the student's internalization of the learning objectives.

Principles taken from Keller's *ARCS* Model

Keller (1987) developed the ARCS model to improve the motivational appeal of instructional materials. This was in response to a lack of macro theories that directly addressed the question of how to design instruction that would motivate learning (Keller, 1987). The ARCS model came about from an earlier macro theory of motivation developed by Keller (1983) and is grounded in expectancy-value theory. This theory stipulated that a learner is motivated to engage in an activity if two conditions are met. The value aspect includes the perception of the activity to be linked to the satisfaction of the learner's personal needs. The expectancy aspect includes perceiving a positive expectancy for success from that activity (Keller, 1987).

The ARCS model comprises of three distinctive features. Only one is highlighted in this thesis as the other two incorporate and use strategies to designing instruction. This feature contains the four conceptual categories that contain what Keller (1987) characterizes as the variables that structures human motivation. Four major conditions define the ARCS model: *attention, relevance*, *confidence*, and *satisfaction*. In order for instruction to motivate learners, these conditions must be met.

Attention

Attention is a pre-requisite to learning and is an element of motivation. This concerns not only getting the learner's attention but also sustaining it. Gaining attention is fairly easy. With reference to computer assisted instruction, the audio and visual capabilities of a computer can be very effective at this level (Keller and Suzuki, 1988).

Unusual content, the effective use of animations and presenting two facts that seem to contradict one another are strategies that a designer can use to gain the learners attention. Caution should prevail to avoid the use of dysfunctional attention getting techniques. Keller and Suzuki (1988) cite: "having words flashing on one part of the screen makes it difficult to concentrate on other parts of the screen. Adding attention-getting animation can be very irritating if it is time consuming and the learner has no choice but to sit through it" (p.409).

The goal is to find a balance between over-stimulation that can result in anxiousness and boredom that leads to indifference. The following list contains courseware development strategies for maintaining attention:

- Stimulate information-seeking behaviour by posing or having the learner solve a problem. Once learners are perceptually aroused, the designer can activate a deeper level of curiosity by engaging them in an inquiring frame of mind. At a simple level, learners' interest can be sustained by using question-response interactions that require more than just verbal recall (Keller and Suzuki, 1988).

- Maintain student's interest by varying the parts of the instruction. Keller and Suzuki (1988) suggest the best way for courseware development is to keep instructional segments short and to intermingle information with interactivity. Although people enjoy variety, learners like to have a sense of stability and structure. Consequently, too much variation can detract from the learning goals just as much as not having enough instructional diversity (Keller and Suzuki, 1988).

Relevance

Relevance problems occur when the reason for the instruction is not evident. Many instructional designers make the lessons seem relevant to present and future career opportunities to satisfy this condition. However, relevance can also focus on the process rather than the means. For example, people with a need for affiliation will tend to enjoy cooperative group work. Learners with a need for achievement will enjoy achieving moderately challenging goals. In designing instruction that offers opportunities for individuals to satisfy needs, the learners will have a feeling of relevance (Keller, 1987). Strategies in which a courseware designer may use to achieve this second condition of the ARCS model include:

- Using concrete language and using examples and concepts that are related to the learner's experiences and values ensures familiarity. Although learners enjoy strange and unexpected instructional events, they feel the closest affinity to things they are familiar with. For example, stories about specific people rather than humankind in general makes instruction more relevant (Keller and Suzuki, 1988).

- Providing statements and examples that present the objectives and utility of the instruction makes instruction relevant. People tend to be goal-oriented in their behaviour. If the goal and the reason for getting there are known, learners will more likely want to achieve this goal. Games and simulations with built-in goals provide this sense of purpose to learners. Making a learning activity a prerequisite to doing the game or simulation further develops goal-achievement within students (Keller and Suzuki, 1988).

Confidence

Some students seem to never achieve success even when conditions are in their favour. Others always seem to excel regardless of the probability for success. The third condition for ensuring motivation is confidence. Differences in confidence levels can influence a student's persistence and accomplishment (Keller, 1987).

A learner's perceived level of confidence and expectancy for success are affected by certain factors. A confident learner attributes success to internal factors such as ability and effort. This learner also tends to be more task-oriented and enjoys learning even though mistakes are made. Confident learners believe they can accomplish an instructional goal by means of their actions (Keller, 1987).

The non-confident student attributes success to luck and other similar external factors. This learner is often more ego-involved in the task than others, and they want to impress others, or they fear failure. The challenge in designing motivating instruction is to develop and encourage confidence despite the competitiveness that often exists in schools (Keller, 1987). For courseware developers, pursuing certain prescriptions can foster confidence.

- Help students estimate the probability of success by presenting performance requirements for the instruction. By simply making known the learning objectives helps learners develop confidence. Several methods for making learning requirements clear within the courseware is to first present the objective and overall structure of the lesson. Second, present an opportunity for practice with feedback. Third, mention any pre-requisite knowledge or skills that may help the student achieve the task. Finally, indicating how many items or lessons are required to complete the test or drill. This information helps the learner anticipate performance requirements (Keller and Suzuki, 1988).

- Providing challenge levels to experience success under both learning and performance conditions gives learners confidence. When people learn new skills, they usually want assurances that they will be successful and that their efforts will payoff in terms of accomplishment. If success is too hard to attain, they may move onto other activities. By providing varying degrees of drill and practice levels allows both the able and the incapable student to choose an entry point that reflects their skill level (Keller and Suzuki, 1988).

Satisfaction

The final condition to designing motivating instruction includes satisfaction. Generally, learners should be motivated given the task and reward are defined and appropriately reinforced. However sometimes people become resentful when they are told what to do and what will be given as a reward. This happens because of control.

Students sometimes feel resentment when they are required to do a learning task. They feel the teacher or computer has taken over part of their ability to control their lives. This is especially true if the learner has no control over an intrinsically satisfying behaviour that limits that person's enjoyment of it. The challenge to the instructional designer is to provide appropriate instructional events without overcontrolling and limiting the learner's satisfaction (Keller, 1987). To develop satisfaction, the courseware developer can use the following prescriptions.

- Provide opportunities to use the newly acquired skills in a simulated or real setting. One of the best ways to develop satisfaction and motivation is to readily provide a setting for learner to perform skills in a meaningful way.

Although a real setting best fulfills this prescription, simulated environments can also be used. Simulation games and drills needing the application of previously acquired skills are most effective (Keller and Suzuki, 1988).

- Provide feedback and other statements that reinforce and sustain the desired behaviour. The use of positive motivational feedback should be given after each success in the student's process of acquiring a new skill. Motivational feedback differs from corrective feedback in that it consists of affirmations. "That's correct" or "job well done" are examples of motivational feedback (Keller and Suzuki, 1988).

Computer-assisted instruction often contains animated graphics, sound effects, interactivity, feedback and the freedom to make mistakes without the fear of disapproval. However, the novelty of these features can quickly fade if the design of instruction lacks motivational appeal beyond this level. Using Keller's (1987) ARCS model and Keller and Suzuki's (1988) prescriptions for systematically designing motivating computer-assisted instruction enables the instructional designer to surmount this novelty effect.

Guidelines for authoring Computer-Assisted Instruction

Considerable attention is required for the effective manipulation of the computer's presentation stimuli. Being inattentive to this technology's capabilities will blind rather than enlighten the instructional designer's use of it (Hannafin & Hooper, 1989). The creation of instruction for certain media is bound by researched and proven design principles. However, a computer's convergence of media sometimes distorts those principles that apply within a medium. For example, people read text from a computer screen more slowly and comprehend less than when reading the same material from print (Orr et al. 1994). This demonstrates the importance of using research-based guidelines for the relatively new, multimedia-capable, computer.

The suggested guidelines are split into two categories. The first part deals with design consideration relating to a variety of interests. It also gives an overview of the detail an instructional designer must attend to when designing for this medium. The second part deals with the adaptation and display of text. I feel the use of text transcends all makes and capabilities of computers and is the most primary method for communicating programmed instruction.

Guidelines for Learner Control

Learner control can be defined as the degree to which learners are allowed to take charge of the instruction and their learning environment (Orr et al. 1994). It is believed that learner control is a highly valuable feature of computer-based instruction (CBI) because it "enables learning to be individualized to each person's needs" (Chung & Reigeluth, 1992, pp.14). It is also assumed that learner controlled instruction increases motivation. However, research concludes otherwise, suggesting learner control more often influences negatively when improperly implemented (Chung & Reigeluth, 1992).

Chung and Reigeluth (1992) suggest certain prescriptions for learner control. Based on the conditions presented by the learning environment needs and learner analysis, these directions can be mixed and matched accordingly.

Offer content control when:

1. Students have prior knowledge of the content. If a student knows about the content, then s/he can use options effectively.

2. Learners are permitted to set their own learning goals.

3. Students have demonstrated a higher ability.

4. The probability of success is independent of the chosen content.

5. Students are older (p.16)

Chung and Reigeluth (1992) warn not to offer control of content when all the contents of an instructional program are required for successful completion or when the material is hierarchically ordered.

Provide learner control of sequence when:

1. Lengthy instructional programs have no specific presentation order.

2. Students are familiar with the topic, or have significant prior knowledge to guide and determine their instructional sequence.

3. The student has the opportunity to control the sequence if s/he desires.

4. When individualized materials such as lab books encourage self-pacing (p.16-17).

To increase the effectiveness of learner control in hypermedia and computer-based learning systems, the following design guidelines (Chung and Reigeluth, 1992) are suggested:

1. Provide a default path or guided tour for those who lack confidence in their navigation abilities. Navigation methods should be standardized and fast. An exit button should be placed on each screen.

2. Provide a graphical browser or template to help with navigation. This allows learners to identify where they are, and where to go within the program.

3. Provide an audit trail or a history of where the student has accessed information.

4. Standardize screen layout to help with identification.

5. Information should be standardized in its presentation.

Guidelines for Employing Graphics

The computer communicates information to the learner in a number of ways. The computer-learner interface is the link that achieves this. A misguided design may negatively affect the purpose of the interface thereby reducing a student's desire to learn from this medium. Lucas (1991) states the "visual design consists of all graphical elements of the interface, such as screen layout, information representations, and the representations for commands on the screen" (p.56). To achieve effective instruction, the design of the interface should be clear, consistent and attractive to the learner.

Visuals should be used as aids to define and elaborate information (Grabinger, 1989). When images are used to show something, they should do so as accurately as possible. Their meaning should be clear and unambiguous. If the intent is to generalize an object's features, a realistic portrayal may not be appropriate, since realism may cause learners to experience information overload when irrelevant detail is included (Lucas, 1991). Merrill and Bunderson (1981) agree that if the graphic is too complex or realistic, "it may be difficult to perceive or distinguish the attributes of the example that are critical to learning" (p.3).

Cueing strategies can be used to draw learners' attention to features that are important to the instruction. Cueing devices also change learners' emphasis on the features being displayed. In effect, it forces the student to look at something in a particular way. Lucas (1991) notes "people learn best when they are cued to specific information" (p.57). Guidelines for designing effective visual cues include:

- Make the cue visually representative of its function. For example, use a question mark to represent the act of questioning and getting assistance. This allows the learner to easily recognize its function (Lucas, 1991).

- Cues should be consistent and the reappearance of these devices should inform the learner that the cue's purpose is the same. If change should occur, it should always be made at the beginning of a new section. This allows the learner to adjust to the change in content (Lucas, 1991).

Employing visuals does not automatically add to the effectiveness of instruction. Merrill and Bunderson (1981) concur with Lucas (1991) that "under certain conditions a given graphic might be confusing and have a negative effect on student achievement. Under other conditions a graphic might be vital for learning to occur" (p.3).

Merrill and Bunderson devised a list of guidelines for employing graphics categorized according to Gagné's (1977) five domains of learned capabilities: intellectual skills, cognitive strategies, verbal information, motor skills, and attributes. For the purpose of this study, intellectual skills and motor skills are discussed.

Intellectual Skills

The intellectual skills domain is further divided into three subcategories named concepts, discriminations and rules. Learning a concept includes behaviours that require classifying previously unencountered objects, symbols, and events. Concept learning is usually a prerequisite to learning other behaviours such as problem solving (Merrill and Bunderson, 1981).

Concept learning is greatly facilitated by the use of graphics. Pictorial graphics should be simplified to reduce irrelevant cues, and increase the redundant ones. Realistic graphics and pictures could be used at the beginning of the lesson to assist with motivation and orientation to the real world (Merrill and Bunderson, 1981).

The ability to discriminate allows the learner to distinguish objects, symbols, and events from one another. Graphics and pictures increase a student's ability to learning this capability. Colour should be used if the object requires colour discrimination. Motion is also necessary if movement is a critical characteristic of the object (Merrill and Bunderson, 1981).

Rule-using behaviour occurs when the learner responds to a class of stimuli with a class of predictable performances. Examples include tasks such as using proper grammar and doing math. When teaching rule-bound procedures, caution should be used when employing graphics. Although effective for simple procedures, the more complex ones may benefit from the use of flowcharts with a scheduled practice (Merrill and Bunderson, 1981).

Motor Skills

Motor skills are acquired when the execution of a physical movement is expected with precision and appropriate timing. Learning these is difficult to acquire solely from verbal and textual information. Demonstration by either a teacher or some form of graphic representation must be made. Learners should be able to repeat, slow down, and fast-forward visuals. Practice is crucial to acquiring these skills as well as feedback on performance. Given the abilities of the computer, both these recommendations can be employed.

Adapting and displaying Text for Computer-Based Instruction

The computer can efficiently convey instruction by delivering information in a variety of ways including audio, video, animation, graphics and text. The latter is an efficient way to representing information. However, displaying text on the computer screen presents unique qualities and constraints that the instructional designer must consider when planning a lesson for this medium. Following are some design considerations for displaying text in the computer-based instruction (CBI) environment.

Capital vs. Lower Case

Aspillaga (1991) notes "researchers have found that capital letters do not provide as many visual cues as do lower case" (p.54). Words formed by capital letters have no ascenders and descenders and supply most of their information in their right hand extensions. As a result, they lose their uniqueness by becoming a solid block, which decreases readability. Words formed by capital letters become more salient and unique when they are used in isolation such as a heading or to draw a reader's attention (Aspillaga, 1991). Words made of capital letters should therefore be limited to titles and headings, and possibly for emphasis.

Interlinear Space

The goal of readability should lead the design of the computer screen. Extra space contributes to legibility by making lower case words more conspicuous, discreet, and perceptible. For words that are capitalized, interlinear space can contribute to a loss of continuation that results in fragmenting the information's concept (Aspillaga, 1991). Headings displayed in capitals should not have interlinear space, whereas text with predominantly lower case letters should have interlinear space to increase legibility (Gillingham, 1988, Aspillaga, 1991, Orr et al. 1994).

Rate of Text and Sequencing

Research shows that reading text from a computer screen is 28 percent slower and that comprehension is lower than reading from print media (Hannafin & Hooper, 1989, Orr et al. 1994). Also, a reader whose reading rate is slower than that of the computer's presentation can hinder comprehension. The presentation of text should thus be reader controlled (Gillingham, 1988, Hannafin & Hooper, 1989). Given that comprehension is lower when reading from the computer screen, information should be elaborated from the basic to complex and should be organized into tables to help learners integrate program content (Gillingham, 1988, Orr et al. 1994).

Length of Text

People read the printed page differently from the computer screen. In a study by Morrison, Ross, O'Dell, and Schultz (1988), high-density screens paralleling printed information were read more slowly and produced more learner frustration than low-density screens containing 50% fewer words. Both, however, had comparable influences on learning. Hannafin and Hooper (1989) suggest this is because lower density text helps cue learners to the important information and is effective for learning a text's main points. Morrison et al. (1988) suggest specific guidelines for shortening text for the computer learning environment:

1. Reduce sentences to their main ideas by removing unnecessary modifiers, articles and phrases.
2. Split complex sentences into single phrases.
3. Use outline forms instead of paragraph forms.
4. Omit sentences that summarize or amplify without presenting new information.

5. Present information in frames or chunks containing limited amounts of new instruction (p.66).

Strategies for Recall and Attention-Getting

Chunking information, margins, and the location of information can be strategically designed to aid recall. Chunking information into meaningful units facilitate encoding. It is also effective for organizing complex text when the structure is unclear. Techniques such as building up the screen, window overlays, and icon buttons can accomplish segmenting information (Hannafin & Hooper, 1989, Orr et al. 1994).

In reference to margins, research shows that ragged margins are preferred over justified ones. Ragged margins also become a spatial attribute, or what Aspillaga (1991) calls a "premonition of meaning" (p.56). A paragraph's natural shape is shown to assist the learner with locating information and recalling content. Standard justified margins also hyphenate words and break endings. This interferes with normal eye movements forcing the learner to work harder at processing information.

Location of information should be consistent as it mediates content and visual data. A standard location facilitates the transfer of information and enhances learning (Aspillaga, 1991, Orr et al.1994). Orr et al. (1994) suggest that key information be located in the center of the screen and away from borders to facilitate detection.

Attention getting techniques should be limited to one per page, as oversaturation will reduce their efficiency. Some suggestions forwarded by Orr et al. include:

1. Limit highlighting and boldface to 10% of the display.
2. Use Italics for titles and headings.

3. Use reverse video and blinking with extreme discretion. Never blink text to be read.

4. Use mixed type sizes or fonts to differentiate screen components (pp.24).

Designing the Screen Page for Text

To ease and accelerate information processing, each line of text should have a self-contained, brief message that reflects meaningful information. Providing learners with graphical examples and cues further enhances retention because people encode pictorial information differently than written information. By using two or more modalities, the learner activates different memory systems that complement one another thus providing an alternate storage mode, which enhances retention (Fleming & Levie, 1978, Aspillaga, 1991). Hannafin and Hooper (1989) caution to use the combination of graphics and text to only when an extensive redundancy exists between the two sources. While it may strengthen encoding, it could also place an unnecessary burden on a learner's capacity to process the information if the two lack congruence.

Colour should also be used with discretion. Certain colour combinations have shown to improve the accuracy and speed of reading. Gillingham (1988) warns that research into this area has not been rigorous. Black text on a white or yellow background best enhances readability. Caution should moderate the use of colour to distinguish textual information in case of a student with colour-blindness. If used, a second cue such as texture, a label, or a background shape will help that learner perceive differences (Orr et al. 1994).

Summary of Designing Text

Computers can disseminate information in a number of ways. The use of text, however, is the most efficient means of doing so. Unlike digital audio or video, textual information needs very little of the computer's resources. Using text as the primary carrier of information also ensures the usefulness of a CBI program if used on computers with divergent capabilities. By applying research-based principles and strategies, text can be displayed to better enhance learning. Some of these include: keeping messages short and to the point; limiting the use of upper case letters to draw attention to important information or for titles; and keeping the location of pertinent information consistent from page to page.

CHAPTER THREE
The *Soundboard Program*'s Instructional Analysis

Learning Environment

Existing Curricula

The Communication Studies Department's "Sound in Media" course offers the student the chance to learn the theoretical and practical aspects of sound production, writing for the ear, the recording industry, and the broadcasting industry. Learners attend a weekly two-hour lecture and a two-hour laboratory (lab). The class size is limited to 36 students to keep the lab portion of this course small. Its purpose is to:

> "...Learn to critique, write and produce audio messages like commercials, soundtracks, and programs. The course serves as an excellent introduction to radio, film and television courses (syllabus for Sound in Media, 1996)."

Two-hour labs are held on various days of the week. Lab size is limited to six students to ensure each gets the attention and time needed to develop working skills on the equipment. Traditionally, teaching assistants (TAs) follow lesson plans that cover most of the equipment over a given period of time. In the fall of 1997, a competency chart system based on the DACUM system (Adams, 1975) was introduced to specify exactly which skills need to be mastered in order to pass the course. The implementation of this chart responded to a demand created by an imbalance in skill acquisitions caused by differing TA teaching methods.

During the lab period, TAs demonstrate how to use the equipment in accordance with the competency chart. Students practice these skills on their own time until they are mastered. The TAs then test them. When the chart is complete, the course instructor randomly tests the student's skills. This process takes ten weeks. After the laboratory exam, students produce audio messages according to their interests.

Hardware

There are three analogue sound production studios housed in the Division for Instructional Development (D.I.D.). Two of the studios are dedicated to simple two-track recordings and dubbing whereas the third allows for more complex multi-track recording. The two dubbing studios serve as an introduction to the sound recording process. Both have broadcasting mixing boards which process signals from various reel-to-reel recorders, CD player, cassette player, and a microphone. Skills, concepts, and procedures such as live mixing, editing and the basic setting of line levels are learned in these studios before students are introduced to the more complex studio.

The 8-track studio introduces more advanced audio production concepts, which are elaborated from the basic skills mastered in the other studios. The studio consists of a multi-channel mixing board, an 8-track recorder, a Lexicon sound processor, a mastering two-track recorder, and a cassette recorder. Concepts and procedures such as setting line levels, signal routing, and multi-track recording are taught in this studio.

In the Fall of 1997, D.I.D. completed a new laboratory space comprising of 36 Pentium 166 MMX computers capable of reproducing sound and capable of handling video and other memory intensive programs. Presently, students use this space for developing language skills, creating multi-media applications, and web-page development. It is open to any teacher who has a computer teaching program s/he wishes to use.

Teaching Assistants

The TAs have previously demonstrated the ability to operate the equipment in all three studios. Most of them have taken the Sound in Media course in previous years and do not have real world experience except for a few who have interned at the University's student-run radio station or have used the personal computer as a tool for sound recording and editing. Their motivation for leading a laboratory in sound production may range from being paid to getting teaching experience. Most are in their early 20's with a few being mature students. These assistants are mostly undergraduate students with a minimum B grade average.

Instructor

The instructor enjoys teaching the course. His strengths lie in the areas of message design and writing for the ear. His technical expertise conforms to current sound production practices but for the most part is related to the production of spoken messages. He has taught this course for the past 13 years and uses it as a pre-requisite to his radio-broadcasting course.

Organization

The Communication Studies Department does not have its own equipment to teach media practices. It uses D.I.D.'s facilities to teach video and sound production. The University of Windsor mandates D.I.D. to provide access to facilities to all students given they are producing a message for course credit or other University related activities. This has occasionally created a shortage of access as booking the equipment is on a first come, first served basis. To add to this pressure, students must book at times when classes are not held within these various facilities. The sound studios are open Monday to Friday from 8:30am to 10:00pm. Fourteen hours a week are reserved for Sound in Media labs during those times.

Problems

Are there learning goals not being met by the students?

The competency chart gives the student a clear gauge of what to learn but many students in the 1997 fall semester did not demonstrate the ability to do higher order procedures. One problem with this system stems from a perceived lack of responsibility students have in determining instructional goals. Because students have not yet developed a sense of controlling their instruction, they rely on their TAs to determine the sequencing of instruction and the correctness of it. TAs, like some inexperienced teachers, omit certain elements in doing key audio related procedures. This results in bad habits or improper procedures.

Another problem stems from the lack of motivation or time to practice and master demonstrated procedures. Some students carry a heavy workload and cannot find the motivation to book studio time; others have not yet developed time management skills and wait until the last minute to practice or produce projects.

These problems, in conjunction with the added time restraint from D.I.D.'s booking schedule, create a need for instruction that can be easily accessed, is available to everyone, and is standardized in content.

Is the existing instruction being delivered efficiently?

During the lecture period, students are exposed to current and correct information due to the instructor's preparedness and experience. This results in a fairly stable learning outcome, which is dependent mostly on the student's will to learn the material. The laboratories, however, have more divergent results.

TAs come from a wide range of backgrounds. All have demonstrated a basic ability to operate the equipment either through prior experience or by excelling both artistically and technically in the 'Sound in Media' course. Some are experienced as teaching assistants, but most are first time facilitators. The latter may:

- Not have developed teaching skills for this type of environment, thereby delivering instruction that is difficult to understand.
- Feel uneasy teaching peers close to their own age.
- Feel uncomfortable in their knowledge of the equipment thereby lacking confidence or forget certain rules and procedures.
- Have a teaching style that does not gain the respect of their students.

Any or all of these problems combined negatively affect the delivery of instruction. Another source of ineffectiveness is the lack of a manual that helps the learner deal with problems when alone. The *G140 Sound Studio Operating Manual* (Moore, Podhorsky, and Tousignant. 1991) is deficient in that it assumes many students understand audio related jargon and can decipher technical schematics. It also contains photocopied pages from the original manuals that were written for sound engineers.

These problems also point to a need for an instructional delivery system that has standardized content. This would allow the TAs to excel at what they do best, which is teach basic concepts, critique student performance and develop within the student the more artistic realm of sound production. In devoting more time to artistic growth, the graduate of 'Sound in Media' would be better for future employment.

Is the instruction impeding the motivation and interest of the learner?

The lab is structured to teach six to eight students. Students are assigned to these labs according to their availability. Given that these labs are made up of homogeneous groups with members who are relatively equal in their prior knowledge of audio recording, the students' motivation and interest in the subject is fairly stable. Naturally, some students have more prior experience in audio production than others, and there has been the occasion where the experienced student joins a group that needs to learn the rudiments of audio. This results in boredom on the part of that student. Depending on the skill of the TA, there can be occasions of disruption by the bored student, which cause a decrease in motivation to both the novice students and the TA. Introducing instruction which experienced students can use to challenge themselves could solve this problem.

Learner Description

The need for producing instructional material will be geared for two audiences. The primary audience are students taking 'Sound in Media.' The secondary audience are those who have passed the course in previous years and wish to have there learning refreshed. A third are film/video students who need to operate the board to produce soundtracks. A fourth are students interested in sound production but cannot enroll in the course for whatever reason. Listed below are some general characteristics these audiences share except where noted.

Cognitive Characteristic:

- Above average intelligence
- Most cannot efficiently read a technical manual
- Most cannot decipher a technical schematic
- Most learn best when a procedure is shown to them step-by-step
- Most prefer to learn a new task actively, in the presence of a knowledgeable person to ensure it was done correctly
- Most learners do not enjoy technical jargon
- Learners enjoy positive feedback

Prior Knowledge:

- All have operated a stereo system which includes a CD player and cassette recorder
- Most can discriminate between poor and good quality audio productions.
- TAs and graduates of the Sound in Media course are familiar with the equipment found in all three studios.

Physiological Characteristics:

- Most of both primary and secondary audiences are in their early twenties.
- All have normal visual and auditory senses.
- All have full use of their hands.

Affective Characteristics:

Possible motivations for Learners:
- Course credit
- Interest in subject matter
- Interest in professor's teaching style
- Tuition costs
- Applicable skills for both job prospects and other courses (film, video, etc.)

Possible motivations for TAs:
- Wages
- Experience
- Work reference
- Enjoyment

Social Characteristics
- Most enjoy team work
- Most learners develop a bond with their classmates
- Most learners enjoy trying new tasks
- Some learners enjoy group work
- Some learners enjoy competition

General Attitudes toward Subject Matter

Students enrolled in Sound in Media generally have a good attitude toward the subject matter. Those who do not usually sign out of class before the end of the course add/drop period. Their attitudes toward learning are associated with their motivation to learn real and relevant skills. Usually, when informed of this relevance, any negative attitude toward the subject matter is alleviated. For example, many students question the relevance of learning skills on analog-based equipment when for the most part the recording industry is digitally based. When it is clarified that the skills they are learning can be transferred to a digital format with little training, students accept the applicability of their learning.

General Anxiety Levels

Learner's anxiety levels run high at the beginning of the course, especially when they are introduced to the multi-tracking equipment. This anxiety regresses with successful demonstrations by the TA and repeated practice. When TAs are ambiguous with their demonstrations, the learners' anxiety levels usually remain high.

TAs are sometimes anxious when teaching for the first time. When procedures are not successfully demonstrated or when they cannot adequately answer student questions, anxiousness may hamper the teaching process. Another possible source of anxiety may be the TAs lack of a solid methodology for operating the 8-track equipment.

Implications for the Design of Instruction

The supplemental instructional unit for the 'Sound in Media' course should have the following characteristics:

- All relevant information should be stated in plain language.
- Lessons should be short.
- It should specify the relevance of the material being learned.
- It should encourage students to explore the equipment on their own.
- The methods for doing procedures should conform to standard audio production procedures.
- It should have an active component where the student participates in the learning process and it should give feedback on student performance.

Drawing from these implications and the media hard ware available to the 'Sound in Media' course, a computer-based training program would best convey how to use the equipment available to students. A multi-media programme benefits the student in that:

- There are ample multi-media computers available for use within D.I.D.;
- The program can be accessed at any time;
- The program can, in the future; be transmitted over the Internet,
- It assists TAs in the instruction of procedures;
- It can be programmed to provide feedback and assess student performance;
- It provides a standard methodology in operating equipment;
- It can be easily modified to include new components.

For the purpose of this thesis, I have selected the multi-tracking room's audio-mixing board, as it is most problematic in teaching. This board will have most of its common functions exemplified and explained which will allow the learner to correctly identify and use the shown component. Two higher order procedures will be included in the instruction. These are: setting line levels, and signal routing.

Setting line levels involves calibrating all the components in the multi-tracking room so that they receive and send signals at a predetermined strength. This is significant in that improperly set levels can ruin an audio recording by introducing distortion or noise. Students learning this procedure should also retain the importance of calibrating any media equipment and will be able to transfer this concept to future production related endeavours.

Signal routing involves knowing from where a signal comes from and knowing where to send it. The mixing board's design complicates this procedure in that it there is only four subgroups. A subgroup or bus is a specialized channel that combines the output of several primary channels such as signals from a microphone or cassette recorder. Its purpose is to send signal to the 8-track recorder and to send signal to the master output faders. Because there are only four subgroups accommodating the recorder's 8 tracks of audio, students must develop a keen sense of how signal flows through these subgroups.

Goals and Objectives for the Instructional Program

a) Goal: **When in the multi-tracking sound studio, the learner will be able to set line levels for all of the equipment**.

Objective #1: The learner will be able to calibrate the 8-track recorder with a 1kHz tone.

Objective #2: The learner will be able to set the mixing board's master and subgroup faders.

Objective #3: The learner will be able set the mixing board's input section with a 1kHz tone.

Objective #4: The learner will be able to calibrate the mixing board's output section with a 1kHz tone.

b) Goal: **When in the multi-tracking sound studio, the learner will be able to signal route to and from various signal sources including the 8-track recorder, microphones, cassette deck, CD player, and reel-to-reel recorder.**

Objective #1: The learner will be able to demonstrate where signals come from when the TAPE button is up.

Objective #2: The learner will be able to demonstrate where signals come from when the TAPE button is down.

Objective #3: The learner will be able to send signal through the subgroups to any track on the eight-track recorder.

Objective #4: The learner will be able to send a signal to a mastering recorder (cassette deck and reel-to-reel)

c) Goal: **When in the multi-tracking room, the learner will be able to identify and use the mixing board's signal processing functions.**

Objective #1: The learner will be able to identify and summarize the functionality of each of the mixing board's components.

Instructional Analysis for each Objective

Goal A:

Objective #1: Psychomotor and intellectual skills

The learner must use the proper sequence in calibrating this piece of equipment. This objective does not require creativity or problem solving if the correct methodology is used.

Pre-requisite skills: Ability to turn knobs, flick switches, read a VU meter.

Objective #2: Psychomotor skills.

The learner must be able to correctly adjust the subgroup and master faders to a predetermined level.

Pre-requisite skills: Ability to slide faders, read the faders' ruler.

Objective #3: Psychomotor and intellectual skills.

The learner must be able to press the correct button in order to receive the 1kHz signal from the 8-track recorder. S/he must be able to assign these signals to a subgroup. S/he must be able to adjust the channel faders' output by reading the subgroup's VU meters.

Pre-requisite skills: Slide faders, press buttons, turn knobs, read VU meters.

Objective #4: Psychomotor and intellectual skill.

The learner must be able to match the combined signal output from the subgroups with the master group by manually adjusting the master faders and reading the master VU meters.

Pre-requisite skills: Slide faders, read VU meters.

Goal B:

Objective #1: Verbal, intellectual, and psychomotor skills.

The learner must be able to identify the equipment connected each of the board's eight channels when the TAPE button is up. The learner must be able to randomly specify a signal source and correct the board's channel when asked to do so.

Pre-requisite skills: Ability to press buttons

Objective #2: Verbal, intellectual, and psychomotor skills.

The learner must be able to identify the equipment connected each of the board's eight channels when the TAPE button is down. The learner must be able to randomly specify a signal source and correct the board's channel when asked to do so.

Pre-requisite skills: Ability to press buttons

Objective #3: Verbal, intellectual, psychomotor skills

The learner must be able to route a signal to any track of the 8-track recorder by assigning to one of the four subgroups. The learner must do this without assigning pre-recorded signals to the same subgroup.

Pre-requisite skills: Ability to press buttons, slide faders, turn knobs, read VU meters.

Objective #4: Verbal, intellectual, psychomotor skills

The learner must be able to set and control signals so that they can be sent to a mastering recorder at an acceptable signal level. Matching VU meters and using audio production rules apply here

Pre-requisite skills: Ability to slide faders, read VU meters.

Goal C:

Objective #1: Verbal, intellectual, psychomotor skills

The learner must be able to correctly identify and summarize the common signal process functions of the audio-mixing board and state when these functions are useful in the audio recording process.

Pre-requisite skills: Ability to turn knobs, read VU meters, discriminate aurally.

Summary of the Analysis

The purpose of the analysis is to inform the instructional designer of what the existing instruction is capable of, where the instruction takes place and who the intended target audience for the new instruction will be. The goals and objectives determine the information that will be communicated. The audience description determines the sequencing and language used for the new instruction. The environment determines the delivery of the new instruction. These will be discussed in the ensuing chapter.

CHAPTER FOUR
The *Soundboard Program*'s Instructional Strategy

The instructional strategy guides the design of instruction by recommending prescriptions and strategies. Three distinct parts comprise this part of the Instructional Design Process Model. The organizational strategy is concerned with how to present the instruction, how to sequence it and what content will be used. It also assists in deciding whether the instructional approach will be supplantive or generative. The delivery strategy determines the appropriate medium of the instruction. Management strategy concludes the third part of the instructional strategy and assists with guiding the schedule of instructional events within the intended curriculum.

Organizational Strategy

Principles from a number of instructional design and message design theories were used to create the *soundboard program*. This section of the organizational strategy discusses the application of these prescriptions.

To present the information, I used both supplantive and generative approaches. This ensures the learner with little prior knowledge gets enough assistance to use the instruction. To avoid feelings of being unchallenged that may result in less motivation for the more able student, the instruction also incorporates generative strategies. One example of both these approaches used in the instruction is the TAPE button/GAIN knob lesson found on page 8 of the *soundboard program*.

The message telling students how to use the instruction informs students that they can either explore the page through trial-and-error or use the provided lessons to guide the use of these components. For the former, a student attempting proceed through the

TAPE/GAIN page without guidance will have the computer to check the student's progress. The computer only allows the procedure to use the TAPE/GAIN in a certain sequence. Pop-up messages and arrows guide the student who is doing the trial-and-error option, to the correct sequence.

Although this option was not available for most pages, navigation buttons and options allowing students to move to other parts of the instruction enables them to control their learning. For example, students mastering the easy 'assigning signals' quiz found on page 9 can easily stop and try the harder quiz. Or if learners feel a need for remediation, they can opt to redo the 'assigning signals' lesson on page 11 of the *soundboard program*.

Overall, the instruction takes on the perspective of a generative approach to decrease the likelihood of feeling controlled by the computer. Research shows that mostly supplantive approaches can decrease motivation (Smith and Ragan, 1993, Keller and Suzuki, 1988). Pages that mostly declare information and show simple procedures are accessed without time limits or sequencing restraints. The uses of supplantive approaches guide only those pages and lessons needing the strict sequencing of instructional events to ensure audio production procedures are taught properly.

Learner control of the instruction also falls conceptually within Smith and Ragan's (1993) arguments for using supplantive or generative approaches. Control of instruction can affect confidence. Chung and Reigeluth (1992) contradict the aforementioned researchers by citing research that claims learner-controlled instruction often has more negative than positive influence on motivation. I implemented their guidelines to offering learner control of the instructional sequence and content because:

- The instruction of the soundboard as a whole has no specific presentation order.
- The individualized nature of the program encourages self-pacing.
- Learners are allowed to set their own learning goals. They may choose not to explore a certain portions of the board at the time of learning.
- The probability of success is independent of the chosen content. All units within the program are self-contained. I designed many visually and textual redundancies for those who may not have been exposed to certain components. For example the GAIN button lesson reiterates the TAPE button's function in case students have not been introduced to it yet.

Applications of the theories described in chapter 2 appear below. There are examples that combine different prescriptions from different theories to facilitate the instruction. These illustrate the pragmatic nature and the compatibility of instructional design theories. However, I will discuss only those design instances that best exemplify the theories and prescriptions in their entirety to demonstrate their application.

Gagné-Briggs: Nine Events of Instruction

Because the instruction included many pages that only declared information, the Gagné-Briggs model was only occasionally implemented to its fullest. Pages such as #5 (the input channel) used mostly step #1 through step #4 combined with strategies from other theories. The 'assigning signals lesson' page incorporated the nine instructional events devised by the Gagné-Briggs approach to designing instruction. A breakdown of these events follows to demonstrate their application.

1. *Gaining Attention*

Figure 4.1 shows the message that greets students when entering the 'assigning signals lesson' page. The message tells students how to use the instruction and it conforms to Overbaugh's (1994) presentation strategy for gaining attention by providing explicit directions.

Figure 4.1: *Message telling students how to use signal routing instruction* (Beckhoff, 1997)

> This page is designed to show you how to assign signals. Press the start button on the right of the page to begin. It will give you detailed instructions on how to process a signal. When you feel comfortable with this page, press the 'easy' test button or 'hard' test button. It will quiz you and give you some feedback on your knowledge. If you run into any problems, press the 'signal chart' button and slide the mouse over the equipment that is giving you a problem. Good Luck!!

The graphics could also be deemed as an attention-getting device as it is a student's first encounter with the page. Another attention-getting technique is the use of a 3-dimensional pop-up used to highlight the three main sections of the soundboard. These are found in the *soundboard program* on page 3 (the subgroup section), page 4 (the master section), and page 5 (the input section).

2. *Informing Learners of the Objective*

Learning objectives are stated in plain language. The first three sentences in Figure 4.1 conforms to this step in the Gagné-Briggs model.

3. Stimulating Recall of Prerequisite Learning

Figure 4.2 demonstrates this event by using the metaphor 'doorman' I used to describe the TAPE buttons function in *soundboard program* on page 5. I also restate its function in the following sentence. This simple reminder suffices in stimulating recall of prerequisite learning.

4. Presenting Stimulus Material

Presenting stimulus material can be presented a number of ways including simple statements, example, or demonstration. The statement in Figure 4.2 encourages students to search for the TAPE buttons by telling them where they are located. This focuses students' attention and directs them to the stimulus that needs processing.

5. Providing Learner Guidance

Lesson 1 provides guidance by telling students what to expect when they perform the tasks required of them. Stating how to 'click' the TAPE buttons and informing them of a colour change sufficiently guides learners through this lesson. This lesson conforms to Smith and Ragan's (1993) use of an expository sequence. The ensuing lessons builds on this one as shown in Figure 4.2.

Figure 4.2: *Instruction for lesson 1 of assigning signals* (Beckhoff, 1997)

> First we'll go over the TAPE buttons. They are located at the very top of each channel and they act like a 'doorman'. When they are pressed 'in' or down, signals can ONLY come from the 8-Track recorder. Your first assignment is to press 'in' all of the TAPE buttons by clicking on them with your left mousebutton. Notice they turn green. This is to help you and is not a feature of the 'real' board. When you're finished, press the 'check work' button.

6. *Eliciting Performance*

There are ways to program a computer to disallow a student to move on unless the performance is demonstrated. Even so, the learner can simply walk away from it. However, given that the student is motivated to learn and the instruction seems appealing, the likelihood of a lesson objective's performance being elicited is increased. By making the assignment relatively easy should motivate students to perform the task. Because there are no time limits, able students can speed through the instruction until performance demands matches their abilities.

7. *Providing Feedback and Performance Correctness*

Students performing an action are given feedback and performance correctness. For example, once the learner finishes lesson 1, s/he is directed to press the 'check work' button. Given that the procedure from that lesson is correct, an explanatory message pops up as shown in Figure 4.3.

Figure 4.3: *Computer feedback after lesson 1 is done correctly* (Beckhoff, 1997)

GOOD! You have properly 'told' the board that all signals are coming from the 8-track recorder. HINT: Use the label to your advantage. If the TAPE button is up, read the top portion of the LABEL (e.g. M4). If the TAPE button is down, read the bottom portion of it (e.g.T4). Press the LESSON button for the next lesson.

If the procedure is done incorrectly, the computer advises the learner to check all of the TAPE buttons and reorients the student to the top portion of the board. Once corrected, the student presses the 'check work' button to continue.

8. *Assessing the Performance*

Formal performance assessments such as percentages and grades were not programmed into this courseware. The reason is that this program is intended for use prior to being introduced to the 8-track studio. The less able student may find the instruction not motivating if s/he were to continually fail or receive poor marks. TAs and the course instructor can adequately give students an appraisal for performances learned. If the teacher wishes to incorporate an assessment section within the *soundboard* program, one can easily be programmed.

9. *Enhancing Retention and Transfer*

To enhance retention and transfer, students, upon completion of the 'assigning signals' lesson, may do the quizzes designed for these purposes. The easy quiz asks students to solve single source routing questions. When students feel they have mastered this quiz, they may move on to the harder quiz, which asks students to solve multiple signal routing problems. These quizzes mimic common signal routing problems that occur during the production of audio within this studio.

Design Principles based on Gropper's Behavioral Approach

The 'assigning signals' lessons and the ensuing quizzes best illustrate the behavioral approach to instructional design. Once the learner finishes the lessons in signal routing, s/he is encouraged to do the quizzes. These quizzes serve the purpose for active practice and reinforcement of signal routing concepts and procedures. Following details the use of behavioral instructional design concepts used in this lesson and its quizzes.

Students learning signal routing concepts and procedures need discrimination of stimuli on two levels. First they must identify that signals can be accessed from any or all of the board's eight input channels. Second, each channel contains four separate components that maneuver the signal to its intended location. Three of these components are relatively the same in size and colour and are only distinguished by their captions; These are the TAPE, 1-2, and 3-4 switches or buttons. Once these two conditions have been classified from one another, generalization can occur.

All eight channels, as mentioned before, contain four components that work in concert to sending signal to a certain destination. Generalization of these components from one channel to the next occurs when students are able to identify its proper function. For example, the 1-2 button serves the same function for every channel. When it is down, signals will be sent to subgroups #1 and #2 from the channel it was activated. This concept is the same for every channel and must be generalized as such by the learner.

Association happens when the student responds appropriately to the generalized concept. The TAPE button allows signal to come from one of two possible sources. Given the student has associated the proper signal to the position of the TAPE button, the learner will be able to assign that signal to wherever s/he wants.

A stimulus-response (S-R) unit is acquired when the learner has discriminated, generalized, and associated a proper response to each of the four components for all eight channels. The lessons designed to teach students signal routing concepts and skills follow a behavioral approach to complete an S-R chain. During the lessons, students are asked to participate in the learning process by demonstrating the procedures they have just learned. The lessons take a step-by-step approach with many cues in the form of computer feedback to ensure learners respond to the relevant stimuli. The lessons are what Gropper (1983) describes as an incrementing technique to mastering an activity.

Once students finish the lessons, they may practice these skills on one of two lessons designed to reinforce their learning. The first lesson asks students basic signal routing problems involving one signal source. Cues are provided, but are not as explicit as the lesson cues. These cues direct the learner to investigate general areas where a mistake has occurred. By cueing only the general area in which a mistake has occurred, problem-solving skills are developed by the student. Shaping describes this technique in which students are expected to meet a criterion standard for signal routing.

When students master the signal routing quizzes, they go through a "fading" phase where cues are made weaker and real-world situations are practiced. This phase can be implemented when the student transfers the knowledge gained from the computer program to the real soundboard. The TA can guide learners through several sessions providing cues similar to the computer's feedback to enable students with the transfer of audio production skills.

Keller's ARCS Model

Attention getting devices are similar to the techniques described under the Gagné-Briggs model of instructional design. One noteworthy example under the *Attention* category is keeping instructional sequences short and intermingling it with interactivity (Keller and Suzuki, 1988). For the most part, all lessons and examples are short and are interactive. If students feel overwhelmed at any point of the instruction, they may choose to leave or move on to another lesson.

Relevance problems are addressed by explaining why certain components and procedures need to be learned. Only concrete language and terms that are familiar to students are used. For example, Figure 4.4 illustrates the relevance of the lesson when the learner first enters the main menu for setting line levels on page 18.

Figure 4.4: *Orienting message for the line level lesson* (Beckhoff, 1997)

Here are seven steps to calibrating the 8-Track recorder and the sound board. Setting your line levels correctly is important because it allows signals to properly flow from one equipment to another without distortion or noise. Slide your mouse over the graphic for more information. Click on the graphic if you want to practice that step.

When students click on a graphic for practice, information explaining the relevance of the step also conforms to Keller and Suzuki's (1988) suggestion to developing goal-oriented behaviour.

Student practice setting line levels and doing signal routing problems in an environment without the pressures of time, peers, and the fear of failure. This practice develops the confidence to do these skills in the real setting. Keller and Suzuki's (1988) prescriptions to foster confidence are exemplified by the following:

- The setting line levels lessons presents seven steps with clear and concise learning objectives to meet the overall goal of calibrating the equipment.
- Performance feedback provides the student with additional information and cues to help maintain motivation and confidence.
- The signal routing quizzes are named "easy" and "hard" to provide challenge levels and to allow students to choose an entry point that best reflects their perceived abilities.
- Indicating the number of lessons and drills help anticipate performance requirements.

Confidence is gained by allowing the student to practice newly acquired skills in a virtual setting. Signal routing skills are practiced in a form of a quiz, where setting line levels are practiced by doing the procedures on a graphical representation of the equipment. Corrective feedback differs during the signal routing "hard" quiz. Its purpose is to give the student reasons why certain problems occur and how to correct them during the recording of a message. This not only exposes students to solving difficulties; it provides production-planning solutions to avoid potential problems.

Prescriptions for Designing Textual Information

Because comprehension of text is lower and slower than when reading from a computer screen, all textual information was reduced to its most singular and shortest element. Information was chunked into text boxes that were placed in one of three areas of the screen depending on the nature of the graphic. These boxes were all coloured pale yellow to help the student identify the location of text information. All fonts were the same, aligned left within the message box, and were black. Textual information carefully reflected the graphics they sought to explain to help reduce possible cognitive overload in the user.

Where elaboration was needed, students have the option to further explore the soundboard by going deeper into the instruction. For example when the student explores the 1-2 button, the message box displays only the most basic information: "The 1-2 button tells the signal to which subgroup it is supposed to go. It is used with the

PANPOT. Click on this button to learn about signal routing" (Beckhoff, 1997). By clicking the button, the user goes to the signal routing lesson on page #11, where the 1-2 button's function is further elaborated upon with a practical element.

Prescriptions for employing Graphics

I chose not to animate bitmapped pictures of the soundboard as realistic portrayals may take away from the instruction. All graphics were designed for the purpose of illustrating a function as accurately as possible by showing only those attributes that were needed. I omitted details such as 3-dimension and depth, the angled part of the board housing the VU meters, exact colours, and exact dimensions. When needed, I omitted recreating parts of the board during lessons to help students focus on the relevant components.

Utilizing these prescriptions for the design of graphics conforms to Merrill and Bunderson's list of guidelines for employing graphics according to Gagné's domains of learned capabilities. For example, students are able to manipulate buttons as required until precision of certain procedures is mastered. The ability to perform these without time limits enables students to practice motor skills with the graphics.

CHAPTER FIVE
Description of Toolbook II Publisher and the *Soundboard Program*

There are many multi-media authoring programs on the market. They accomplish the same goals in that they can combine graphics, sounds, video, pictures and text into a multimedia package. Some of the more notable multi-media authoring software packages are *Asymetrix Toolbook*, *Macromedia Director*, and *Adobe Acrobat*. I chose *Toolbook* because it was available, I had access to technical support, and because it was relatively easy to use.

During the analysis stage, the instructional designer assesses a client's learning environment and suggests the instruction's medium for delivery. This is based on the availability and utility of the teaching resources at hand (Smith and Ragan, 1993). At the University of Windsor, *Toolbook* is used by both the Communication Studies program and the Division of Instructional Development (D.I.D.) to create computer-assisted instruction. This access to *Toolbook* appeared advantageous because:

a) the soundboard program can be updated by staff and teachers when new knowledge needs to be integrated;

b) Bugs and other technical malfunctions can be remedied more easily because of the availability of knowledgeable staff when I move on;

c) D.I.D. staff was available for solving design and script anomalies when *Toolbook*'s help menu were not of use to me.

Asymetrix Toolbook II Publisher: How it works

The software itself was fairly easy to comprehend but difficult to master. *Toolbook* uses the metaphor of a "book" to help with the conceptualization and development of a multi-mediated unit. There are two user levels. The 'reader' level is for the user of the unit whereas the 'author' level allows for the unit's modification. The easy transition between these two levels facilitates the experimentation of ideas and concept development.

A book comprises of 'pages' which present and control the instruction. Pages are divided into segments called the background and the foreground. The background serves as a storage unit for information that frequently repeats itself from page to page like standardized navigation buttons, redundant lesson headings and background colours. The foreground contains the information or 'objects' unique to that page. Objects can be made of text, sound, graphics, and video.

The designer can animate graphics, link information, or create hotwords by writing codes or scripts for the object. Scriptwriting is further facilitated by the use of plain language. For example, if one wanted to define a cassette-recorder's 'play' button, a 'pop up' explanation of its function could be created with script similar to Figure 5.1.

Figure 5.1: *Example of a script to create a 'pop-up' message box.*

Script	**Description**
to handle mouseEnter	← when the mouse pointer enters this graphic
show field "playbutton"	← show (pop-up) the object with text named "playbutton"
forward	← send this information to the processor
end	← this command is finished
to handle mouseLeave	← when the mouse pointer leaves this graphic
hide field "playbutton"	← hide the object with text named "playbutton"
forward	← send this information to the processor
end	← this command is finished

Although this example serves to elucidate the ease at which scripting can accomplish tasks and manipulate, it is not an indicator of how powerful the software can be to create instruction.

Toolbook Publisher can create instruction that simulates interaction with the user. This is accomplished by using what *Toolbook* calls system variables. A 'system' variable can be declared true or false and it causes *Toolbook* to react a certain way. To illustrate this point, I will use an example of a person encountering a flat wooden surface for the first time.

If this person sees this surface as a chair, they will use it to sit on. If they see it as a bed, they will use it to lie on. Declaring beforehand how the person will react to the surface is similar to how *Toolbook* determines its system variables will be used.

Another useful technique for creating simulated interaction is the use of 'system real' variables. These variables are similar to lists that are dependent on numbers. The author of a program can create these numbered variables to anticipate many possible behaviours and actions. When the program user makes a selection from a range of choices, the picked variable can be made to control the program.

Much of the feedback that is programmed into the instruction was made possible by 'system' and 'system real' variables. For example, the computer was programmed to randomly pick 'system real' dependent questions so those students working side-by side had less of a chance of working on the same question. Five 'system' variables were devised to analyze the status of four components needed to correctly assign a signal. Some of these were further dependent on 'system real' variables that told the system variables which position they were in. If one of the variables did not match the correct status for the question, the computer would advise the student to check a certain part of the virtual board.

A Description of the Soundboard Program

Twenty-two pages make up the book. The purpose of this description is to give the reader a general overview of what comprises the instruction. For an in-depth look into the soundboard program, please refer to the appended CD-ROM. To facilitate comprehension, I have listed some of the more common terminology used in the *soundboard program*.

- **Input section**: This section of the soundboard receives signals.
- **Subgroup section**: This section of the soundboard groups signals together from the input section. It sends signal to the 8-track recorder and to the master section.
- **Master section**: This section of the soundboard sends signals to the master recorders. A master tape is the final product once a recording is finished.
- **Panpot**: Short for a 'panning potentiometer,' a panpot positions the signal. It is similar in function to a home stereo's balance knob.
- **VU meter**: A voltage unit meter allows the recording engineer to monitor the signal's strength.
- **Fader**: A fader allows the recording engineer to fine-tune a signal's strength. It moves up and down.
- **Knob**: A knob's function is to increase or decrease a signal's strength. Some are specially equipped with filters that allow an audio engineer to increase or decrease parts of a signal's frequencies.
- **Button**: A button is a switch. Usually when it is up, a button is OFF. When it is down, a button is ON. The exception is the soundboard's TAPE buttons. When the TAPE button is down, it allows a signal to pass from the 8-track recorder. When it is up, another signal will pass depending on which source it is hooked up to.

Page 1: Demonstrating how to use the mouse

This page shows the user how the mouse can be used for the ensuing lessons. Some of these lessons require different mouse movements to activate an object's animations, illustrations and text. In total there are five demonstrations. The text box at the center of the screen displays the necessary instruction. These procedures are dependent on which lesson is activated. The background is white. Two link buttons allow the user to exit or to go to page 2.

Page 2: The three main parts of the soundboard

This page consists of a simple graphical representation of the soundboard. It highlights the board's three main parts. Each is colour-coded into one of three shades of gray. A banner at the top right hand corner names the soundboard as a Yamaha 842 mixing board.

A message appears describing what to do with this page. When students move the mouse pointer into the areas a message generally describes the section's function. Each message ends with a prompt to click the section they wish to learn more about. The dark gray section is linked to page 5, which describes an input channel's function. The medium gray are is linked to the subgroup section found on page 3. The final light gray are is linked to the master section, which is located on page 4.

The background is white. Two navigation buttons allow the user to exit the program or go to the yet to be designed "G140" page.

Page 3: The subgroup section

The graphic in this page is similar to the one found on page 2 but has the middle subgroup section blown-up into a 3-D like graphic. A red and blue message at the bottom left of the page informs the learner to: "Slide Mouse over the SUBGROUP for definitions. Click on parts of the SUBGROUP for functions and practice." The banner on the top-right hand portion of the page identifies this part of the soundboard. A message box is located on the right of the page.

Sliding the mouse over the blown-up components reveal a message in the box. This message is limited to no more than 4-6 short sentences describing the object's function. Sliding the mouse over another component clears the message box and displays a new one. To assist the user with finding relevant objects in the subgroup, the mouse pointer turns into a hand.

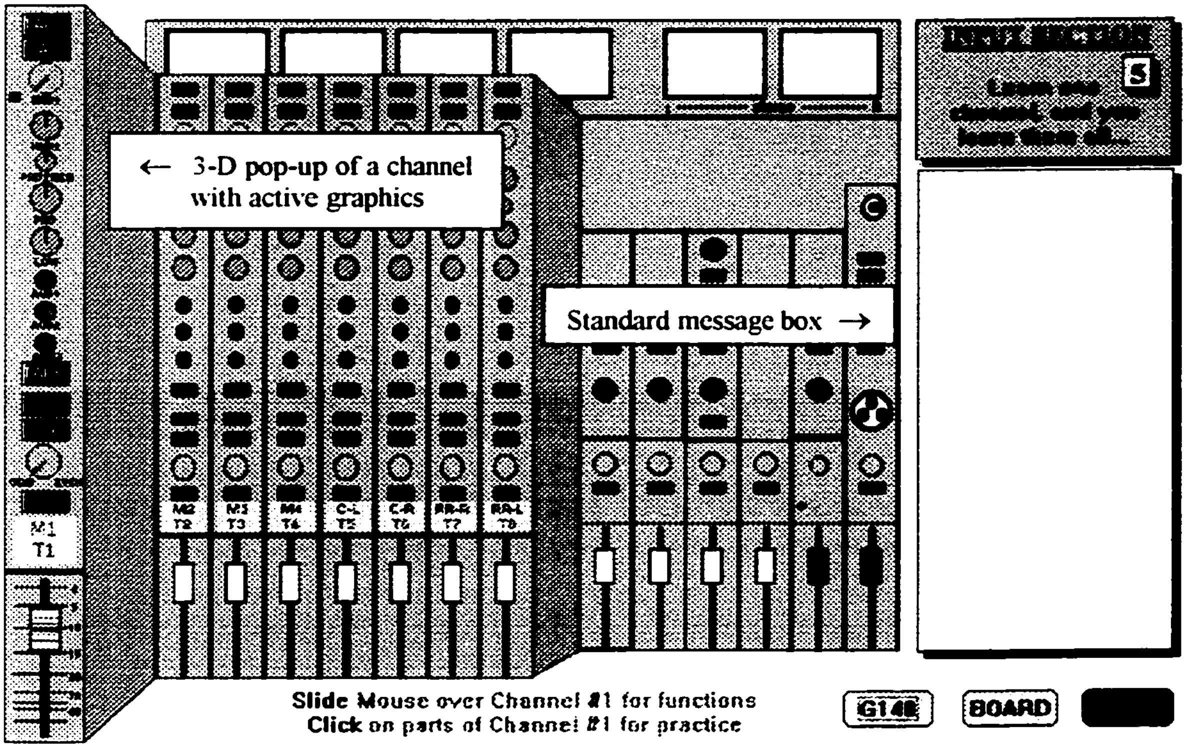
The four subgroup-faders are linked to page 18: setting line levels. Three buttons are located on the bottom right corner of the page. The "G140" and exit buttons are identical to the previous page. The 'board' button is used to allow the learner to go back to page 2.

Page 4: Master output section

This page uses the same graphic as page 2 but has the master output section blown-up into a simulated 3-D effect. A banner at the top-right corner names the section. A message box occupies the approximate place to previous pages. A message at the bottom-left corner explains how to use the page: "Slide Mouse over the MASTER SECTION for definitions. Click on parts of the MASTER SECTION for functions and practice."

Navigating and obtaining pertinent information is similar to that of the previous page. Text follows the same structure. No links illustrate the master section's functions. The master section page only declares information. Navigation buttons are the same as its subgroup counterpart.

Figure 5.2: *The soundboard program's input section page* (Beckhoff, 1997)



Page 5: Input section

This page (see Figure 5.2) uses the same graphic as page 2 but has one channel of the eight that comprise the input section popped-up. A banner at the top-right corner names the channel and has the subheading "learn one channel, and you learn them all." The message explaining how to use the page is in the bottom center of the page.

Navigating and obtaining pertinent information is similar to the previous sections except for only the 3-D pop-up is active. The reason is that all eight channels from the board's input section have the same functions. Only the channel labels differ and are identified by their accurate connection.

When the user slides the mouse over some of the channel's parts, arrows point to illustrate secondary information the message may be referring to. Otherwise, navigation and obtaining information is similar to previous pages. Links elaborating some of the input channel's many functions can be activated by clicking on the graphics. There are four such links.

The 1-2 and 3-4 buttons link to page 12 that teaches students how assign signals. The panpot graphic links to page 6. This page demonstrates to students how this board's feature works. All four equalizer knobs link to page #7 to teach students how to manipulate frequencies. The TAPE button links to page #8 to show how to use this button in relation to the gain knob. The AUX buttons link to page #9 to assist students with using this feature.

Page 6: The panpot section

One can only access this page by clicking the panpot graphic on page 5. It comprises of a more detailed and blown up graphic of the panpot section. A graphic at the top of the page represents the VU meters. Depending on which assignment button is pressed the perceptual cues of these meters change.

A message box gives students information of the panpot's function and tells them how to use the page. Students are to slide the mouse pointer around the panpot. This activates a series of simple animations to convey how sound can be positioned with this pot. The animations are dependent on an assignment button being pressed. If the student attempts to move the panpot, a message pops up asking students to press an assignment button. If a student presses the CUE button, a message pops up describing its function.

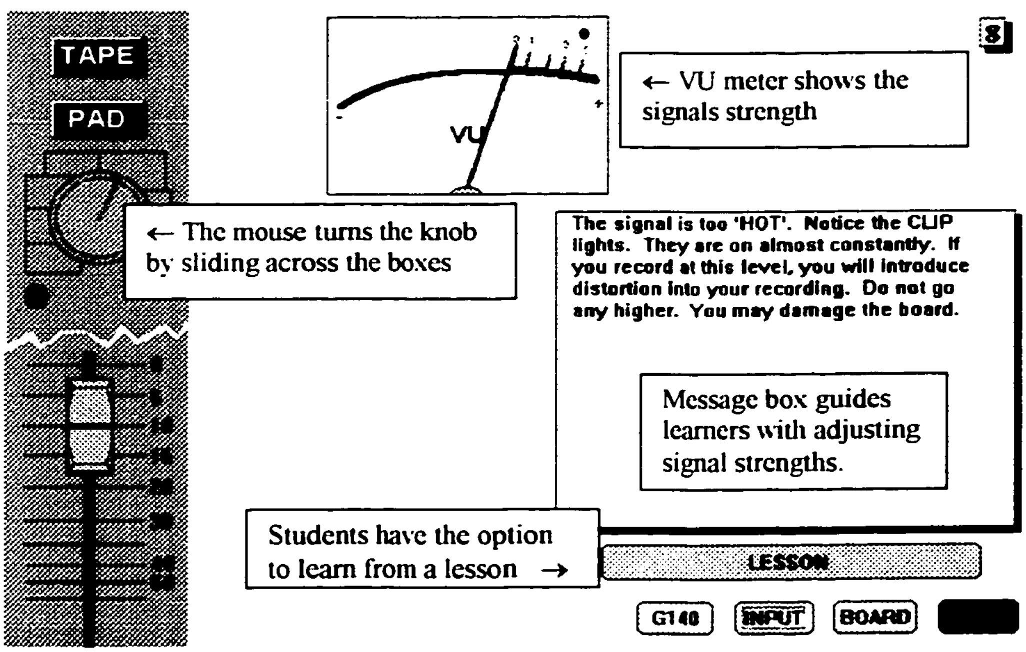
A fourth navigation button labeled "input" complements the three that have been present in the previous pages. Its purpose is to send students back to the input section once they have used the instruction.

Page 7: Equalizers

Clicking one of four green equalizer knobs found on page 5 accesses this unfinished page. Its purpose is to demonstrate how the equalizers work. This is one of the pages that are dependent on sound to best demonstrate its utility.

Four navigation buttons identical in function to page 6 are located at the bottom. A message box positioned to the right of the page conveys most of the information pertinent to using the instruction. A message at the top of the page pops up upon entering the page. It asks students to remember these knobs' positions as they may affect the setting of line levels. Students need to click on this message in order to make it disappear. When it does, a banner stating "the equalizer section" becomes prominent and identifies the page.

Figure 5.3: *The TAPE button and gain knob page* (Beckhoff, 1997)



Page 8: The TAPE button and gain knob

Clicking the TAPE button or the GAIN knob on page 5 accesses this page. Its purpose is to teach students how to use these two components in conjunction with one another (see Figure 5.3). Although the instruction is not dependent on sound, this media will be added to enhance learning.

Only parts of the channel that are relevant to adjusting signal strength are shown on this page. The message box states that students have a choice in learning the procedures to adjusting a signal's strength. The first involves a step-by-step lesson describing the process. The other method allows students to explore and determine the proper procedure.

With the latter procedure, I programmed system variables to ensure certain steps were taken before activating the gain knob. Pop-up messages advising students what steps to do. When students finally access the gain knob, a series of animations show them how to read the VU meter. Students read the message box for guidance. If a student turns the gain knob too far, an animation depicting the VU meter exploding occurs. To illustrate the PAD buttons function, graphics representing the CD player, cassette player and the reel-to-reel recorder pop-up to assist students. Navigation buttons are similar to the previous three pages.

Page 9: The auxiliary knobs

This page depends on sound to successfully demonstrate these components. Access to this page comes from clicking the AUX knobs on page 5. Navigation buttons are similar to the previous four pages.

Page 10: Easy signal routing quiz

The learner accesses this page by clicking the 'easy quiz' buttons located on pages 11 and 12. The graphical interface is the same as the next two pages (see figure 5.4). It comprises of the necessary components to assign signals. These include the TAPE buttons, the 1-2 and 3-4 buttons, labels and panpots for all eight input channels. The message box is located where the equalizers and AUX knobs would normally be. Faders, PAD buttons, CUE buttons and GAIN knobs are present to assist learners with transferring their learning.

To use the instruction, students need to press the 'start' button in order to activate the instruction. The computer randomly picks one of 35 questions seeking the procedure required to do a single source routing problem. These 35 questions almost comprise every possible routing procedure for a single source.

When students think they have accomplished the task demanded of them, they press the 'check work' button for the next question. If it is correct, a pop-up message congratulates them. If the procedure is wrong, a message counsels learners to check a key area of the board to correct the procedure. The computer analyzes four areas: the TAPE button row, the 1-2 button row, the 3-4 button row, and the positioning of the required panpot.

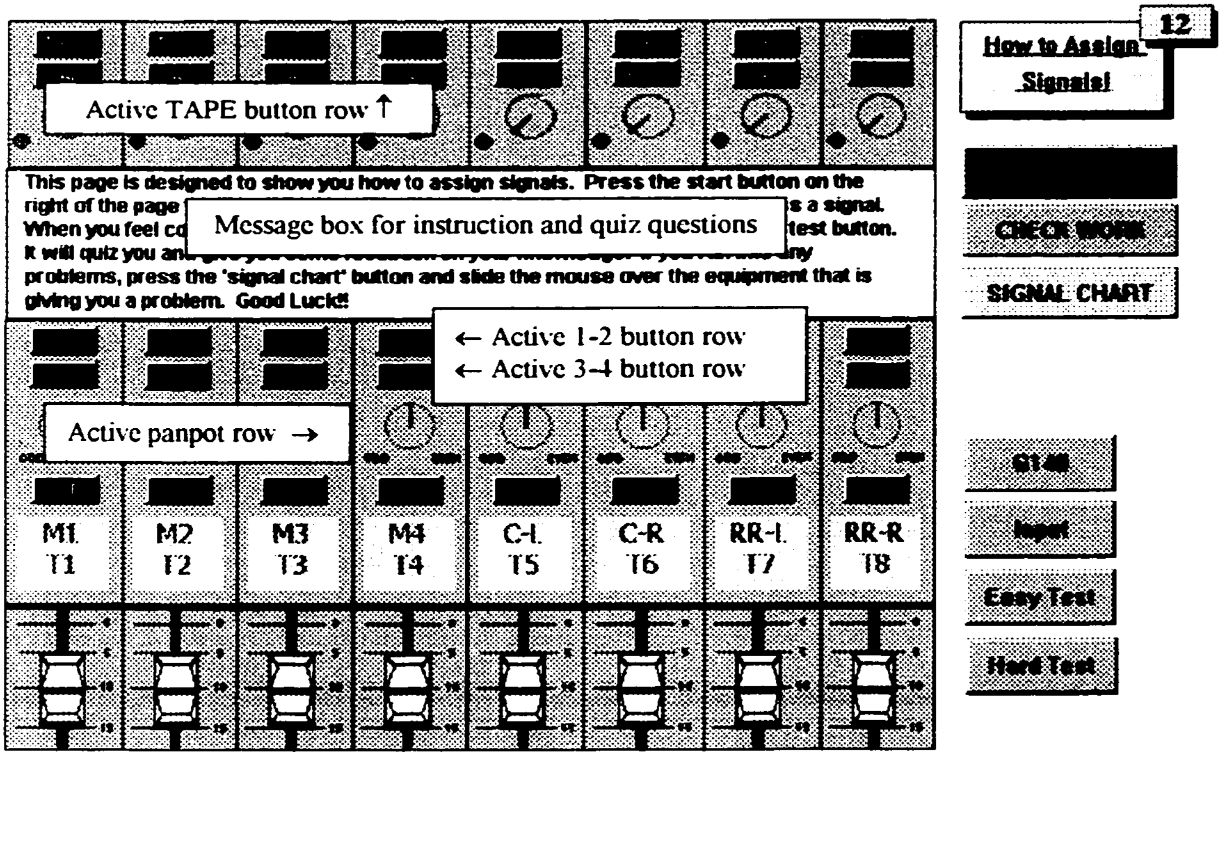
To assist students with signal routing problems, a 'signal chart' button links to a page designed to help students with signal flow. Navigation between these two pages does not turn page 10 to its default status. This allows students access to guidance without interrupting their position within the quiz.

Two extra navigation buttons complement the four standard buttons found in previous pages. These link students to the 'harder quiz' when this one no longer challenges them, and to the 'assigning signals' lesson page if they need to reinforce the learning.

Page 11: Hard signal routing quiz

The learner accesses this page by clicking a 'hard quiz' button located on pages 10 and 12. Its graphical interface is the same as these two pages. The random questions asked by the computer include typical multi-signal source problems that a student may encounter. Thirty-two questions comprise this quiz. Feedback and interaction are the same as described in page 10. Navigation buttons include access to the 'easy quiz' if a student feels they have not yet mastered these procedures.

Figure 5.4: *Computer-user graphic interface for pages 10, 11, and 12* (Beckhoff, 1997).



Page 12: Assigning signals lesson

This page's graphical interface and navigation buttons are similar to the previous two pages except for access to both hard and easy quizzes. Fourteen small lessons comprise the instruction. This stepped method helps students with navigating and using this page as well as learning how to assign signals.

Computer feedback within these lessons are more specific than the previous two quizzes. The reason lies with my ability to predict mistakes because the assignments are linearly presented and elaborated upon. The computer can therefore give more accurate feedback and specify where the student made the mistake.

Page 13: The eight-track recorder

Students could not access this page. Parts of this graphic were scavenged to help design other pages. When the soundboard program expands to include other audio components, this graphic could fulfill a similar function to page 2.

Page 14: Step #1 for setting line levels

This page features the front panel of the eight-track recorder. Students read a message within a box similar in style to previous pages and follow the instructions. All pertinent buttons and knobs are active and simulate movement to assist with learning.

A side view of the eight-track panel assists those students who may find this page confusing or who may lack depth perception. By sliding the mouse pointer onto a switch activates a label within the side view graphic to help with identification. When a switch clicks into a new position, the side view graphic mimics the movement. The bottom row has three positions whereas the top has two. This side view graphic will also be helpful for future instruction concerning the functions of this equipment.

Access to this page comes from page 18. Two buttons complete student's options for navigation. A 'go back' button allows students to jump back to page 18 which describes in brief all the steps to setting line levels. A 'step #2' button allows students to proceed to the next step.

Page 15: Loading the tape

Access to this page comes from the checklist on page 22. It comprises of two graphics depicting different angles of the eight-track recorder's transport section. A 'load tape' button is located near the center of the page.

When this button is pressed, an animation shows the user how to load tape onto this particular recorder. The side view and the birds-eye view complement each other and complete the instruction. Students may press this button a number of times. The 'checklist' button allows the user to go back to the checklist page. It is also the only navigation button on this page.

Page 16: Step #2 for setting line levels

This page shows the top panel, which comprises the eight-track recorder's VU meters. A message box similar in design and function to previous pages centers the page. Learners read the instruction and do the procedures required in this step to setting line levels.

Three navigation buttons are present. One allows the student to go back to step #1. Another gives access to step #3. The third button accesses the main page that briefly describes all the steps to setting line levels.

The instruction states that students are required to set signal strength of this equipment. Learners click into position the VU meter's needle until it reaches "0". Given they go over, a series of animations humorously depict the consequences of this action. In total, there are three animations.

The first animation shows a reel of tape going into a toaster and coming out burnt. A message pops up and states that the tape will be toast if one incorrectly sets the line levels. The second shows a reel of tape bouncing into a blue recycling box. The accompanying message states that you might as well throw the reel in the garbage if the levels are not set correctly. The third animation shows a reel of tape spinning in the air. A jet fighter swoops down and launches a missile at the reel of tape. It explodes. The message that follows states that the reel of tape will only be good for target practice if the signal strength is incorrectly set.

Page 17: The signal chart

Pages 10, 11, and 12, which deal with assigning signals, access this page. Two navigation buttons are present. A 'back' button goes back to the page from which the signal chart was accessed. The exit button allows student to leave the instruction. A message at the bottom of the page advises students how to use the instruction.

The top of the page includes graphic depictions of equipment that is plugged into the TAPE UP portion of the board. By moving the mouse pointer over these graphics, arrows pop-up and show the signal flow from the equipment to the board. A message box describes how to access this audio equipment from the board.

To the right side of the page, the eight-track recorder's VU meters sit on top of gray boxes that simulate the shape of the recorder. Messages inside the boxes state how the recorder connects to the soundboard. It also mentions how the subgroups connect to the eight-track recorder. By sliding the mouse over the VU meters, two arrows show the signal flow from and to the recorder. A label identifying the VU meters sits above the VU meter graphic.

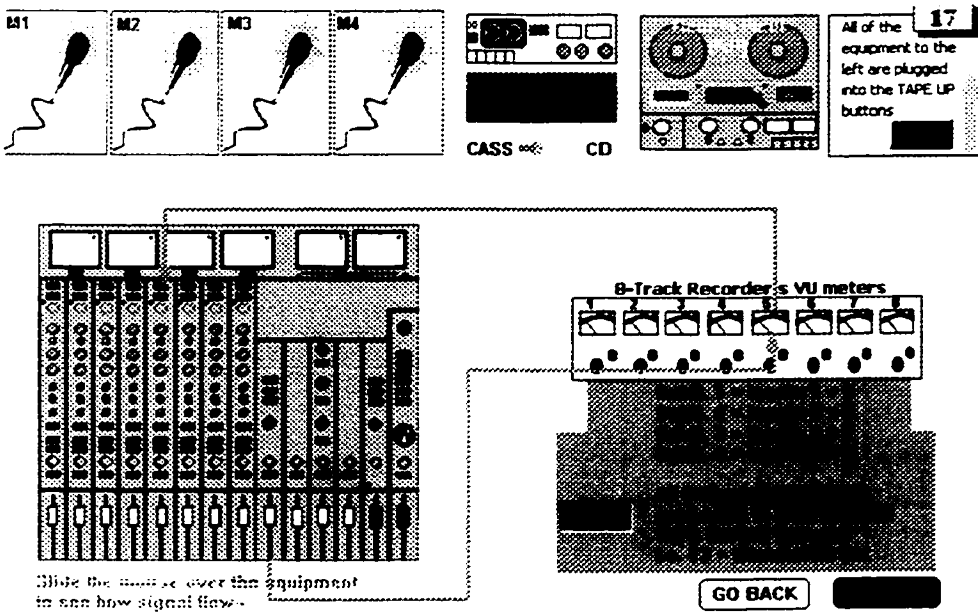
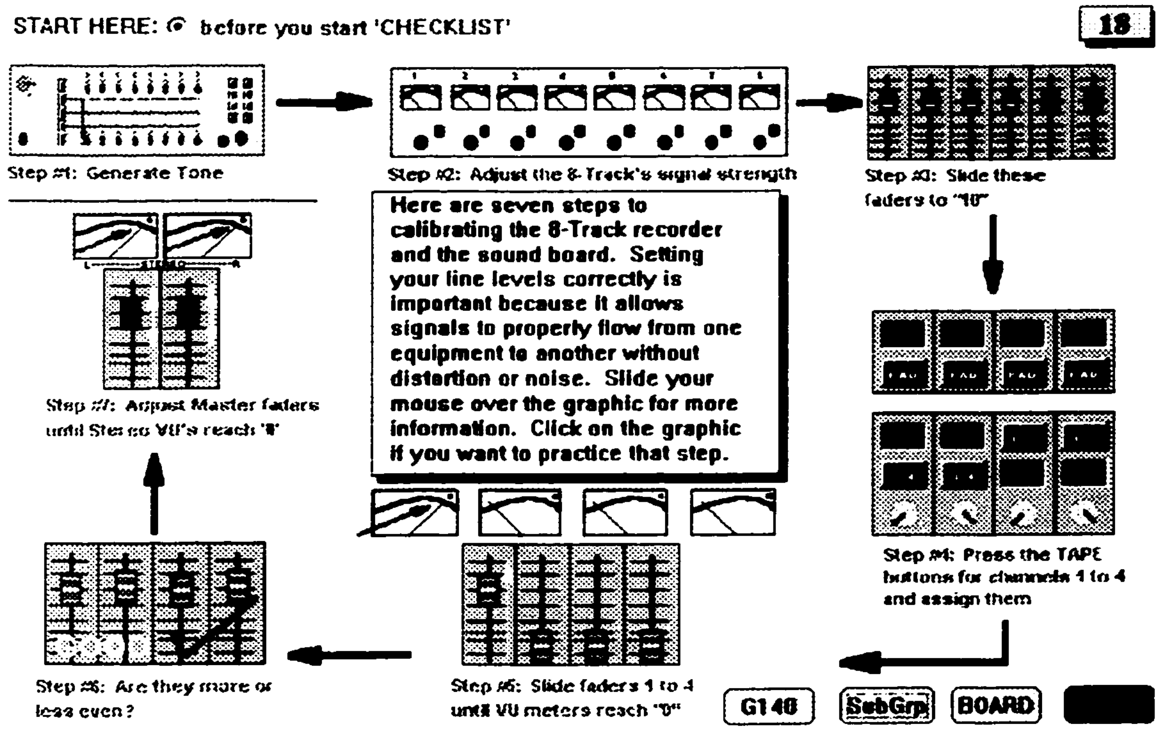


Figure 5.5: *The signal chart. Students can slide the mouse pointer over these graphics to see how signal flows. In this instance, Subgroup #1 flows to track #5. This signal then goes to Channel #5.* (Beckhoff, 1997)

The bottom left side of this page shows a graphic representing the soundboard. When the mouse pointer enters the input section, it shows the possible signal flow from both TAPE-UP and TAPE-DOWN sources. When the mouse pointer goes over the subgroup section, it shows where the signal can be assigned to the eight-track. The master section shows the signal flowing to the master recorder.

The real studio has two pieces of audio equipment sharing parts of the board. A switch in the studio determines which equipment will send signal. To mimic this condition, I programmed a message to pop-up when the wrong equipment is selected. To change this, students must click on a switch.

Figure 5.6: *Main page for setting line levels* (Beckhoff, 1997)



Page 18: Main page for setting line levels

Clicking the subgroup faders on page 3 accesses this page. Four buttons allow students to navigate back to the subgroup page, exit, go to the main soundboard page, and to the yet to be designed "G140" page. A message box centers the page and describes to learners how to use the instruction.

Seven graphics depicting the steps to setting line levels circle this box. When the mouse pointer slides over a graphic, the message box describes in brief the step. By clicking the graphic, the user can access a page that allows the student to practice that step.

A checklist banner sits atop step #1. Its purpose is to give students a list of conditions the board must be in before starting the line level procedures. Clicking this banner sends the student to page 22 for these settings.

Page 19: Step #3 for setting line levels

Clicking the step #3 graphic on page 18 and clicking the 'step #3' button on page 16 accesses this page. Upon entering the page, a series of number "10" pop-up randomly. A message then appears in the message box explaining the pertinence of this number. Students click on the subgroup and master faders to bring them to this level. Channel faders were also included to help discriminate between these faders. If learners mistakenly click on a channel fader, a pop-up message tells them of their error. Buttons for navigation include a step #2; a step#4 and a 'go back' button which will send them to the main line-level page.

Page 20: Step #4 for setting line levels

Clicking the step #4 graphic on page 18 and clicking the 'step #3' button on page 19 accesses this page. A graphic depicting the first four channels of the soundboard takes up the left side of the page. The instruction rests inside a message box on the right side. This page is programmed to provide feedback if the instruction is not followed properly. It also will not allow a student to leave the page if it is incorrect. Three navigation buttons allowing the student to proceed or review steps complement the standard 'go back' button.

Page 21: Step #5 for setting line levels

Clicking the step #5 graphic on page 18 and clicking the 'step #5' button on page 20 accesses this page. A message box similar to previous pages contain the information needed to perform this procedure. Animations showing the VU meters going to their correct position are activated when the faders are clicked. Only two navigation buttons are present. One allows students to review step #4, while the other sends students back to the main page for the final two procedures in setting line levels.

Page 22: Checklist

Only by clicking a banner found on page 18, can one access this page. Its purpose is to reveal certain conditions the soundboard must be in before setting line levels. Three simple messages state these conditions. Each have a a radio button with the word 'example' beside it to show these states. The first two buttons pop-up a graphic depicting the condition. A 'hide me' label allows the user to click and hide the graphic. The third radio button send the learner to page 15 which demonstrates the proper way to loading the tape. One navigation button sends the student back to the main line level page.

Summary

Asymetrix Toolbook II Publisher's worth lies in the ability to create interactive instruction without the need for advanced programming skills. Designing graphics also seem to be user friendly. All tools inherent to the program enable the instructional designer to create these with some effort.

One drawback is the lack of a comprehensive textbook to use as a guide. This makes the program fairly difficult to master. While it is easy to create presentations similar to *Microsoft PowerPoint*, it requires a lot of patience, time, and preparation to create interactive instruction. I recommend to those considering the program to have access to a good resource person or to enroll themselves in a course that can help them develop the necessary skills to accomplish their design objectives.

CHAPTER SIX
Evaluation Method

The evaluation method conforms to Smith and Ragan's (1993) procedures for a formative evaluation. This process specifies three stages: the expert review, the one-on-one evaluation, and the group evaluation. Its purpose is to uncover design weaknesses and pedagogically weak material within the instruction. A trial study is included in this chapter as it influenced the design of the program and its evaluation.

Pre-Student Evaluation Activities

Trial Study

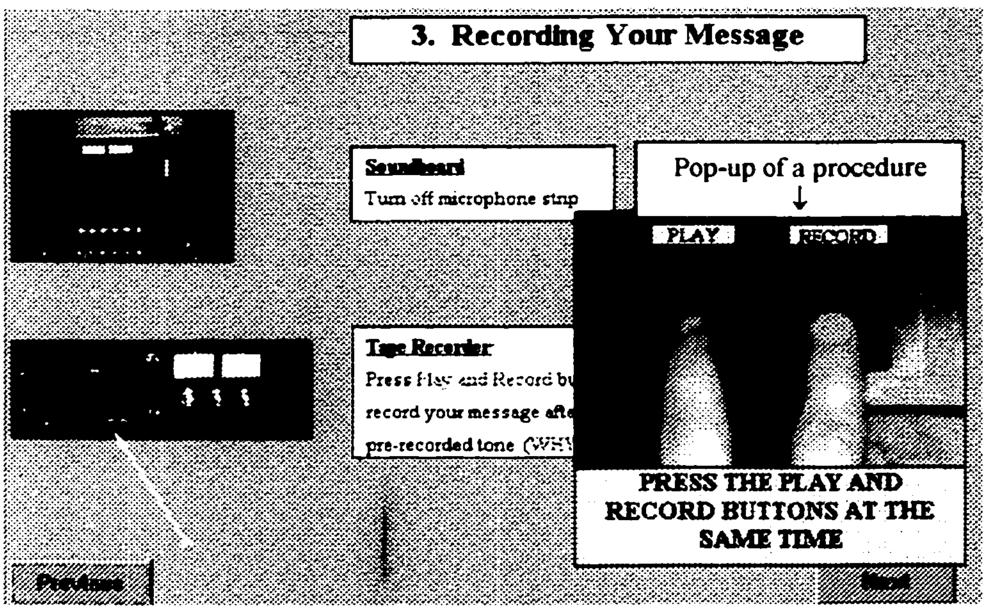
Prior to the development of the interactive *soundboard program*, I was asked to lead a workshop for a first year Communication Studies survey course. The purpose was to introduce basic methods in audio recording and to stimulate interest in the study of communications. I used this opportunity to learn *Asymetrix Toolbook* on which the *soundboard program* was created, to try out design principles, and to experiment with a possible program and courseware evaluation design.

The computer based learning program showed students how to record a simple message in one of the Division for Instructional Development's (D.I.D.) dubbing studios using digitized black and white photographs and text. The instruction also taught basic recording concepts and terminology commonly used in a recording studio. Fifteen students participated in the workshop.

A questionnaire was given prior to and after the program. The introductory questionnaire was designed to inquire about the participants' computer knowledge and how they felt about computer-assisted instruction (CAI). The second questionnaire reexamined student's feelings about CAI after their experience with the instruction.

Students were free to leave when they felt they learned the required tasks. Time slots for demonstrating learned skills were given on the basis of availability. These ranged from 2 days to 4 days after being introduced to the instruction. Most students recorded their messages in small groups because of time constraints. They were assisted by an instruction sheet that told them the steps to recording a message, but without the pictures provided by the instruction. The average amount of time a student spent with the program was 45 minutes. The average amount of time to record a message was approximately 50 minutes. Students recorded their messages with the aid of a sheet that assisted them with the steps.

Figure 6.1: *Example of a page in the recording lesson program* (Beckhoff, 1997) *made for the trial study. Students found the pop-ups jarring and the instruction boring.*



This study concluded that students did not fear computerized instruction. This conformed to Welsh's (1993) argument that "pre-post studies of student's attitudes towards computers before and after the use of CAI indicate that students have favorable attitudes and usually endorse CAI after the computer has been introduced" (pp.221). The trial study also demonstrated that an illustrated manual would have probably achieved the same results as the computer-program. The reason is the computer program was supplantive in nature and did not have an active component to it. Most mentioned they were frustrated by the instruction because there was nothing to do. Some mentioned they found pop-up text boxes to be jarring and the language to be too confusing.

Based on these results, I decided to limit the instruction to information that would be needed about the recording studio where students could record. Testing of students would be standardized so that results would be more conclusive. When students were to be tested, they would do so without written assistance. Students' fear of computers would also not be investigated.

Expert Review

The expert review of the instruction involved three individuals familiar with the content found in the *soundboard program.* Two were teaching assistants (TA) for the Sound in Media course. The other was the instructor for the same course. The latter was also an expert in the field of instructional and message design. All reviews were done qualitatively.

After the completion of the *soundboard program*'s first draft both TAs were asked to use the program and submit a brief report outlining their critique. One TA focused primarily on design issues such as navigation whereas the other examined content.

The instructor reviewed the program during the production phase of the instruction. Most of the critique was verbal and focused on applying principles of instructional design and message design.

Evaluation Procedure

Two separate evaluations of the instruction were organized during the 1997-98 school year at the University of Windsor. All students who volunteered for these were enrolled in the Communication Studies 101 survey course (40-101) because they did not have extensive prior knowledge with sound recording equipment. This lack of experience greatly improves the chances of uncovering erroneous instruction and weak design features. An extensive analysis of these volunteers follows the description of the evaluation procedure.

Group Evaluation

The small group evaluation took place during the fall semester. Its purpose was to imitate the conditions under which the instruction was to take place. A workshop was designed to teach 40-101 students rudimentary sound recording procedures over five one-hour sessions within a two-week period. One group of seven and one group of eight students participated.

The first two workshop sessions demonstrated basic sound production concepts and procedures. These sessions were taught in D.I.D.'s dubbing studios to maintain student's unfamiliarity with the equipment found in the 8-track room. This procedure paralleled the traditional routine of presenting recording methods and concepts when enrolled in *Sound in Media*; students enrolled in this course first master skills in these studios before utilizing the 8-track room's equipment.

The CAI program was introduced on the third session. Participants from both groups were combined for this session. Students were asked to fill out a questionnaire prior to using the instruction. It asked questions about the participant's prior experience with sound recording and whether they had worked in the 8-track room. It also asked about students' use of the computer in everyday situations. I acted as a resource person during this session, assisting students with navigational problems and guiding them through the content. When students felt they had learned the tasks, they wrote down what they liked and disliked about the program.

Two days later, the group was tested using two tests. One test focused on signal routing, and the other focused on setting line levels. These tests were created from the information found in the instruction. Since these volunteers were originally split into two groups for the workshops, the first group did the signal routing test on the actual equipment while writing the line level quiz as a paper-and-pencil test. The second group did the reverse doing signal routing as a pencil-and-paper test and setting line levels on the actual equipment. All questions were identical for both groups whether they worked on the actual equipment or not. The same tests were later administered to the one-on-one participants. The paper-and-pencil test contained the same graphics found in the instruction without the headings and other textual information. A detailed analysis of these tests follows the description of the one-on-one evaluation.

1-on-1 Evaluation

The one-on-one evaluation was conducted in the winter semester of the 1997-98 term. Volunteers for this phase of the CAI program's evaluation came from another 40-101 class offered by the department. Interested students were told in class to expect to spend at least 1 hour of their time on the program.

Students filled out the same questionnaires given to the group participants. Prior to using the program, I gave a short lesson about stereophonic and monophonic sound because most students had no prior knowledge of these concepts. This lesson also demonstrated how signals are recorded to tracks on audiotape.

During their use of the program, I took detailed notes on which parts of the instruction were unclear and where navigational problems arose. When the student finished, she or he was asked to give general impressions of what they liked and disliked about the CAI program.

Testing of their knowledge followed the same routine and the same tests as the group. Both paper-and-pencil tests and equipment testing were alternated for all one-on-one participants. Where one participant would write a signal-routing test and set the line levels on the equipment, the next volunteer would do the opposite. These tests were done two days after the program use to ensure that they could be compared to the group testing results.

Tests

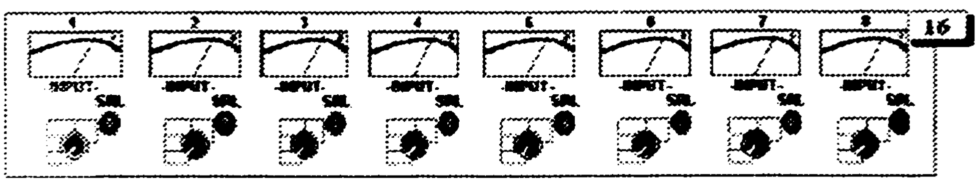
Both tests administered to students were designed to test retention, understanding, and ability to use the information found in the CAI program. The purpose was to help uncover weaknesses within the program and to see whether the instruction teaches successfully.

Line Level Test

The line level test consisted of seven procedures performed by an audio engineer familiar with the 8-track equipment. To create the paper-and-pencil, I photocopied the graphics from all seven procedures of the computerized instruction and excised the written information including all headings. Students were asked to recall the information in the program. They were told not to worry about correct terminology and they could use arrows and other attention focusing techniques if needed.

The line level test on the real equipment followed the same seven steps (see Appendix E). All students participating in this test version were shown the photocopied graphics prior to manipulating the real equipment, because none remembered where to begin when they entered the studio. Correct terminologies were not required. If needed, the steps were corrected when the student felt the procedure was finished, because each step was dependent on the other in order for the equipment function properly.

Figure 6.2: *Photocopied graphic of Step #2 for the line level test*



STEP #2: 8-Track Top Panel

What would you do with this step? (Describe in your own words)

Table 6.1 is a brief description of the steps required to setting line levels for this particular studio. In order to receive full-marks, students were expected to follow these procedures. I have intentionally omitted technical jargon and the functionality of each step to give a better understanding of what processes needed to be demonstrated.

Table 6.1: *A description of the procedures involved with setting line levels*

Step #1:
Purpose: To generate a 1 kHz tone from the 8-track recorder.
Procedure: Turn the appropriate knob to 1kHz
Press the individual button
Flick the bottom row switches to INPUT
Flick the top row switches to READY

Step #2:
Purpose: To calibrate the 8-track's input and output strengths.
Procedure: Press all 8 SRL buttons to black
Turn track #1's gain knob until VU #1 reads "0"
Repeat for the remaining seven tracks

Step #3:
Purpose: Setting the soundboard's subgroup faders and master faders.
Procedure: Slide up all four subgroups until they reach to exactly "10" on each fader's ruler.
Slide the master faders until they are approximately at "10.

Step #4:
Purpose: Setting up the board to receive the 1kHz signal from the 8-track recorder.
Procedure: Press the appropriate tape buttons (channels 1 through 4)
Press the appropriate assign buttons (channels 1 through 4)
Turn the panpots to the appropriate setting (channels 1 through 4)

Step #5:
Purpose: Adjust the subgroup's input strength.
Procedure: Slide channel #1's fader until subgroup#1 reaches "0."
Repeat for channel's 2 through 4.

Step #6:
Purpose: What could cause the channel faders to be uneven?
Response: Equalizers are activated thereby skewing the 8-track's signal strength.

Step #7:
Purpose: Adjust the soundboard's signal output.
Procedure: Adjust both master faders until both master VU meters read "0"

Table 6.2 shows how each question was broken down for evaluation, and where the information was located in the CAI program. I included the Gagné's (1977) skill acquisition type for each question to help explain the possible complexity for gaining these skills. All questions for both small group and one-on-one line level tests were weighted equally when calculating the overall averages. To achieve 100%, all seven questions must be answered correctly in their entirety.

Table 6.2: *How the instruction was weighted.*

Instruction	How Many Steps? (% of question)	skill	Found where in the instruction?
#1: Getting tone	4 steps (25 % each)	Psychomotor/procedural	p. 14*
#2: Adjusting 8-Track	3 steps (33% each)	Psychomotor/procedural	p. 16*
#3: Setting subgroup and master faders	2 steps (SG only.75%) MF only. 50%)	Psychomotor/procedural	p.19*
#4: Sending signal to board	4 channels (25% each)	Psychomotor/procedural	p.20*
#5: Adjusting board's VU meters	1 step (part marks were assigned. 25-50%)	Psychomotor/procedural	p.21*
#6: Why would faders be unequal?	100% for correct. part marks for various ans.	Intellectual (awareness of how the board works)	p.22** p.18
#7: What's the last step?	Part marks were given.	Psychomotor/procedural	p.18***

* These are practice pages. All information was presented in a declarative form on p.18.
** This page showed how equalizers should be set prior to setting line levels.
***This step was presented in declarative form only

Signal Routing Test

This test was designed to sample most of the signal routing exercises practiced in the CAI program. Some of the questions were taken directly from the program whereas others tested the student's ability to problem solve signal routing puzzles based on what they learned. I added a few questions to see whether students were able to find certain facts about the soundboard. In total, fourteen questions were asked (see Appendix D).

Volunteers writing the paper-and-pencil version of this test were given a similar graphic representation of the virtual board they learned and practiced from. This photocopied graphic was modified from the computer program and it contained the pertinent information needed to complete most questions.

Most students participating in the equipment version of the test needed to be oriented to the parts of the board they were being tested on since the graphic on which they practiced showed only those buttons and dials needing manipulation. The questions for both paper-and-pencil and equipment tests were the same.

Each test question and its correct answer are illustrated in Table 6.3. I added a difficulty statement to exemplify possible information processing abilities. Where a question deemed simple is taken directly from the instruction, a moderate to difficult question is one that has been reworded or paraphrased.

Table 6.3: *Test questions for the Signal Routing Exam*

Question #1: A simple signal routing task.

Q: The signal comes from Track #1 and you want to send it to Subgroup #4.

A: For channel #1 only:
Tape button down
Assign button to 3-4
Panpot to even

Question #2: A moderate signal routing task.

Q: The signal comes from Microphone 1 and you want to send it to Track #3.

A: For channel #1 only:
Tape button up
Assign button to 3-4
Panpot to odd

Table 6.3 (*continued*): *Test questions for the Signal Routing Exam*

Question #3: A simple multi-signal routing task.

Q: The signal comes from Track #1, #2 and #3 and you want to send it to Subgroup #2.

A: Channel #1, #2, #3 tape buttons down
Channel #1, #2, #3 assign buttons to 1-2
Channel #1, #2, #3 panpots to even

Question #4: A moderate to difficult concept.

Q: How are the subgroups connected to the 8-track recorder?

A: The subgroup outputs are shared by the 8-track recorder's inputs. Therefore:
SG #1 is connected to the inputs of Track #1 and #5
SG #2 is connected to the inputs of Track #2 and #6
SG #3 is connected to the inputs of Track #3 and #7
SG #4 is connected to the inputs of Track #1 and #8

Question #5: A moderate multi-signal routing task.

Q: Record a stereo signal from the CD player to tracks #3 and #4 on the 8-track recorder.

A: Channel #5 and #6 tape buttons up
Channel #5 and #6 assign buttons to 3-4
Channel #5 panpot to odd
Channel #6 panpot to even

Question #6: A simple concept.

Q: What is connected to the master faders (red)?

A: The stereo output of the soundboard is connected to the cassette deck's stereo inputs and the two-track reel recorder's stereo inputs.

Question #7: A simple procedure.

Q: List one way you can turn a reel-to-reel's stereo signal into a monophonic one?

A: Assign both signals (left and right) to one subgroup.

Question #8: A moderate to difficult signal routing task.

Q: How would you assign a signal from M1 to record onto T #5 of the 8-track recorder.

A: Assign it to SG #1 (note: marks were given for right subgroup, wrong pan)

Question #9: A moderate to difficult signal routing task.

Q: How would you assign the above signal to record onto T #7 of the 8-track recorder.

A: Assign it to SG #3 (no part marks given)

Table 6.3 (*continued*): *Test questions for the Signal Routing Exam*

Question #10: A difficult signal routing concept.

Q: You have just recorded 4 tracks. List, if any, problems which might occur if you want to record more tracks.

A: In order to avoid being re-recorded, recorded tracks need to be assigned away from tracks being recorded to.

Question #11: A simple signal routing problem.

Q: You have a signal coming from tracks #5 and #6. Can you listen to those tracks while listening to music coming from the cassette recorder? Explain your answer.

A: No, because tracks # 5 and #6 and the cassette's stereo output are connected to channels #5 and #6. You can listen to either one or the other by using the tape button.

Question #12: A moderate to difficult signal routing task.

Q: You want to listen to tracks recorded onto #1 and #3. You want to record a signal from M2 to track #2. How would you set this up?

Answers

A: Channel #1(track #1): Tape button down Assign to 1-2 or 3-4 Panpot to odd if using 1-2 Panpot to odd or even if using 3-4	A: Channel #3(track #3): Tape button down Assign to 1-2 or 3-4 Panpot to odd if using 1-2 Panpot to odd or even if using 3-4	A: Channel #2 (M2): Tape button down Assign to 1-2 or 3-4 Panpot to odd if using 1-2 Panpot to odd or even if using 3-4

Question #13: A simple to moderate signal routing task.

Q: Can you record from the CD player to the cassette recorder.

A: Yes, because the input of the cassette recorder is connected to the output of the master faders. Problems would arise if you wanted to listen to both units at the same time.

Question #14: A difficult and impossible signal routing problem.

Q: You have a stereo signal from the CD player that you want to record onto tracks #1 and #2. You want to play back some vocal passages that you recorded onto tracks #, #4, #5. How would you set this up?

A: You cannot set this up as #5 will not be heard because it is in conflict with the CD player.

Table 6.4 shows how signal routing questions were weighted when being marked. Gagné's (1977) skill acquisition type required for these questions is included to better explain the complexity of these skills. All questions for both small group and one-on-one signal routing tests were weighted equally when calculating the overall averages. I also included how I marked this test when a student performed parts of the question correctly. To achieve 100%, a student must correctly answer every question in its entirety.

Table 6.4: *How the Signal Routing Test was marked.*

Instruction	How Many Steps? (% of question)	Skill Type	Found where in the instruction?
#1: T8 to SG 4	3 steps (33% each)	Intellectual/psychomotor	p.9*
#2: Mic 4 to T3	3 steps (33% each)	Intellectual/psychomotor	p.10, p.17**
#3: T1, T2, T3 to SG2	3 steps (33% each)	Intellectual/psychomotor	p.10
#4: How are SG connected to 8-track	100% for correct ans. part marks given	Intellectual	p.17
#5: CD player to T3 , T4	6 steps (16.67% each)	Intellectual/psychomotor	p.10**
#6: What are connected to the master faders	100% for correct ans. Part marks given	Declarative/verbal	p.17
#7: How do you turn stereo into mono	100% for correct ans. No part marks	Intellectual	p.9, p.10
#8: M1 to T5	3 steps (33% each)	Intellectual/psychomotor	p.10, p.17**
#9: M1 to T7	3 steps (33% each)	Intellectual/psychomotor	As above***
#10: Problems with 4 tracks recorded	100% for correct ans. Part marks given	Intellectual	p. 10, p.17
#11: Listen to Cass and T5+6 same time	100% for correct ans. No part marks	Intellectual	∇
#12: Multitrack playback and record	6 steps (16.67% each)	Intellectual/psychomotor	p.9, p.17 ∇∇
#13: Can you record from CD to Cass	100% for correct ans. Part marks given	Intellectual	p.9, 17
#14: Impossible routing question	100 No part marks given	Intellectual	p.9, 17

* All signal routing procedures were learned on p.11 of the program. P. 10 refers to the easy quiz from which this question was taken. P. 9 refers to the hard quiz.
** I wanted to see if the learner made the 'subgroup to 8-track' connection.
*** This was to check whether question #8 was a lucky guess.
∇ This was a check to see if learners understood the tape button's dual function
∇∇ Of the three problem solving questions, this question was moderately difficult (#3-easy and #14-difficult)

A Description of Students

Twenty-nine students enrolled in the 40-101 survey course participated in this study. Survey courses traditionally include students with diverse interests, which was one reason why volunteers were sought from it. I also wanted to explore the instruction's effectiveness with learners who were not predisposed to developing media production skills. The characteristics that make up the participants in this study follow the questionnaire's format (see Appendix B).

Of the 29 participants, twelve (41%) had declared Communication Studies as a major. Six of the participants (21%) had not yet declared a major; they formed the next largest group. Other groups of students declared majors as Social Sciences (3 =10%), Business and Marketing (2=7%), Human Kinetics (2=7%), and Psychology (2=7%). One student each declared Music and Computer Science as the major. The students were on average 19 years of age. The two oldest participants were 34 and 27 years old, whereas the three youngest students in this study were 18 years old. Fifteen students were female (52%) and fourteen were male (48%), making for a well-balanced sample.

Prior Knowledge

To inquire about a student's past experience with audio recording, two open-ended questions were used. The first asked the student about actual experience with sound recording equipment. The second question inquired about the student's participatory experience with sound production like theatre or broadcasting. It should be noted again that those who participated in the workshop had 2 sessions that taught basic sound production concepts. All students who participated the one-on-one sessions were given a brief lesson about basic audio concepts.

Concerning the first question, three tiers of experience unfolded. The first tier, those with little and no experience, was comprised of 14 (38%) who claimed no experience with sound recording equipment and seven (24 %) who cited their home stereo equipment as their only experience. The second tier comprised 3 students (10%) with relevant audio recording experience who had worked for their high school audio/visual club or who owned a home recording studio. The final tier contained 5 students with advanced or professional experience including four students (14%) who had worked as disk jockeys or live sound engineers and one student (3%) who owned a digital audio-recording sampler.

The second question confirmed the first question's results. Some notable sound production experience came from two individuals. One participated as a singer in a recording of their high school theatre production, the other was a member of an audio recording team on a film production. The latter did not specify the responsibilities for this experience.

Experience in D.I.D.'s 8-Track Studio

A question about studio experience in D.I.D.'s 8-track studio was asked to ensure the integrity of this study. It also served to expose prior knowledge of the concepts and procedures being taught. No student claimed to have worked in any capacity within this studio. All students also claimed they had never seen the studio's equipment.

Signal Routing Concept

Participants were asked to explain and exemplify the concept of signal routing. Three students (10%) gave satisfactory, albeit incomplete answers. One student explained the concept well. The remainder (87%) could not explain signal-routing.

Computer Experience

Students were asked to select from a list of fourteen categories encompassing computer use to ensure that students had the necessary skills to warrant navigational complaints and other problems the soundboard program may have. Its second purpose, given the program failed to teach, was to include or exclude a student's computer competence as a variable if they failed to learn the concepts.

Four computer usage categories received mentions by more than two-thirds of the participants. All except for one (97%) used a computer for word processing. Twenty-five students (86%) mentioned using a computer for E-mail. Twenty-two students (76%) cited using the computer for navigating the Internet. Finally, 20 students (69%) used the computer for games.

Some sections need to be cited as they demonstrate the diversity of the students' familiarity with computers. Compiling databases with a computer was checked by almost a third (31%) of the students. Desktop publishing was mentioned by 7 of the volunteers (24%). Given the inclusion of four Business and Marketing students, it was not surprising that using the computer for accounting purposes was also mentioned. Four students (14%) programmed computers. Surprisingly, only one student mentioned HTML in the "open ended" (other) category. I suspect students may have interpreted the Internet category to include web-page design.

I concluded that the participants in this study were computer literate enough to warrant an investigation into any complaints they may have had with the CAI program. Their experience with computers also excludes computer competence as a possible variable if the program does not teach.

CHAPTER SEVEN:
Program Evaluation: Responses and Test Data

This section reports the experts' review of the program's instruction, the participants' impressions of the program, and the data yielded from both tests. All of these serve to identify design weaknesses and strengths the program may have. They also help to expose pedagogically unsound material as well as suggest instructional methods that may assist the development of future products. A discussion of these findings follows this chapter.

Expert Review of the Program

Three experts took part in the review of the program. Two reviewers had experience as teaching assistants (TA) for the *Sound in Media* laboratory. These TAs had contrasting objectives. The first TA, who had experience with radio broadcasting, looked over the content and reviewed the program as a possible aid to the course. The second TA, an accomplished web page designer, concentrated on navigational problems. The third expert, who designed and instructs the course, reviewed the instruction of the program.

Soundboard Program as a Possible Aid

The first reviewer noted the program was representative of the real equipment it was supposed to simulate. This in itself would be an argument for replacing the outdated lab-manual currently offered to students. This reviewer also saw the benefit of teaching students basic procedures and concepts before using the studio. This would eliminate a student's waiting period in learning these concepts: "There are 5 students in each lab and each stands around until another student [finishes a procedure]. I can see a computer terminal that will allow 2 students to learn the actual board while [the others] learn on the simulated board."

The reviewer noted the benefit of creating a manual as a possible companion piece to the program. Some of the technical language could intimidate those students not proficient with the sound studio. The instruction also appeared to be puzzling in some places and needed standardization to eliminate confusion. This expert's final thoughts focused on the interactivity of the program, especially during the signal routing quizzes. Although the reviewer found some signal routing quiz questions challenging, he noted the feedback and suggestions provided adequate support to solving these questions.

Navigational Issues

The second expert focused on the navigational and design issues offering guidelines that are standard in navigating web pages. One rule mentioned throughout this review was the need to standardize mouse-clicking procedures. Learners should have to click on an object in order to activate it. Currently, during some procedures, the user only needs to slide the mouse pointer into the object for activation.

The benefit of back and forward buttons common to typical web browsers would help in navigating the program. Although there are a few instances scattered in the program, they should be common. A main summary or menu page would be helpful as a jumping off point into any lesson, without having to navigate through many pages.

Speed was also a concern for this expert. Suggestions included the ability to click certain procedures into their correct positions immediately without having to go through the whole process. Page 16 elicited this concern: "[This page and others] should not [force] you to step through the levels of the knob. You should be able to click on them right away."

Review of the Program's Design and Instruction

Concerns from the third expert centered on the fidelity of the instruction and perceptual cues. The program's virtual buttons and knobs elicited concerns. Three-dimensional effects for most buttons were unsatisfactory cues for this expert. Colour coding the two positions of a button was suggested. The signal chart warranted another design suggestion namely imitating the procedure a student needs to go through when selecting using either the cassette recorder or CD player.

In the real studio, both the cassette player and the CD player share the same input channels. A switch determines which signal is sent to the soundboard. The suggestion to require learners to switch between these two units like the real environment was made and implemented during the production of this program.

Group Participants' Impressions of the Instruction

Thirteen participants used the program in a group setting. The intent was to mimic an instructional environment in which the program would be used. I chose D.I.D.'s computer lab because it has capable computers with the necessary peripherals to handle the instruction's animations and other CPU intensive features.

This part of the evaluation employs the general comments participants wrote on the post-program questionnaire. Three sections make-up this evaluation. The first section gives the group's positive statements. Their negative statements about the instruction follow. My observations of the volunteers as they were using the program conclude the *group* part of the evaluation.

Positive Group Statements

Overall, the group described the instructional experience as being "somewhat" enjoyable. Many cited colours, graphics, and interaction with the computer as being well designed. Student #1's comments encapsulated the latter theme with reference to the *signal routing* instruction:

> "I felt the messages conveyed the importance of each step…I especially liked the [program's] encouragement. The "Well Done" and "Good Work" messages after each [quiz] were done properly."

Student #4 confessed that the instructions were at first confusing, but was able to figure them out once he started the lessons. Many enjoyed the mouse pointer's attributes. When the mouse pointer moved over an important object within the lesson, it turned into a hand. Participant #6 echoes his cohort's impressions: "I really liked the [mouse pointer] turning into a hand. I knew when to press down for more information and when it was okay to proceed." Table 7.1 compiles common positive references to the program's instruction.

Table7.1: *General positive comments from group evaluation members.*

Design Feature:	*Statement* (participant #):
Graphics	• I liked the graphics…the interaction and the colours…Plus [the computer] telling you what you have to do with the graphics (#11). • The graphics were very appealing to the eye and [helped] to sustain attention (#1). • The pop-up screen [of the input section] was very enjoyable (#12)
Interaction	• I liked how you could…put the [mouse pointer] on different things and it told you what they were (#6). • I liked how it tells you when you make a mistake (#10).
Instruction	• Program seemed to do a good job teaching the concepts it was designed to teach. When I started, the ideas weren't sinking in and I [feared I] wouldn't be able to do the tests. However, after completing numerous scenarios, I was able to answer the [quizzes] with relative ease (#9). • The instructions were simple (#10). • The program was very thorough and in-depth (#12). • [The] line-level calibration part was very intuitive and easy to use (#13).

Negative Group Statements

The second part of the post-program questionnaire asked students to state what they did not like about the instruction. Most students reserved their comments for this section of the questionnaire. Two common themes arose from analyzing the group's statements. First, these volunteers found there was too much information within the instruction and that it was hard at times to grasp the main points. As student #5 wrote: "[There] was too much going on and I got overwhelmed." Students recommended a range of prescriptions from the use of pop-up definitions to giving more 'hints' when doing quizzes.

The second theme stemmed from numerous navigational issues. Students requested menu buttons, the ability to manipulate some computer-controlled graphics and the inclusion of 'back' buttons to repeat parts of lessons. One repeated complaint was the lack of a standard navigational method for one particular lesson. Student #3 explained: "[It] was hard to find out where to push and click the icons." Another wanted the option to go to different parts of the board at any time during the exercise. This option was there, but it had gone unnoticed.

Table 7.2 samples some of the common complaints the students had with the program.

Table 7.2: *General negative comments made by group evaluation members*

Design Feature:	*Statement* (participant #):
Navigation	• I had problems turning the [panpot] (#10). • The sensitivity of the mouse made it difficult to select areas on the board (#12). • [I wanted to] click and drag faders (#13). • I wanted the ability to switch from page to page (#7). • There should be a menu button on the screen at all times and a 'back' button to go to previous lessons (#4).
Interaction	• When I got an incorrect answer, it gave unclear hints (#3) • I tried to manipulate the board as it told me [but I became] confused. I didn't understand what it wanted me to do…Maybe after 4 or 5 tries, the program can show the correct way to do what it is asking (#6). • I found it difficult to move on when I already knew the step. I had to do it anyway and I wasted time (#10). • The fact that you could check [your] work allowed me to figure out the answers without having to remember any of the concepts (#9)
Instruction	• I did not like the signal routing [lesson] (#13). • I [felt] I lost all the information the second the screen changed (#5). • Messages were too long (#1). • I found the program boring…I got frustrated when I got something wrong (#10). • I found it confusing at times…Sometimes [it was] unclear what task you had to perform (#11).

My Observations

My role during this session was to perform duties similar to that of a *Sound in Media* teaching assistant. I facilitated navigational problems, answered content related questions, and motivated the learner. The latter was especially difficult as all had just written an exam and there were technical delays at the start of this session. In my experience, this closely duplicated the realities of a sound production laboratory and it fulfills Duncan's (1993) suggestion for conducting "naturalistic observation" to identify potential problems with the courseware (p.225).

Students did not seem to read all the information provided. One particular student among a few with this inclination asked on two occasions where specific navigational buttons were located. This person had failed to read these buttons' captions. Common difficulties with instructions also stemmed from this habit. For instance, reading aloud the messages in their entirety assisted in solving minor instructional issues.

Students' did not seem to enjoy the ability to control the instruction. Many became frustrated when they could not find the lessons on which they were to be tested. Most opted for specific directions to these lessons and were not interested in exploring some of the board's functions. This frustration became more apparent when students stumbled upon unfinished pages when first exploring the soundboard. In total, three pages explaining some of the board's many functions were incomplete because they were dependent on sound media which was not yet included into the program.

Some of the instruction confused individuals. These people benefited from paraphrasing the message. This happened most often when the concept of "subgrouping" was included in the signal routing instruction. I noticed during the line level exercise that some students questioned why they were doing certain tasks, when prompted by the computer to perform. When I explained the relevancy, these tasks became more appealing to do.

The signal-routing quizzes that were designed to familiarize students with many common signal-routing possibilities also posed some problems. Specifically, the hard quiz failed to motivate students to solve beyond two or three questions. It seemed the computer randomly selected the harder questions first. Students seemed to give up on these, even when I tried to help solve the questions with them. The easy quiz seemed too easy. Students asked whether it was necessary to do the more than 30 questions.

I was impressed by the amount of time most participants spent with the program. Before the start, I told participants they were free to leave when they felt they learned the material they were being tested on. I also mentioned that marks received from the tests would not affect their workshop grades. Because more than half the students were not enrolled in Communication Studies, I expected a few individuals to leave within minutes. The minimum time spent on the program was 30 minutes (3 students); these three students were Communication Studies majors.

1-on-1 Evaluation Results

Sixteen participants volunteered for the 1-on-1 evaluation. Again, students used the program while I observed them. All but two students did both Line Level and Signal Routing lessons; the two felt overwhelmed by the exercise. I recorded comments and suggestions while noting where problems with the instruction occurred. When they finished, students wrote down general impressions about the program.

Participants' Comments and Impressions made during the Instruction

I told the one-on-one volunteers to where they could go to within the program. The purpose was to uncover specific problems and to note design features the users liked within the program. All students started on page 2 which introduced the board's three main sections. I omitted their use of page 1 because the previous group participants reacted strongly to the inconsistencies of that page. The non-linear presentation of 1-on-1 comments follows the path students used the program.

Page 2: Introducing the soundboard

Most students found this page simplistic. However, when asked to reword the meaning of content they seemed unsure. Most had to look at the screen to do this task. One student called it "boring but straightforward." Most others seemed unimpressed.

Page 5: Introducing the input channel

Page 5 garnered many responses. Students enjoyed the graphics, colours, and the three dimensional pop-up of the channel. When queried, all students noticed this feature except one who was more concerned with the flat portion of the board.

Students then scanned the board for more information. At the bottom of the page, an instruction directing the use of graphics seemed to catch their attention next. It stated: "Slide your mouse over channel #1 to learn its functions. Click on them for practice." Many students could not infer from the graphic that the 3-D pop-up was channel #1. One student thought the whole graphical representation of the soundboard represented this and randomly slid the mouse pointer over various parts hoping to get information. These students stated they would benefit from a label.

Many students judged the information about a channel's many functions to be wordy. Participant #19, who admitted to hating technical terms, became frustrated by some of the jargon. The instruction in question described a button located at the top of the 3-D channel. It stated:

"This is the TAPE button. It tells the channel where the signal is coming from and how to process it. When it is down, the signal [comes from] the 8-Track recorder's 'tape' or tone oscillator. It will bypass the GAIN knob found below. When it is up, the signal comes from another source and will activate the GAIN knob. Check the channel's label for [its] source. It is located just above the channel's fader" (Beckhoff, 1997)

The confusion stemmed from words like 'tone oscillator' and information concerning the gain knob and label. This person, among others, suggested that the instruction could benefit from arrows and labels identifying secondary information.

Students questioned the logic of having the message box opposite to the 3-D channel. These students also moved the mouse unintentionally and changed the message, due to the close proximity of the 18 active objects that conveyed information.

The cue button graphic troubled many individuals. This button forced a label identifying secondary information to appear for a period of nine seconds. While appropriate when first inquiring about the CUE button, it annoyed people when they accidentally touched it later. During the latter stages of the 1-on-1 evaluation, I warned people of this peculiarity.

Page 11: Learning to assign signals

The 'assigning signals' instruction had 14 lessons. Most participants understood the first six lessons, which demonstrated the parts of the board that were used to receive and send signals. Lesson 2 confused some students. The instruction was stated as follows:

"Now we'll do the oppesite. Before you do, press the SIGNAL CHART button and navigate around that page by sliding the mouse over the equipment. When you come back, depress all of the TAPE buttons so that they are 'up' and press the CHECK WORK button. The signal will now correspond to the upper portion of the channel's LABEL (e.g. M1 or RR-L). Notice the PAD buttons move when you press channel's 5, 6, 7,and 8. This is to remind you that these buttons have to be pushed in when using the CD, CASSETTE and Reel-to-Reel" (Beckhoff, 1997).

Students seemed confused about the message and needed to read it a number of times. One student mentioned the benefit of breaking up this lesson into smaller chunks. Others suggested the use of arrows and labels to identify the secondary information.

While watching the learners use the instruction, I noticed the 'check work' button frustrated some. These individuals kept pressing the lesson button without checking the work. While the lesson counter of this button kept increasing, the information in the text box did not change. The lesson button is dependent on the check work button to go to the next lesson. I prompted these students to alternate between these two buttons when this phenomenon occurred.

Lessons 7 through 14 were too difficult for students to learn. The instruction attempted to introduce students to multi-signal processing and assigning. When this instruction was found to be unusable by the first few participants, I advised the remaining volunteers to proceed to the easy signal-routing quiz following lesson 6.

Page 17: Signal chart

The function of the signal chart was to assist students in solving signal routing questions. Users moved their mouse pointer over equipment that is plugged into the board. Arrows would indicate the signal flow. This page was accessible from the 'assigning signals' lesson page and both quizzes. Students' use of this page seemed erratic.

Those who had little prior knowledge of recording equipment benefited the least from this page because of their unfamiliarity with the equipment. The graphical representation of the 8-track recorder only showed its VU meters. When asked, people assumed the 8-Track recorder had only these features. The other equipment, like the microphones, was more recognizable. In contrast, participants who had some prior knowledge of signal flow seemed to enjoy and use this page more.

The direction for this page stated: "Slide your mouse over the equipment to see how signal flows." Students did not want to explore this page. Most slid the mouse pointer over a few objects and returned to the instruction. When I noticed this as a common occurrence, I told individuals to investigate further.

The board and the 8-track recorder garnered the least use while the upper portion of the signal chart page garnered the most even though the upper portion's statement seemed unclear to some people: "The equipment to the left is plugged into the TAPE UP buttons." One individual assumed the message referred only to the reel-to-reel graphic found to its immediate left. Another inferred from the message that most of the page including the soundboard was plugged into the TAPE UP buttons. Most had not noticed the message, but could explain it when asked to.

The message within the 8-track recorder was the least noticed part of the page. This information stated how the subgroups connect to the 8-track. It also stated how the 8-track sends signal to the board. When I asked students to explain the attributes of both these connections, many could not. I then directed confused students to the message and asked the same question. They tended to read this message aloud but could not expound upon it. The combination of the signal-flow arrows from the subgroup with the message seemed assist students most. Students mentioned more attention focusing techniques such as blinking messages, labels, and arrows should be used to help combine this information.

Page 9: Easy signal routing quiz

The 'easy quiz' page along with the 'hard quiz' page were identical visually and functionally with the 'signal-routing lesson' page. Navigational complaints were few. Before starting the quiz, I asked students to note at which question they felt they had mastered single-source routing problems. I qualified this comment by telling students that their procedural responses to these questions must be automatic.

On average, students stated they mastered the single-source routing problems by the sixth question. The highest number of questions done by students was thirteen while the lowest number was four. In total, this exercise had 35 questions covering most single source possibilities.

Page 10: Hard signal routing quiz

The hard quiz did not fare as well as the easy quiz. I believe this is due in part to the signal routing lesson's difficulty in teaching multiple signal routing. The highest number of correct responses before asking to retire from this drill was three. Most students gave up on the first question. Multiple-source signal routing also appeared to discourage students, especially those with little prior knowledge of sound production.

Page 18: Setting line levels

Because the program could be integrated as a tutor within the real studio, the design of this page is a proactive attempt to display pertinent information about setting line-levels. One can move the mouse pointer over the various graphics to get the necessary information. If confusion persists, a click on the graphic will allow one to practice the procedure in question. In total, seven procedures need mastering in order to correctly set line-levels. Graphics representing these processes circle a common message box. A link to a checklist page precedes step#1 and is located at the top left-hand portion of the page.

When students first entered this page, I noticed that students did not read the instructions governing the use of this page. Many haphazardly moved the pointer over the graphics until I prompted them to do otherwise. When asked why they did not read it, excessive wordiness was most often cited.

Only four students noticed and proceeded to the checklist page. All others collectively thought the link referred to step #1. Some suggestions provided by the participants included centering the checklist and making its heading larger.

Page 22: Checklist

This page graphically represented two conditions for the board to properly set line-levels. A third optional condition demonstrating the threading of the 8-track recorder was also provided since many students traditionally fail to do this properly. All students enjoyed the graphics and animations but were confused by their location within the board. Students suggested a graphic that specified the exact location of these components within the board would better assist in conveying this information.

Page 14: Practicing step #1

Students found this page straightforward. Some annoyances stemmed from the graphic representing the Test-Osc knob. Most wanted to click instead of point this graphic into the required position. Another navigational complaint arose from the switches. Students found these graphics small and hard to manipulate. Surprisingly, learners wanted more information as to why they were doing this task.

Page 16: Practicing step #2

Students cited few complaints with this page. Some with very little prior knowledge only did parts of this exercise. The hidden animations showing students the consequences of improperly doing this procedure were never activated.

Page 19: Practicing step#3

Upon entering this page, a colourful animated display of 'tens' appeared across the screen. Many enjoyed this feature. The instruction elicited no complaints and all thought it was straightforward. Some wanted to drag the faders to their correct positions and mildly protested this inability. Those caught by the trick faders thought it was a good idea to reinforce the correct faders. Four students wanted to know the location of the subgroup faders and suggested a small soundboard with their positions highlighted.

Page 20: Practicing step #4

This step involved assigning the first four channels to subgroups. It was interesting to see most students attempting to perform this step without reading the instruction. When asked, they mentioned they thought it was similar to the signal routing lessons. All students within this group did the signal routing lesson first. Two students complained of the computer forcing them to do this procedure. I programmed this page to prompt students to correct mistakes, as this step is crucial to setting line levels.

Page 21: Practicing step #5

No complaints were registered except for the inability to drag the faders to their required positions.

Page 18: step#6 and #7

Students were surprised to return to page 18 to complete the final two steps. The instruction was programmed to take two routes. Learners had the option of going to each practice step without going back to the main page. Only one student was observed toggling between practice and main pages. She mentioned this was to keep track of where she was. Students failed to take note of the large headings within each practice page indicating the step they were doing.

The final two steps registered little disapproval. The final step elicited clicks and confusion by some because the mouse pointer changed into a hand. This step had no practice element.

Tests

Tests were administered two days after participants used to the instruction. The purpose of these tests was to see what parts of the instruction facilitated retention within the students. The first test posed signal routing questions. The second test asked students to set the line levels for the soundboard. Each test was divided into two versions. One was a paper-and-pencil version that used photocopies of the graphics from the program. The other required students to perform the same procedures on the actual studio equipment. Test questions did not change for either examination.

Twenty-six students performed the signal routing test while only twenty-two did the line-level test. Four members representing both evaluations did not get to the line-level lesson. Paper-and–pencil tests and equipment tests were somewhat divided evenly. The line level test comprised of 12 written and 10 performed. The signal routing test enjoyed a perfect split at 13 written and 13 performed on the equipment.

Overall Averages

The combined average for both tests was about 43%. Table 7.3 shows the breakdown for each test version along with the differences between each test. Excluding the four students that did not perform the line level test, marginally influences the signal routing score but does not affect the overall averages dramatically. These percentages are noted in parentheses. The results suggest the line level test was easier to perform than the signal routing one in both paper-and-pencil (P-and-P) and equipment versions.

Table 7.3: *Breakdown and differences between each tests*

	Average Line Level Score	Average Signal Routing Score	Difference between both Tests	**Overall Average**
Paper-and-Pencil Ave.: Number of Learners:	**48%** 12	**31%** (26%*) 13 (11*)	**+17%**	**39%** (33%*)
Actual Equipment Ave.: Number of Learners:	**51%** 10	**41%** (47%*) 13 (11*)	**+10%**	**46%** (53%*)
Total Average: Total Learners:	**49.5%** 22	**36%** (36%*) 26 (22*)	**+13.5%**	**42.5%** (43%*) 26 (22)

***** ***Number in parentheses refer to the 22 students who did both tests.***

Students who used the equipment did better than those who had only the graphics to refer to. While the equipment line level test averaged 3% higher than its counterpart, the signal routing test shows a 10% gain when using the equipment over P-and-P.

Group Results vs. 1-on-1 Results

The overall group average for both tests in both versions stands at 34%. The equivalent 1-on-1 average is at 51% respectively. To further compare test results, Table 7.4 shows test results broken down into P-and-P and equipment averages for both participant clusters.

Table 7.4: *Group vs. 1-on-1 results* (all results have been rounded)

	LL Ave EQ	LL Ave PP	LL Total Ave	SR Ave EQ	SR Ave PP	SR Total Ave	Overall Ave.
Group Ave: Number:	**47%** 5	**35%** 6	**40.5%** 11	**23%** 6	**31%** 7	**27%** 13	**34%**
1-on-1 Ave: Number:	**55%** 5	**62%** 6	**59%** 11	**56%** 7	**30%** 6	**44%** 13	**51%**
Total Ave: Number:	**51 %** 10	**48.5%** 12	**49.5%** 22	**41%** 13	**30.5%** 13	**36%** 13	**43%**

The 1-on-1 participants fared better in most categories by at least 8% (line level equipment test). The greatest difference resulted from the line level paper and pencil test where the difference between the two was 27% in favour for the 1-on-1 participants. Surprisingly, the group did marginally better (+1%) than the 1-on-1 participants with the signal routing P-and-P test.

Time

The average amount of time spent on the program was 55 minutes. The least amount of time was 30 minutes (n=3) whereas the longest time was 90 minutes (n=2). Three students spent 70 minutes with the program; they received the best-combined average for both tests. Their average score was 60%, with the line level test at 63% and the signal routing at 57%.

Strictly speaking, regression procedures cannot be used due to the small sample size and because statistical assumptions necessary for regression do not hold. However, a regression analysis suggests that for every 10 minutes spent on the program, students would increase their success rate by 2.5 percentage points.

The average amount of time spent on the program by the group participants (n=11) was 50 minutes. It should be noted that two members of this evaluation forgot to log their times. The 1-on-1 evaluation members spent on average 12 minutes more than their counterparts.

Gender Differences?

Table 7.5 compares women and men within group and 1-on1 situations. Women and men's performances tend to be better in 1-on-1 situations where both scored higher results than the test means.

Table 7.5: *Comparing women and men's performance against both tests*

	GROUP LL	1-on-1 LL	**LL Ave.**	GROUP SR	1-on-1 SR	**SR Ave.**
Male:	**42.7%**	**64.2%**	**51.7%**	**32.6%**	**46.5%**	**37.9%**
N	7	5	12	8	5	13
Female:	**36.5%**	**54.2%**	**47.2%**	**18.9%**	**42.7%**	**33.5%**
N	4	6	10	5	8	13
Average:	**40.5%**	**58.8%**	**49.6%**	**27.3%**	**44.2%**	**35.7%**
N	11	11	22	13	13	26

Interestingly, women and men seem to mirror each other when comparing their test averages against the style of testing. Men score higher than women on the equipment version of the line level test while the women score higher in the paper-and-pencil version of the same test. However, women better their counterparts with the equipment version of the signal routing test whereas the opposite for the paper-and-pencil version holds true. Table 7.6details these results.

Table 7.6: *Women and men compared with test versions*

	Equip. LL	P. and P. LL	**LL Ave.**	Equip. SR	P. and P. SR	**SR Ave.**
Male:	**60.4%**	**45.4%**	**51.7%**	**35.2%**	**41.2%**	**37.9%**
N	5	7	12	7	5	13
Female:	**41.8%**	**52.5%**	**47.2%**	**47.5%**	**21.6%**	**33.5%**
N	5	5	10	6	8	13
Average:	**51.1%**	**48.4%**	**49.6%**	**40.8%**	**30.6%**	**35.7%**
N	10	12	22	13	13	26

Major Area of Study

Student's areas of study is the last possible variable considered that may have influenced the outcome of the tests. Overall, students from the social sciences (n=2) category achieved the highest results at 50.2%. The lowest average for both tests was 19.7% recorded by two declared Human Kinetics majors. Communication Studies (n=12) and those who had not yet declared a major (n=6) both recorded an average of 43.6% which closely paralleled the overall combined average of about 43%.

A Breakdown of the Tests

This final section of the evaluation chapter looks into what parts of the test students excelled or failed at. The purpose of this exercise is to expose specific instructional content that is either weak or strong. In doing so, the instructional designer can suggest changes to better the instruction.

Line Level Test

The overall percentage for this test was 49.5%. Six of the seven questions had ranges from a minimum of 0% to a maximum of 100%. Question #6 received no correct answers by all students except for one for a total of 5.6%. Question #5, which asked students to zero the VU meters, had the highest average of 78.4%. After omitting outliers, the remaining five questions averaged approximately a 52.6% success rate.

Table 7.7 shows how the twenty-two participants did with the line level questions. Column #2 shows how many students scored perfectly. Column #3 represents those students who did not know (DNK) any of the procedures involved with the question. The parenthesis indicates their evaluation group. Column #4 indicates the question's procedure that was most often omitted or gotten wrong by students. Column #5 describes the faulty procedure. Refer to the evaluation method chapter for a detailed analysis of the question's procedures.

Table 7.7: *Question performance and missed procedures for the Line Level test*

	Perfect	**DNK**	**Most often missed procedure**	**Description of the missed procedure(s)**
Question #1	1 (G) 7 (1on1)	2 (G)	#2	• Failing to press the 'individual' button found on the 8-track recorder
Question #2	3 (G) 6 (1on1)	1 (G) 1(1on1)	#1	• Failing to press the SRL buttons to deactivate predetermined line level
Question #3	2 (G) 4 (1on1)	3 (G) 1(1on1)	#1	• Distinguishing subgroup faders from other faders
Question #4	1 (G) 3 (1on1)	4 (G) 2 (1on1)	#1 #2	• Failing to push in TAPE buttons • Failing to correctly assign channels to subgroups
Question #5	7 (G) 9 (1on1)	3 (G)	#1	• Failing to focus on the VU meter for guidance because of failure to distinguish it from the fader's function
Question #6	1 (G)	10 (G) 11 (1on1)	#1	• Failure to check EQs
Question #7	2 (G) 2 (1on1)	8 (G) 9 (1on1)	#1	• Distinguishing master faders from other faders • Failure to set master faders properly

Many of the questions posed to students contain multiple actions. Examining the data listed in Table 7.7 reveals that most procedures missed except for question #4, were singular in nature. Surprisingly, the one person who received full marks for question #6 came from the group evaluation. I expected this question to yield in favour for 1-on-1 participants because I had steered students toward the page containing the information.

Signal Routing Test

The overall percentage for this test was 36%. Fourteen questions were asked and all ranged from a minimum of 0% to a maximum of 100% correct. Students scored best on questions 1 and 2. The combined average for both questions was approximately 69%. Students did poorly on questions 6, 10, 13, and 14. These received a combined average of only 14%. After eliminating these outliers, the combined average for this test was 28% which demonstrates the difficulty of signal routing tasks.

Table 7.8 follows the same method outlined in the previous test. Twenty-six students performed this test and they equally represented both groups. The data reveals difficulties with certain signal-routing concepts. Of concern are functions for the TAPE button and the subgroup. Master faders and their signal flow also warrant attention. Volunteers who performed perfectly were most likely to have performed this test on the equipment rather than as a P-and-P test. Equipment tests also garnered more part marks, which may explain the 10% difference between the two test versions (EQ 41% vs. PP 31%). Chapter eight discusses the data and its implications.

Table 7.8: *Question performance and missed procedures for the Signal Routing test.*

	Perfect	DNK	Most often missed procedure	Description of the missed procedure
Question #1	5 (G) 11 (lon1)	3 (G) 1 (lon1)	#1	• Failing to press the TAPE button
Question #2	4 (G) 8 (lon1)	3 (G) 1(lon1)	#1	• Failing to press the TAPE button
Question #3	5 (G) 11 (lon1)	4 (G) 2 (lon1)	#1	• Failing to press the TAPE buttons
Question #4	2 (G) 3 (lon1)	11 (G) 2 (lon1)	All*	• Failure to conceptualize the subgroup's function
Question #5	3 (G) 4 (lon1)	3 (G) 4 (lon1)	#1	• Failing to press the TAPE button
Question #6	1 (G) 1 (lon1)	7 (G) 6 (lon1)	All**	• Failure to knowing what is connected to the master faders
Question #7	4 (G) 4 (lon1)	8 (G) 7 (lon1)	#1	• The concept of stereo and monophonic sound
Question #8	2 (G) 7 (lon1)	10 (G) 6 (lon1)	All*	• Failure to conceptualize the subgroup's function
Question #9	2 (G) 5 (lon1)	11 (G) 8 (lon1)	All*	• Failure to conceptualize the subgroup's function
Question #10	2 (G) 1 (lon1)	10 (G) 9 (lon1)	All*	• Failure to conceptualize the subgroup's function
Question #11	3 (G) 3 (lon1)	7 (G) 7 (lon1)	All*	• Failure to conceptualize the TAPE button's function
Question #12	1 (G) 4 (lon1)	10 (G) 7 (lon1)	#1	• Failure to conceptualize the TAPE button's function • Difficulty conceptualizing dual functions like playback and record at the same time
Question #13	2 (lon1)	10 (G) 6 (lon1)	All*	• Failure to conceptualize signal flow from source to destination
Question #14	2 (lon1)	9 (G) 11(lon1)	All*	• Failure to conceptualize the TAPE button's function • Failure to conceptualize signal flow from source to destination

* This is an open ended question with only one possible answer
** Open-ended question with multiple correct responses

CHAPTER EIGHT
Discussion

This chapter analyzes the evaluation results in three sections. The first section discusses variables such as time and gender. The second section considers changes to the instruction with respect to the data that deconstructed the tests in the previous chapter. Also included are the weak and pedagogically unsound instruction uncovered during the one-on-one evaluation of the program. The final section lists recommended changes to the program's pages attending to spelling, grammatical and navigational errors found during the evaluations. It also notes the recommended changes listed in the second section.

Data Analysis

Five variables are considered for this analysis. Although not generalizable, these variables may be useful in case an evaluation with a large sample is devised. These variables include group instruction versus one-on-one instruction, paper-and-pencil versus equipment-based tests, gender, time spent on the program, and students' majors. Following these analyses, the ideal environment in which the instruction should take place will be discussed.

Group vs. 1-on-1 Evaluation

The test results showed that 1-on1 participants did better than the group instructed members. One reason that could account for this finding was my intervention in 1-on-1 instruction. Peculiarities that arose during the group instruction were noted and subsequently addressed in the 1-on-1 instruction. This meant 1-on-1 students had less of a chance to encounter navigational and other problems that might diminish their motivation for learning. An example of this is page 1, which intended to demonstrate how to use parts of the instruction. It became apparent during the group process that this page was flawed. During the subsequent 1-on-1 instruction, students started on a page introducing the soundboard (page 2).

Students in the 1-on-1 evaluation also seemed to enjoy having a resource person readily available. Students within this sample had questions immediately answered, whereas the group participants had to wait for their concerns to be attended to. This demonstrates the need for providing capable teaching assistants who are familiar with both content and method, to augment the computer assisted learning environment.

Tests

The high overall success rate (43%) for the tests astonished me. I was also surprised at the greater success of the equipment-based test compared to the paper-and-pencil one. I expected the opposite would be true, based on the fact that students were completely unfamiliar with the equipment, and their only source of information about the soundboard, certain recording concepts and other aspects of this studio came from the CAI program.

Some possible explanations for these phenomena include:

- My presence in the control room may acted to motivate, encourage, and reassure students.
- The real equipment may have stimulated students' senses, whereas the photocopied B&W graphics may have lessened their interest in the subject matter.
- I may have allocated more part-marks to students doing the equipment tests, because I could interpret their intended actions more readily.

- Learners may enjoy demonstrating learned actions more than describing learned actions.
- Learners may receive more gratification therefore getting better results using newly acquired skills in real environments.

The line level test results show that many of the mistakes were singular in nature. Usually these errors were due to the inability to remember small albeit important steps, such as pressing the 'individual' button on the 8-track recorder. This suggests the line level lesson did teach what it was supposed to, but that practice is needed. I believe a practice component with the real equipment scheduled soon after using the CAI program would greatly enhance the transfer of the learned material.

It does not surprise me that the signal routing test is weaker. I have found in the past that it takes students time to acquire signal-routing concepts such as the acquisition and combination of intellectual and fine psychomotor skills, whereas setting line levels is mostly rote procedure. What the results show, however, is that this time could be significantly reduced if the program were implemented early enough in the 'Sound in Media' course. I base this conclusion on two results the evaluation uncovered.

The first is that most students demonstrated a mastery of single-source routing problems in a short period of time. This was proven by the first three test questions. Had students access to comparable instruction that taught signal routing problems from multiple-sources, I believe that mastery of this audio production impediment could be achieved.

The second basis for my belief are the results of the equipment-based test. This test shows a 10% higher success rate than the paper-and pencil one. If students are introduced to these concepts by computer instruction and then given the opportunity to practice on the real equipment with a knowledgeable teaching assistant, multiple-signal routing could be mastered by most learners.

Gender

Gender differences were marginal and insignificant. Although women scored lower averages, three participants who had different impressions to what the study was about, could have influenced these results. These volunteers, both women and men, enjoyed better results in 1-on-1 situations, which reinforces the benefit of a tutor being present.

Interestingly, women's 1-on-1 scores improved 23% over group scores on the signal routing test. Women also scored better in the equipment version of the signal routing test than men. This suggests women may be more attentive than men to the intricacies of signal-routing and are better able to transpose signal-routing rules to the real equipment. Surprisingly, on the paper and pencil test for setting line levels, women achieved a 10% higher score than men. Perhaps, the familiarity of the graphics provided more visual cues for these participants to apply this procedural type of knowledge.

Conversely, men's scores on the line level test in 1-on-1 situations were 22% better than their group averages. They also seemed to enjoy performing line level tasks with the equipment more than the signal routing tasks. With the signal routing exercises, men preferred the paper-and-paper test. This may suggest that men's problem solving skills are better when using familiar objects such as the photocopied graphics.

Time spent on the CAI Program

No real patterns emerged except for the regression analysis which suggests that for every ten minutes spent with the program, test scores increase by 2.5%. It should be noted, however, that performance on the tests dropped after 70 minutes of use. The reduction in scores from the combined average of 60% for this time dropped to 47 % at 80 minutes (n=1) and to 42% at 90 minutes (n=2). These students may have had navigational problems with the program or they may have taken longer because they simply did not understand the content.

Student's Major

I expected to see higher scores from students enrolled in Communication Studies than other majors. Most of these learners have a vested interest in this field and look forward to enrolling in production related courses. Their combined average for both tests was almost 45%, or 8% higher than other non-Communication Studies majors.

All non-Communication Studies averages, the total averaged about 37%. Given the nature of the evaluations, I cannot further hypothesize why Human Kinetics students would perform differently than Social Sciences majors. Although the sample size does not allow such inference, I can mention that my experience as a teaching assistant suggests that if a student has an interest in the subject matter, learning is more likely to take place.

What needs to be fixed and Why

The soundboard program succeeded in its goal to teach. However, the evaluation results show that this instruction needs modification to better illustrate the basic operations of the board. Two crucial concepts of subgrouping and the functions of the TAPE buttons need clarification. A menu page needs to be developed as it was suggested as a desirable design feature. Navigation buttons need to be standardized. Finally, instructional issues involving messages and lesson design need to be investigated.

Subgroups

The program fails to clearly outline the concept of subgrouping. Although information is scattered in declarative form throughout the program, a lesson needs to be developed that shows learners how the subgroups work. Preferably, this lesson should have the same interactivity of the signal-routing instruction. A practice session to allow students to master the content would also benefit the program's user. Links connecting this lesson to other exercises should be in place in order to allow students to refresh their learning.

TAPE Buttons

TAPE buttons always confound students in laboratory situations and they also seem to confuse learners using the CAI program. The instruction should illustrate and frequently repeat only the basic functions of this switch. Problems likely stem from the superfluous information found on page 6 of the program. The TAPE button message was too long and too technical, thereby reducing the chances of being read in its entirety. Although some of the more able students may find this information useful, this does not motivate students with lesser abilities. To include secondary information and advanced functions, a "technical stuff" button similar to the "*dummies*" series of books or the use of 'hotwords' (links) could be implemented.

Menu Page

The intent to create a program in which students can explore different parts of the board without conforming to a strict agenda did not work because students seem to want to know what is expected of them when learning. This exercise shows that students need and benefit from a menu page to orient them. The menu page should be like a map. Information that must be learned should be highlighted, but all links should be identified to allow students to note where information is found. Programming the links to change colour when they have been used will also benefit the student. The evaluation results also show that on occasion students do not read information. Where possible, icons representing significant portions of the board coupled with pop-up messages may benefit these learners.

Navigational Issues

The proposed icons should always identify the section in which the student is currently working. Not only will this help learners familiarize themselves with the board, but it will also help alleviate some navigational issues. Back and forward buttons could also be implemented to help those students who are familiar with web browsers.

The signal chart needs visual cues telling learners where they can place the mouse pointer. Although visually stimulating, the chart was seldom used unless I directed learners to parts of this page. Hands pointing to parts of the equipment should suffice in directing students to these areas.

Instructional Design Issues: Messages and Lessons

Both the group and 1-on-1 evaluations confirmed the need to further "chunk" textual information. A standard message box might suffice in framing and presenting information.

All textual information could also benefit from standardization. A heading followed by messages designed on Reigeluth & Stein's (1983) *elaboration strategy* would best display information. This strategy suggests ways to present instruction. For this instance, general information about a concept or function could be elaborated on by more specific facts. A double space to delineate statements would also better help learners retain information and assist in mentally organizing content.

The message boxes conformed to research into displaying text in that students knew where to read pertinent information. However, the location of some of these boxes was not conducive to being easily read. For example, students complained the 'input section' page's message box was too far from the graphic to easily decode messages. The message box's location opposite to the graphic also created the phenomenon of the 'wandering mouse.' Had the mouse touched another graphic, the student would receive a different message thereby forcing the learner to relocate the original object. By moving the message box close to the graphic should alleviate this annoyance.

All pages should have a centered message box or one that is close to the graphic it represents. The sizes of some of these message boxes were also a concern. They should be made big enough to accommodate the previous suggestion of spacing "information chunks."

The line level lesson taught well but failed to explain the importance of certain procedures. This lack of knowledge may have hampered the motivation to learn these procedures for a few of the evaluation participants. The proposed "technical stuff" buttons and hotwords could assist students wanting more information. I originally chose not to include some facts because I thought excessive information would take way from learning the procedures and because TAs could elaborate on missing facts.

Evaluating the signal-routing lesson uncovered many problems. While it taught single source routing problems well, multiple-signal sources presented extreme challenges to the learners. Part of the reason was the design of the instruction. The latter part of the "assigning signals" page was ineffective. Lessons 7 to 14 only served to confuse students and did nothing to motivate them to learn these crucial skills.

These lessons need revision. Ideally, the instruction should also follow an elaboration strategy that introduces in small increments the nature of assigning multiple signals. To strengthen the learning, another quiz section asking relatively simple multi-signal questions should be devised. As it presently stands, the 'easy' quiz does not promote advanced problem skills whereas the 'hard' quiz is not motivating because of the instruction's deficiency.

Technical jargon should be reorganized to reduce feelings of alienation by some of the less able students in the program's evaluation. These words are vital to students wanting a career in audio production. However, some audio recording procedures and concepts can be accomplished without the use of proper terminologies. I suggest that words used by audio recording professionals be linked to pop-up boxes that further elaborate their meanings. This will allow the more able student to learn more if the need arises. It will also allow the less able student to concentrate on tasks needing attention without overloading their senses.

Suggested Revisions

Below I list the changes that need to be made in order for the instruction to be more effective. This is done on a page per page basis. Four pages need development and links to other pages: a menu page, a page representing the 8-track recorder, a medium signal routing quiz, and a subgrouping lesson.

The proposed menu page is described within page 1. A page with a graphic representing the 8-track recorder in its entirety has been developed (page 13) but has yet to be linked with other pages. In linking it to the signal chart, the 8-track graphic will better help students visualize the studio. A medium quiz for assigning signals needs development. This will enable students to gradually increase their signal routing problem solving skills. The final suggested addition is a subgroup page describing how signal flow from the subgroup to the 8-track recorder. An exercise component should accompany the instruction to enhance learning.

Page 1: How to use the instruction

- This page should be deleted and replaced with a functional menu or orientation page.
- This page should connect to all pages in the program.
- Topic headings should change colour when students use the instruction. This will enable learners to keep track of where they have been.

Page 2: Introduction to the board.

- All information displayed in the message box should be small caps. The information should also be "chunked" with spaces in between "chunks." Only general information should describe the board's three main parts.

- An icon representing this page should be included in the heading. This icon will represent the link to this page when the learner is using other pages. The icon should have the word 'board' as part of its structure to facilitate its identity.

Page 3: The subgroup

- All information of the components found within the subgroup should be "chunked" following this format: a heading, its main function, and its secondary functions. A space delineating the information should also be incorporated.

- All relevant items should turn into a hand when the mouse pointer touches them.

- An icon with a descriptive word should be developed. The icon will represent this page in subsequent pages and will allow learners to get information from here when needed. The word 'sub' should be included in its construction. A small message box to elaborate its function should also be developed.

Page 4: Master output section

- All information should conform to the suggestions proposed in the subgroup section. Declarative information along with suitable graphics should further elaborate where signal flows to from the master section.

- An icon with a descriptive word should be developed. The icon will represent this page in subsequent pages and will allow learners to get information from here when needed. The word 'master' should be included in its construction. A small message box to elaborate its function should also be developed.

Page 5: Input section

- The message box should be put to the left of the screen to facilitate reading. Information should follow the format put forward in the subgroup section.

Page 5: Input section (*continued*)

- Arrows identifying secondary functions should be developed to assist information.

- The 'cue' button should have the timed arrow deleted as it caused some annoyance in students.

- An arrow pointing to Channel #1 should be included.

- An icon with a descriptive word should be developed. The icon will represent this page in subsequent pages and will allow learners to get information from here when needed. The word 'input' should be included in its construction. A small message box to elaborate its function should also be developed.

Page 6: The panpot

- To move this knob, students should be able to click at certain sections instead of sliding the mouse pointer in position.

- Information should be concise and to the point following the format put forward in the subgroup section.

- A button or hotwords that elaborates technical matters should be developed.

- Sound should be added to better illustrate this knob's function.

- Icons representing the part of the board previously visited should be present. The menu page should also be accessible.

Page 7: The equalizers

- This page needs revision.

- Sound should be added so students can hear how an equalizer affects signals.

- Information reinforcing the notion that equalizers can change signal strengths when setting line levels should be prominent.

- Information should follow the elaboration strategy format put forward previously.

- Icons representing the part of the board they are investigating should be present. The menu page should also be accessible.

Page 8: The gain knob

- Sound is needed to strengthen the instruction.
- The lesson portion of this page needs to have clear instructions with appropriate descriptions and examples. The position of the 'back' and 'forward' buttons for the lesson should be reversed. This conforms to most web browsers.
- Buttons should click the knob into position instead of sliding the mouse into the boxes.

Page 9: Auxiliary knobs

- This page needs to be redesigned in its entirety because it does not work.
- Sound is needed.
- All information is too wordy and needs to conform to the previously suggested format.

Page 10: Easy quiz

- All navigational buttons should be icons representing various portions of the board.
- The panpot should have a visual cue to assist students in clicking this graphic into the required position.
- A link to the proposed subgroup lesson and 'medium' quiz for assigning signals should be included.

Page 11: Hard quiz

- The hard quiz page should conform to the navigational suggestions of page 10.

Page 12: Assigning signal

- It should conform to the navigational suggestions of page #10.
- Instruction should be made more concise and to the point. All lessons should include only one concept.
- Lessons 7 through 14 need thorough revision to enable students to develop multi-signal routing skills.

Page 13: The 8-track recorder

- Links should be established to other pages.

- General descriptions of the recorder's functions should be described following the suggested elaboration and chunking format.

Page 14: Step #1 for setting line levels

- Information chunks should have a space between them. Message box should be made larger to accommodate this.

- Test-Osc knob should be clicked into position.

- An information button to accommodate students wishing for more information needs development.

- Clicking the top and bottom row buttons must be made easier.

- Standardize navigation buttons.

Page 15: Animation loading tape recorder

- Include a small message box telling students what to do.

- Include information as to why threading the tape correctly is important.

- Standardize navigational buttons. Include an exit button.

Page 16: Step #2 in setting line levels

- Delineate information chunks to facilitate reading. Increase the message box's size to accommodate this.

- Take out from the message box, "Press the check work when you are finished" because the computer does not check the student's work.

- Increase the probability of making a mistake. Perhaps the "stop '0'" message box should not be included for all eight input/output meters. This would activate the animations and perhaps strengthen the probability of retaining this information.

- Include a technical button further explain the importance of this step.

Page 17: The signal chart

- Include pointers to assist students in navigating this page. Hands or graphics similar to he mouse pointer would benefit the most.

- Include a link to the 8-track recorder (page 13 of the program).

- Identify all 8 channel inputs of the soundboard with a numeric.

- Revise the cassette/CD interrupts. These annoyed both students and the experts alike. Devise a more user-friendly system reminding them of the rackmount switch.

Page 18: Setting line levels main page

- Chunk the information and separate these with spaces. Increase the message box size to accommodate this.

- Rewrite the instruction to only procedures. Students can find more information when clicking the graphics for practice.

- Center and highlight the "start here: before you start checklist."

- The mouse pointer should not turn into a hand when it enters the step #7 graphic.

- Navigational issues should conform to previous suggestions.

Page 19: Step #3 in setting line levels

- Information in the message box should be chunked. Increase the box to accommodate this.

- A graphic representing this portion of the board should be included. This will assist students with orientation.

- Include a technical button further explain the importance of this step.

Page 20: Step #4 in setting line levels

- Chunk the information and increase message box size.

- Include a technical button further explain the importance of this step.

- Standardize navigational buttons.

Page 21: Step #5 in setting line levels

- If possible, develop a way to allow students to set the fader on their own. At present, this step only shows students how it is done.
- Highlight the importance of setting VU meters to "0" and not the faders.
- Chunk the information and increase message box size.
- Include a 'technical' button to further explain the importance of this step on a more technical level.
- Standardize navigational buttons.

Page 22: Checklist for setting line levels

- Make this page more visually appealing.
- Pop-up graphics should have larger "hide me" messages.
- A technical button explaining why these checklist steps are important needs development.

These revisions may suggest that the overall design of the program was faulty. It should be noted, however, that this is a natural process when designing instruction; the instructional designer constantly reevaluates the instruction in order to make it better. Many of these suggested changes are common navigational problems inherent to most pages. Given this knowledge, it can be assumed that the next evaluation for this courseware will uncover fewer problems. I can also say that I have learned from these mistakes and they will not be repeated in future courseware designs.

CHAPTER NINE:
Conclusion

Five sections conclude this study. The first investigates the conditions for which the soundboard program would be best suited. The second section describes possible summative evaluation designs to formalize the conclusion of the soundboard program. *Toolbook* as a multimedia-authoring program is discussed and considered as an effective courseware-authoring program. The fourth section explores suggested future research. The final section discusses the cyclical nature of the instructional design process.

The Ideal Environment in which to use the *Soundboard Program*

My original intent was to create an instructional unit that could relieve many of the duties of teaching assistants in the Sound in Media course. However, it became clear during the evaluation phase of the program that this goal cannot be achieved. The evaluation showed the power of computer-assisted instruction increases when human intervention is present. TAs therefore must be retained and adequately trained prior to facilitating an audio production laboratory in order to maximize their potential.

The conditions in which a program such as this one would excel are listed as follows:

- Teaching assistants should be introduced to the program prior to giving the instruction to learners. This would standardize TAs' methodologies for teaching these concepts in the real studio. It will also assist them in solving minor navigational problems students may have with the program. This recommendation comes from my experience with teaching the laboratory section of this course. At times students bring conflicting methodologies that hinder audio productions. This holds especially true when projects are produced with learners from different labs.

- Groups should be limited to no more than six so that TAs may attend to questions. I recommend this because of my experience during the group evaluation. Thirteen students showed up for this lab which severely handicapped my ability to attend to them all.

- Learners should be able to practice skills soon after using the program. A TA to reinforce rules and concepts should first supervise this practice. TAs should use examples provided by the computer drills to ensure the abstractness of the CAI program's language and graphics are made concrete. This recommendation is based on the equipment test data that confirms practicing learned skills in real situations enhances learning.

- Signal routing rules and concepts should be introduced early in the curriculum. This prepares students' expectations for what is needed to master advanced audio production equipment. This suggestion comes from my experience in witnessing students become dismayed and unmotivated when introduced to the multi-tracking recording studio. Students sometimes develop a false impression of audio recording after mastering the relatively easy dubbing studios.

- Learners should have access to the CAI program at all times to refresh their skills and learning. Computers never become tired but students do. Regardless of a professor's agenda, students sometimes prefer to study at different times. Access to a computer at these times would benefit this type of student. Preferably, this program should be integrated into the Communication Studies Department's web address so students can practice skills in their homes.

- The program should be part of the studio to assist students outside of normal laboratory times. People forget procedures especially when deadlines force them to produce. The atmosphere within a control room can be hectic and confusing. A computer in the studio could help allay this confusion.

- If cost prohibits the aforementioned suggestion, a well-designed booklet containing most of the pertinent information from the computer should be developed. Ideally, students should take part in completing the booklet. Omitting labels and key information will help students focus on the program and the information it provides.

- Sound should be integrated within the program to clearly demonstrate some of the board's many functions. I originally omitted sound in case this program was accessed through the Internet. Some students may own computers without the capability of reproducing sound. I wanted to ensure that the instruction was independent of this medium.

Before implementing some or all of these suggestions, the program needs revision. Although effective in some areas, the soundboard program could benefit the student more by being more user-friendly with respect to navigational concerns and more concise in wording and instruction.

Summative Evaluation

A summative evaluation should conclude this case study. Smith and Ragan (1993) and Castellan (1994) note that these types of evaluations should be implemented two years after the development of the teaching program. The reason lies with giving management and similar stakeholders a year to incorporate the program into the curriculum and to allow students and prospective TAs to become familiar with the soundboard program. The second year would involve the incorporation of a testing schedule designed to discover when the program should best be used and implemented. Two methods testing the efficacy of the program could be devised.

The first involves a testing schedule to follow a format where the five or six audio labs would be introduced to the CAI program in different stages. The purpose is to determine when this program would best serve the needs of the students if the course is not altered. Comparisons between students and the time when they were introduced to the program could be made after the evaluator does the laboratory exam.

While the possible correlation between time and performance in the studio has been suggested, the course evaluator could analyze the curriculum to note which concepts, procedures, and knowledge were introduced into the classroom to create this relationship. This would give the teacher resources to alter the curriculum in the future if the desire for modification is there. To increase the validity of the proposed evaluation, a similarly structured summative evaluation should be repeated the following year to confirm relationships.

The second method could integrate the proposal for using a manual to assist students with learning the soundboard of the studio. A test group using a manual with the program could be compared to two groups, one using the program by itself and the other using the manual on its own. This evaluation would confirm which media is best suited to teach audio concepts to students.

Given ethical concerns, I would not devise a summative evaluation that would preclude anyone from using the new instruction. I believe that this study demonstrates the program's value in teaching the audio concepts it sets out to teach and that it fulfills the need for giving students a chance to practice skills in an environment that provides guidance. What hasn't been established is that whether this computer-assisted instruction is better than another medium or if a combination of media would best help students develop audio production skills.

Toolbook as a Multimedia Authoring Program

Toolbook is a powerful multimedia-authoring program. People learning the program can achieve results with relatively little effort and time. However, these results are similar to presentation programs like *Microsoft's PowerPoint*. To exploit its potential, the instructional designer needs to develop concepts that require a steep, and sometimes overwhelming learning curve. Being versed in how concepts like 'system variables' and 'system real variables' operate allow for the development of simulated computer interaction, which in turn makes multimedia instruction exciting. Scripting tends to be the hardest part of learning the software even though it uses higher order language, i.e., the words used to convey commands are similar to every day language.

Textbooks designed to teach *Toolbook* were lacking, although I found many describing popular authoring programs like *Macromedia Director* and *Adobe Acrobat*. This tempted me to use another software program, but the unavailability of a competent resource person for these programs precluded me from doing so. In turn, I used a manual designed to explore an older version of this software. It helped me formulate basic concepts and design skills and it taught me to use language that would assist in getting scripting information from D.I.D.'s *Toolbook* expert.

I was surprised by the simplicity of designing graphics. Although they were not high definition representations of the real soundboard, the drawing tools provided adequate support to recreating the desired components. They also eased fears stemming from my inability to draw. All graphics provided sufficient cues to learners. Had I time to recreate this program, the graphical interface to the soundboard program could be designed better.

When high definition graphics are needed, *Toolbook*'s ability to import media makes up for its lack in its drawing capabilities. Media can be imported in a number of ways, which accommodates those who are comfortable with a certain methodology of importing media. Sound, video, and graphics developed by more sophisticated programs can be implemented with relative ease into the designer's courseware.

I believe this authoring program is useful for creating instruction that requires an interactive element. *Toolbook* is also a good program to create courseware that will assist students enrolled in similar equipment intensive courses. However certain conditions must be met in order for future designers to accomplish their instructional goals.

Time and dedication are a must to learning the program. I am fortunate to have had the availability of a resource person to guide me through the many stages of the soundboard program's development. Given the possibility of devising a course that teaches people the development of interactive courseware, a pre-requisite study in the use of this multimedia authoring program should be arranged.

Possible Future Research Topics

Student performance during the tests confounded me. I expected those writing the paper-and-pencil tests to do better than those demonstrating skills on the real equipment. The opposite was found. Research needs to examine how students transfer knowledge from a virtual environment to a real one. Motivational, cueing, and perceptual factors are domains that could be explored when investigating this phenomenon. This would help the development of future courseware by describing the variables needed to ensure success.

Although extensive studies have been done with advanced virtual environments, relatively little has been researched into learning more mundane skills such as those taught in this study. Test flight simulators are a prime example of a training program that involves the use of a graphical interface to help condition pilots to many different flight situations.

I would have like to have seen more work in the area of using animated graphics as a teaching tool for less intensive situations. Possibilities could include the research of developing courseware for everyday situations from setting up a stereo to learning how to use a video camera. With the proliferation of computers and the introduction of the Internet into many households, companies could offer simple interactive instruction to common problems normally solved by a '1-800' help-lines.

I would like to see computer-assisted learning programs such as this one developed further. The next logical step is to integrate the CAI program with the physical equipment it is teaching. Learners going into the recording studio could 'ask' the computer to demonstrate correct procedures. Studies could be devised to see how students retain the information with a control group using traditional CAI, to compare retention under different conditions. Possible research questions from this type of study could include:

- Do students become dependent on technology the more it intervenes? Can this knowledge be transferred to other equipment in other recording studios?

- Is there a correlation between technical ability and artistic vision? Given that a computer supplies procedural rules, will student projects be closer to learners' original intent provided they know the limitations of the equipment being used?

The Cyclical Nature of the Instructional Design Process

I conclude this study by adding my thoughts on the instructional design process. When I first chose to study this field, I assumed incorrectly that the design of instruction would be linear: One does an analysis, an instructional strategy is devised on that analysis, an evaluation uncovers problems, problems are fixed based on the evaluation findings. However, the instructional design process is circular in nature; one is constantly revising, reorganizing, and redesigning the instruction to achieve the goals set out in the analysis.

I based this impression during analysis stage prior to the development of my courseware program. I thought that if this stage of the process were done with rigor, the strategy and the evaluation stages would be straightforward. However, I found elements within the analysis that changed constantly. For example, I originally was going to produce a manual to address the problems with the 'Sound in Media' course. When the Division for Instructional Development built the computer lab, the delivery medium changed to the computer.

While the strategy stage naturally evolved as I researched ways to develop interactive courseware, the evaluation stage of the instructional design process entrenched the notion that designing instruction was not a linear process. No matter how well I thought I created instruction, the evaluation uncovered problems and better ways of communicating information.

I suggest to people wanting become instructional designers to find a model that they can work from; there are many models available that address specific or general instructional problems. The instructional designer should not only be well versed with some instructional design theories, but be familiar with most available theories. Being cognizant of these theories allows the designer to organize information depending on the needs of the instruction. For example, some theories are better than others in organizing instruction for the student with extensive prior in the subject matter. Because instructional design seems to take 'one step back before taking two steps forward,' knowing these theories can be valuable tools when an initial design fails. Finally, the instructional designer should develop a "thick skin." After many design-revisions there will always be one learner who will say: "This is really boring!" (participant #6).

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APPENDIX A: Consent Form

Consent Form

Stephan Beckhoff is a Masters student within the Communication Studies Department. As part of his thesis, he must test an instructional unit he designed as part of the requirements for completing his studies. All your answers will remain sealed until he has assigned a grade for your participation in this study.

Your answers will help Stephan correct any mistakes and redesign any technical ambiguities you feel are present. It is important you answer honestly and that you suggest alternate changes where necessary. Your help will enable Stephan to design a working instructional unit for next semester's 40-214 class.

Your names will remain confidential and will not be included in the thesis. You may be contacted to elaborate some of your answers if you desire, but you are not required to participate any further than your present commitment. You may not answer any questions you feel impose upon your privacy. If you have any questions that are not satisfied by S. Beckhoff, you may contact his thesis advisors, Dr. Richard Lewis and Dr. Kai Hildebrandt.

Thank-you,
Stephan Beckhoff

Date:____________________

I ______________________ agree to take part in this study.

Signature:____________________________________

E-mail (if you wish to be contacted later):__________________________________

APPENDIX B: Pre-Program Questionnaire

Pre-Test Questionnaire:

1. Name:
2. Age:
3. Major (if declared):
4. Gender:
5. Describe any experience you have had with sound recording equipment:

6. Describe any experience you have with sound production (theatre, home studio, band, broadcast, etc.):

7. Have you ever done work in D.I.D.'s 8-track studio? If yes, please describe your role.

8. Describe the components needed to calibrate the line levels of any sound recording equipment:

9. Describe how you would calibrate the line levels in G140:

10. Describe the concept of signal routing:

11. What do you use a computer for (check any that apply):

☐ Word processing	☐ Database	☐ Statistics
☐ Games	☐ Digital video editing	☐ Digital sound editing and recording
☐ Accounting	☐ Programming	☐ Presentations (e.g. PowerPoint)
☐ Graphics (e.g. PageMaker)	☐ Digital photography	☐ Internet
☐ MIDI	☐ e-mail	☐ Other:

APPENDIX C: Post-Program Questionnaire

Unit Testing Study:

In this part of the workshop, you are being introduced to a program being developed for the 40-214 class (*Sound in Media*). It is designed to teach students how to use the soundboard. There are two areas the researcher wants you to specifically concentrate on: **Signal Routing** and **Setting Line Levels**. You will be tested on these skills on Thursday. If you wish to return to this lab to learn more you may do so. Note the date and time spent on the program. It is important for the study.

Name:
Time Started:
Time Finished:
A) Describe what you liked about the program. Use the numbers at the top right hand corner to identify specific pages. Use other pages if necessary:

B) Describe what you did not like about the program. Use the numbers at the top right hand corner to identify specific pages and suggest an alternative method or design. Use other pages if necessary:

APPENDIX D: Signal Routing Test

SIGNAL ROUTING TEST

In this test, provide the answers in point form. Use the supplied "channel" sheets to help you. You have twenty minutes. Please print.

Example:
Q: You have a signal coming from Microphone input #1 and you want to record onto Track #3.
A:
Leave Channel #1's tape button up
Press in (down) Channel #1's 1-2 button
Turn the PANPOT to EVEN **OR** all the way to the right.

---

1. Your signal comes from Track #8 and you want to send it Subgroup #4.

2. Record the signal from Microphone input #4 to track #3.

3. Playback tracks #1, #2, and #3 by assigning them to subgroup #2.

4. How are the Subgroups connected to 8-Track recorder?

5. Record the stereo signal from the CD player to tracks #3 and #4 on the 8-Track recorder.

6. What components are connected to the MASTER faders (red)?

7. You have a stereo signal coming from the Reel-to-Reel recorder. List one way you can turn this into a mono signal?

8. How would you assign a signal from M1 to record onto track #5 of the 8-Track recorder?

9. How would you assign the above signal to record onto track #7 of the 8-Track recorder?

10. You have just recorded four tracks onto #1 through #4. List, if any, some problems which may occur if you want to record more tracks.

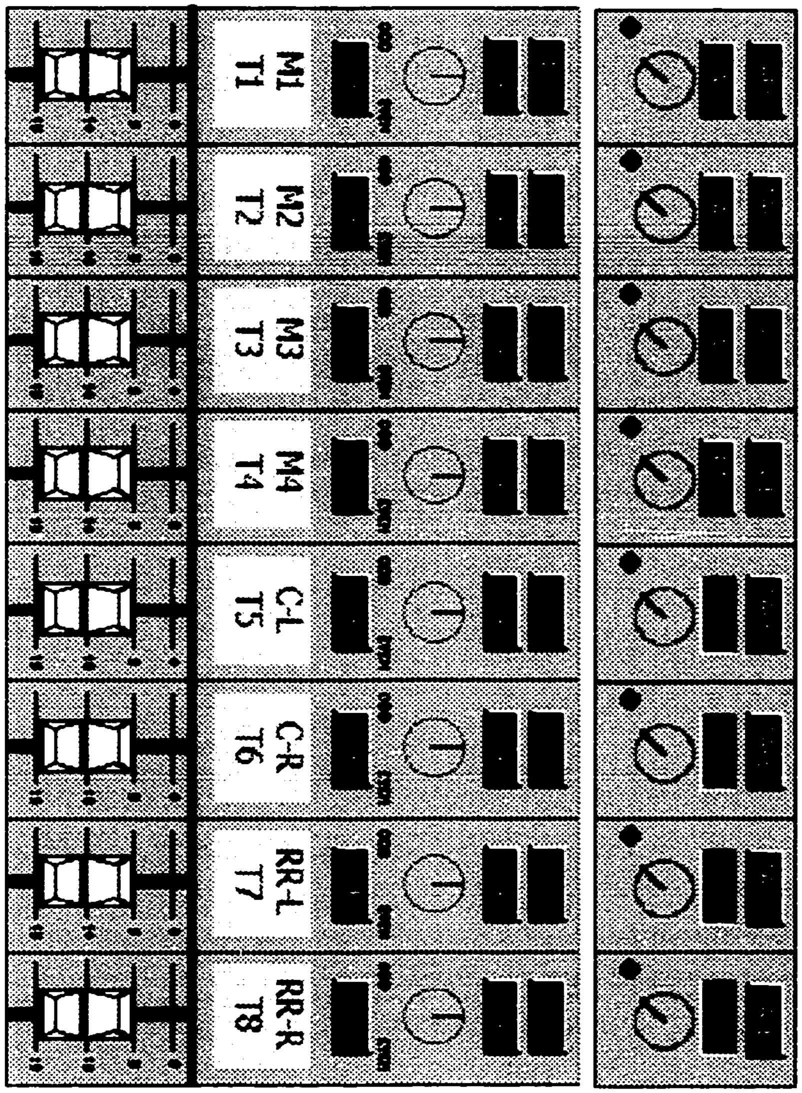
11. You have a signal coming from Track #5 and #6. Can you listen to those tracks while monitoring signals from the Cassette Recorder? Explain your answer.

12. You want to listen to tracks recorded onto #1 and #3. You want to record a signal from Microphone #2 to track #2. How would you set this up?

13. Can you record from the CD player to the Cassette Recorder? Explain your answer.

14. You have a stereo signal from the CD player that you want to record onto tracks #1 and #2. You want to play back some vocal passages that you recorded onto tracks #3, #4, and #5. How would you set this up?

Appendix D: graphic supplied with signal routing test



Appendix E

LINE LEVEL TEST

Name:
# of times you used the program:

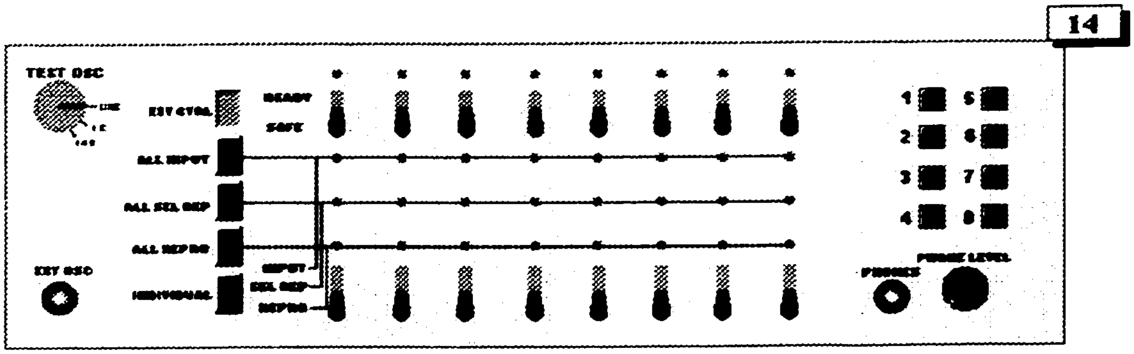
In this test, you are to indicate how one would set the line levels in G140. The steps are in order. You may answer in point form and draw arrows on the supplied graphics. Please also describe the "logic" for each step if you can.

For example:

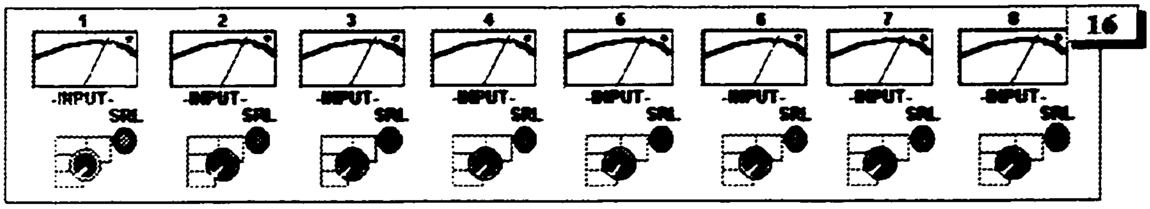
Step #8: Push in the *thingamabobber* button down.
I am pushing this button down because it allows things to bob.

REMEMBER:

This test is being administered to help the designer better the instruction. Do not worry whether your answers are right or wrong. Just write down what you remember from the instruction I gave on Tuesday Oct. 28.

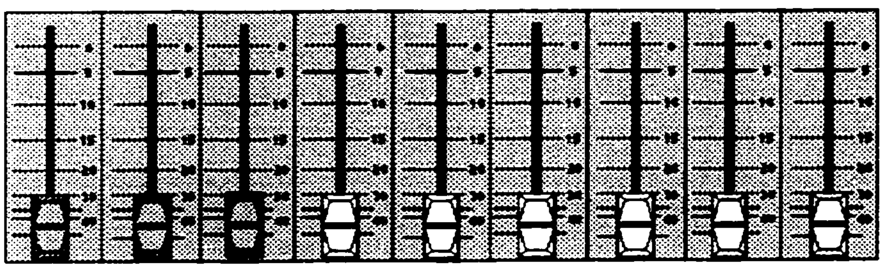


What must you do in this step? (Describe in your own words)

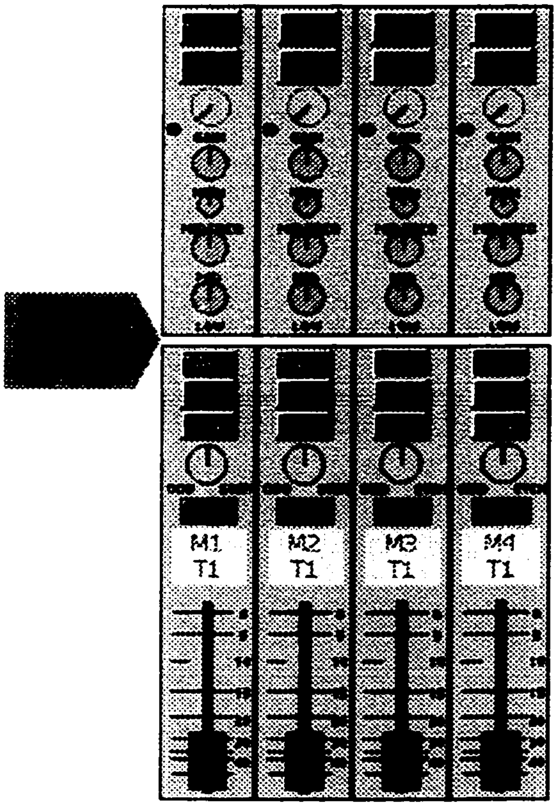


STEP #2: 8-Track Top Panel

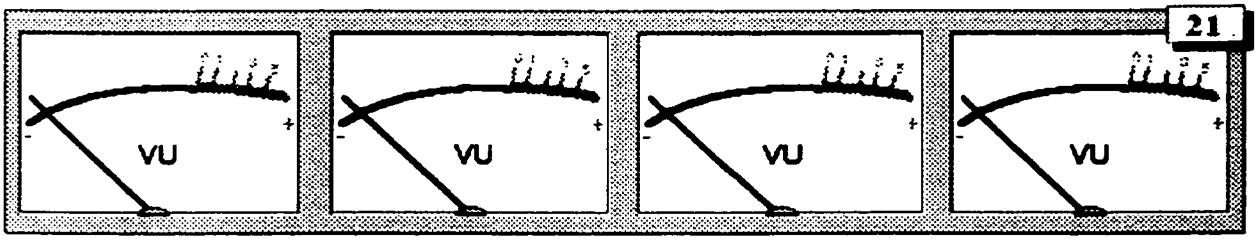
What would you do with this step? (Describe in your own words)

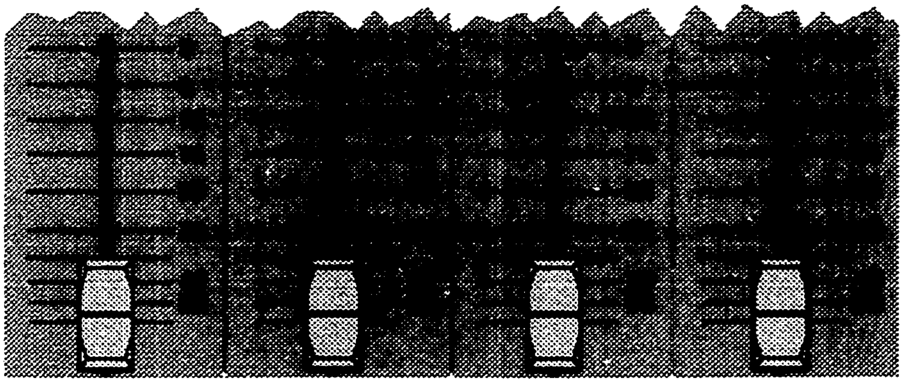


What must you do in this step? (Describe in your own words)

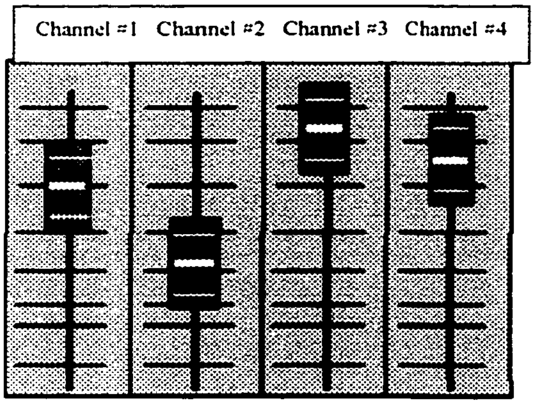


What must you do in this step? (Describe in your own words)





What must be done in this step?



Describe in your own words why the above may happen:

What is the final step in adjusting G140's line levels?

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