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Production and Evaluation of Video Segments to Stimulate Productive Problem Solving Behaviors in a Mechanical Engineering Course

Joost Davidson

A Thesis Equivalent

in

The Department

of

Education

Presented in Partial Fulfillment of the Requirements
for the Degree of Master of Arts at
Concordia University
Montréal, Québec, Canada

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ABSTRACT

Production and Evaluation of Video Segments to Stimulate Productive Problem-solving Behaviors in a Mechanical Engineering Course.

Joost Davidson

The aim of this thesis-equivalent was concerned with the design, development, and evaluation of two video segments, as introduction to problem-assignments, in an Undergraduate course in Fluid Power Control Systems, to stimulate creative thinking processes by increasing directed motivation and cultivating a more positive attitude towards productive problem-solving behaviors.

The theoretical basis to this study expands into the field of transactional psychology, cognitive and affective learning behaviors, visual thinking, and audio-visual communication.

Two types of video-taped introductions to the problem assignments were used, a descriptive as well as a case-study format introduction . For purpose of control in the evaluation of the video-taped introductions to the problem assignments, similar printed introductions to the problems were applied. The subjects for this study consisted of 28 students.

Two measurement instruments were used. Measurement instrument I was based on the assessment of four major response properties as criteria to productive problem-solving behavior, and identified as (1) unusualness, (2) appropriateness, (3) transformation, and (4) condensation. Measurement instrument II was a Semantic Differential test, used to assess the students' emotional responses towards each of the assignments during the course of study. A 3 x 3 factorial regression design was used for evaluation, and the results were statistically analyzed using Analysis of Variance and Covariance.

The results obtained in this study indicate that the video-taped introductions to the problem assignments, had a positive effect on increased student motivation and cultivated a more positive attitude towards productive problem-solving, over the printed presentations. The work of the students, who were introduced to the problem assignments through the video segments, demonstrated statistically significantly more transformation in their solution to the problem, and more condensation in their arguments in design ($p < 0.05$). When asked to record their emotional responses to the assignments in the semantic-differential tests, these students found that these assignments were more helpful, meaningful, relevant, important, useful, and purposeful, as well as exiting, interesting, stimulating, and intellectual ($p < 0.05$).

The experiment was conducted within the parameters of the existing academic curriculum and the established educational environment. Consequently, a relative small sample was available for evaluation. Because of the pseudo-experimental nature of the evaluation programme, it is not considered justifiable to derive general conclusions following the results of this study.

Acknowledgements

The author wishes to acknowledge the support that was given by Dr. J. Svoboda of the Mechanical Engineering Department of Concordia University. His expertise to bridge industry and education and his personal interest in the education of his students, was instrumental to the success of this project.

Thanks are also due to Dr. G. Boyd and Jan Veldman for their invaluable guidance, Dr. M. McKinnon of Canadian Aviation Electronics Inc., Mr. D. Barklay of Rite Manufacturing Ltd., Mr. A. Soch of Festo Inc., Mr. B. Queenan of the Audio Visual Department, and many others who gave generously of their time, expertise and patience without which the project could not have been successfully completed.

Preface

The following dissertation represents a summary presentation of the theoretical antecedents, design framework, and evaluation processes of two video-tape productions prepared, modified, and accepted for inclusion as curriculum support materials in an undergraduate programme offered in the Mechanical Engineering programme in the Faculty of Engineering in Concordia University, Montréal, Québec, Canada.

The Video-tapes, together with this background account, are submitted as a thesis-equivalent in partial fulfillment of the requirements for the Degree of Master of Arts in Educational Technology, option B, at Concordia University.

As a prelude to the project, a Professor in the Mechanical Engineering Department expressed a need to enhance the learning experiences of engineering students in the fluid-power control system course which he taught, by the introduction into the course-work of the types of engineering problems found in industry.

A proposition was accordingly prepared, to research, design, produce, and evaluate, two video-tape segments introducing such engineering problems, given during the course to the students as assignments, on a trial basis.

The objective of these video-taped introductions was to simulate a real engineering problem-situation in industry. It was expected that through these introductions, the students would be able to relate to the problems in a professional manner, and as a result, the students would be educated to display productive problem-solving behaviors.

The Professor, who had taught the course in fluid-power control systems over the four previous years, expressed the need to redesign the existing curriculum. New developments in fluid-power control, and the addition of many educational materials, which had been acquired over a period in the laboratory for student experimentation and support of the lectures, as well as the addition of the use of video-taped introductions, called for a basic re-examination of the published course-content and educational objectives.

During the winter term of 1984, two introductory video-tape segments were produced, and with a newly defined curriculum used in the course on a trial basis, to test its effectiveness.

This paper accompanies the two video-tape segments produced. The first two chapters present the educational context to the video-tape segments, the course content and educational objectives, as they were developed as part of this study, and the curriculum, as it was accepted during the trial period.

Chapters 3 and 4 present the strategy in design, design, and evaluation procedures followed in the production and evaluation of the project.

The results and conclusions of the study are described in the last two chapters, and recommendations for future research are given.

Following the trial period, and upon the results of this study, the revised curriculum was implemented as an integral part of the study in Fluid-Power Control Systems in the Mechanical Engineering Department of the University.

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Chapter 1

The Educational Context of this Thesis-equivalent

1.1 Introduction: Motivation and Learning

Although the use of visual media is widely accepted pragmatically in education as a valuable means for fostering cognitive and affective learning, there is little evidence on the direct relationship between visual presentation and purposeful act by the perceiver.

In his article "Perception, Communication, and Educational Research", Norberg (1953) mentioned:

> We cannot say what an individual will learn from any discrete visual presentation, as such, and aside from a context of purposeful acts carried out with continuity of purpose and direction. All action is not overt or 'physical', but to maintain and carry forward a line of purposeful action, in time, requires adequate conditions of sensory contact with the environment. We learn from visual presentations in so far as they make it possible, or easier, for us to carry out our purposes. As we learn from perceptions, and to new ways of perceiving things, our 'assumptive form' world changes and this

> involves the most complex organizations of our behavior including social attitudes and conceptions. We cannot learn without acting. We cannot act without perceiving. (Norberg. K., A.V.C.R., 1953, p.20).

Often the use of visual media is directed towards the acquisition of knowledge and the development of intellectual abilities and skills. The present thesis-equivalent examines one possibility of the use of video presentation in which the educational objective is primarily of a motivational and attitudinal nature. In previous studies, film has been used in teaching for affective change. These films, also called "trigger films" (Boud & Pearson, 1979; Fish, 1972), belong to a class of educational materials, whose aim is to stimulate or provoke affective learning behaviors. The use of "trigger" in these studies refers to "facilitating nothing else but the possibility for future action" (Ascott, 1968). The video presentations of this thesis-equivalent were designed and produced to "trigger" or facilitate the growth of purpose and direction in cognitive learning behavior of students in an engineering course.

1.2 The Educational Problem: Learning and Thinking in Engineering Courses

Much teaching of mechanical engineering to undergraduate students focuses on the acquisition of knowledge through lower cognitive performance levels in the hierarchy of learning. There is a need to stimulate higher cognitive performance levels, such as problem solving, and productive thinking. In his

"Electrical Science Course for Engineering College Sophomores , Development of an Integrated Program Utilizing a Broad Range of Materials", Balabanian (Note 1) mentions the importance of ensuring that students acquire:

1. knowledge of scientific facts and principles, and the mathematical language in which they are expressed,
2. proficiency in recognizing and applying concepts and models,
3. skill in experimentation and evaluation techniques,
4. a thorough knowledge of scientific method,
5. creative insight in their approach to new problems,
6. understanding of real engineering problems in their identification, approximation, optimization, as well as their economic, social and legal aspects,
7. personality traits appropriate to professional engineering, these being defined as: intellectual honesty, and enthusiasm for discovery.

He points out that typically, most conventional engineering programs in higher education give most attention to only the first two of these aspects (scientific knowledge and modelling skills). Brown (Note 2) identifies the importance for a student not to only "know fact X", but moreover to be able to "apply fact X in context Z". The introduction of problems provides the students with context. In his "Evaluation of Learning from Case Method Instruction in Engineering", Vesper (1969) stresses the implications of this method for the development of skills in identifying and defining practical problems, and an increasing tendency to generate alternative solutions. Thus, as Kelly (1955) mentioned in his article "Education is Communication", it is not only the task of engineering education to introduce a context for analysis and evaluation of knowledge acquired, but as well to stimulate these creative thinking processes. Evidence in past research shows that the use of film can be a vital component in teaching for affective change (Boud & Pearson, 1979), through the introduction of some of the complexity and immediacy of the 'real world', in a way that stimulates students to reflect on, and to analyze, incidents, events, and their own values.

1.3 The Educational Objectives of the Media Presentations

The educational objectives of the media presentations produced in the present thesis-equivalent, were to stimulate creative thinking processes by increasing directed motivation and cultivating a more positive attitude towards productive problem-solving behaviors [1]. Kelly states:

> One is always learning. We teachers can simply help to determine rate, direction, and quality by the variety and richness of the experiences we lead our students into (1955, p. 252).

This thesis-equivalent was intended to meet the educational objectives by means of evoking changes in the affective condition of the students. This

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[1] The operational definitions for motivation and attitude are given in section 4-2.

affective condition can be characterized as the students' mental environment. The media presentations were intended to create a condition that support this mental environment, in which the students would exhibit increased productive problem-solving behaviors.

1.4 Rational for Media Selection

It was essential to the media presentation, that a high level of reality be obtained in depicting the problems in the assignments. This meant there should be a minimum of bias (noise) between the coding of the information by the designer and the decoding of the information by the learner (Berlo, 1960). Furthermore, in material designed for motivational and attitudinal change, only limited prediction is possible as to which elements of the stimuli will "trigger" this change. Although, the learner will "perceive what he expects, or is 'set' to perceive" (Flemming, 1970), he will nevertheless perceive "whatever represents, for him, the most likely prognosis for action based upon his experience" (Kilpatrick, 1952). The perceptions of one individual or group may vary markedly from those of another in the same situation (Flemming, 1970), but are likely to vary less if a high level of reality is achieved in coding the two-dimensional representation of the three-dimensional world. Such a high level of reality in the representation of the three-dimensional world through a medium, can only be approximated through optimum coding of the visual, as well as the time dimensions in the medium (hence, tape-slide does not approximate a high level in representation of reality due to the lack of some time dimensions). The use of both auditory, and visual sensory information channels is preferred to allow for preferences in individual learning differences (Romiszowski, 1974). These conditions can only be achieved with film, video, and with very high-resolution computer graphics. The material in this thesis-equivalent was to be directed towards individual future activity of the students in creative problem-solving. The ready access to video production equipment to the writer, as well as playback units for student-viewing, with the possibility for the students to pace the playback and review the material according to personal preference, was the deciding factor in the decision to produce the introductory segments to the assignments in video, rather than film.

1.5 Outline of Content and Form of Media Presentation

A complete description of the video-tape segments produced as thesis-equivalent is to be found in Chapter 3 in the section 'Production Design'.

Two video-tape segments were produced, respectively as introduction to assignments II and III. The segment for assignment II portrays the motion system as it is used for large aircraft simulators by Canadian Aviation Electronics. The segment for assignment III portrays the present testing system for wafer check valves at Ritepro Inc. Each video-tape segment shows the present system, as well as the environment in which this system is used, and identifies and shows the interaction of all elements of the system. Given the educational objectives of the segments, and the printed material that would accompany the assignments, the emphasis in design of these segments was rather on the transfer of a 'feeling of reality', than on the completeness of the information contained. Two approaches in presentation format were used:

Descriptive introduction to a problem assignment: This is a documentary-style introduction to a problem. It is primarily designed to enable the students to familiarize themselves visually with the relevancy of the problem assignment to an industrial situation. This video-tape segment introduces the student to the world of airflight simulation, the use of simulator motion systems, and consequently the problems one faces in the design of a motion system for a light-aircraft simulator.

Case study method introduction to a problem assignment: A case study is a simulated situation, describing a real engineering problem situation in industry, where the student is asked to take up the problem where the professional in the case left off. In this video-tape segment, a consultant is assigned to design an automated testing system for a wafer check valve manufacturer. The student follows the consultant as he is introduced to the manufacturer and is given the reasons for automation of the present system, how the manufacturer presently tests the valves, and some specific technical requirements for the design of a new system.

Each video-tape segment was followed-up with printed material, in which the actual assignment, relevant to the introduction, was presented.

1.6 Some Alternative Methods of Achieving the Educational Objective

Although it is well recognized in professional engineering, that scientists and engineers need to be able to apply knowledge within specific contexts, few engineering courses emphasize the application of the knowledge acquired (Woods, Wright, & Hoffman, 1975). An alternative means to achieve the problem-solving approach in technical education is used at McMaster University in Hamilton, Ontario. A successful approach to the introduction of problem-solving has been used through simulation and gaming. Simulated problems are assigned to the students within the context of a gaming situation, in which students would run an account, calculated in monetary terms, for the purchase of information and debiting of charges for simulated downtime, loss of production, labor, or equipment needed. The objective for the students is "the best possible solution" within the restrictions. The use of gaming has some disadvantages. According to Woods (1967), the assignments need to be worked in class, and the student-to-staff ratio should be less than 10:1. Furthermore, through the use of gaming, the motivation is of a competitive nature, and so may not be effective for those students with preference for involvement in non-competitive areas, such as long-term research. A similar research project concerned the effects of training in a multistage "complete process of creative problem solving" on attitudes and behaviors of engineers, engineering managers, and technicians, actually active in the field (Basadur, Graen, & Green, 1982). Through their direct contact with the active field of engineering ('real world'), the subjects showed significantly higher preference for, and performance in, both problem-finding, and problem-solving. At Cornell University, the use of an audio-tutorial instruction unit was tested on its effectiveness towards intuitive and analytical problem-solving within a college introductory non-calculus physics course (Thorsland, 1971). The findings and conclusions made, showed a significantly increase of student's intuitive and analytic problem-solving tendencies.

1.7 The Strategy used in the Design and Production of this Thesis-equivalent

As a general strategy in the planning and design of the educational material, the procedures as described in "An Approach to the Design of Mediated Instruction" (Cavert, C. E., A.E.C.T., 1974), have been followed. These procedures evolve around an analysis of (see figure 1-1):

- frame of reference
- target population, and needs
- goals, strategy, and structure
- mediation, and diagnosis

The actual format used for the design of the curriculum follows the outline given by Lloyd and Ketchum (1981). It was found, that the professor who taught the course at the time, felt most comfortable with this format. The format was adapted by Lloyd and Ketchum for use in the design of

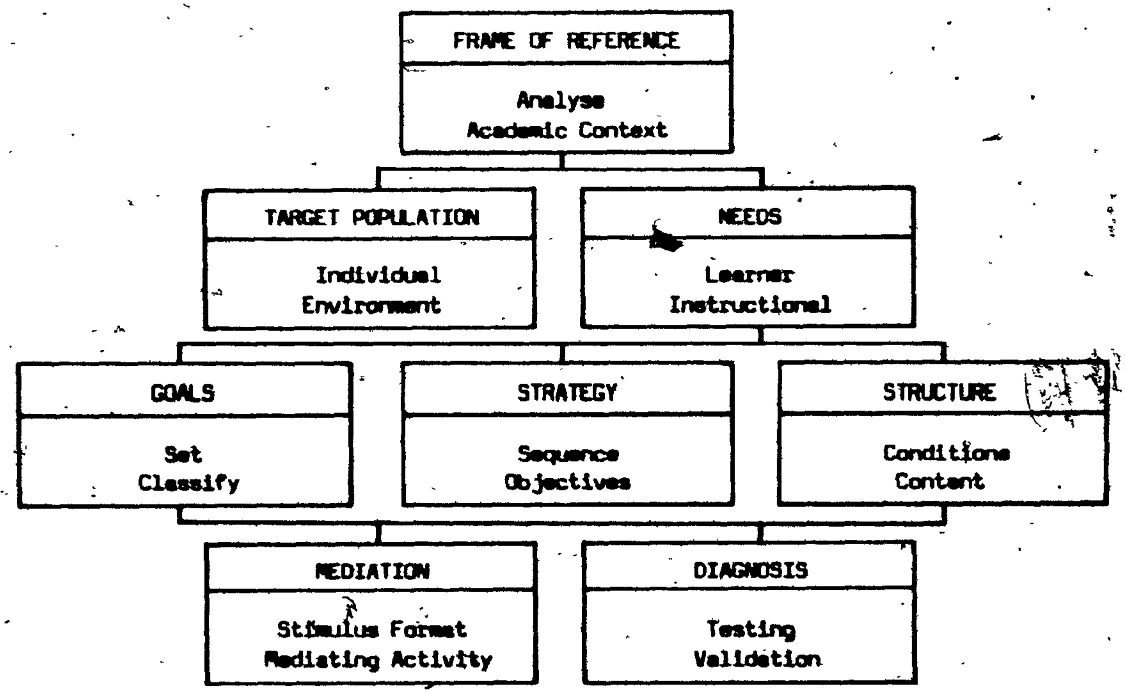


Figure 1-1. Conceptual Framework to the Design of Mediated Instruction.
(From: An Approach to the Design of Mediated Instruction, Cavert, 1974)

engineering courses from educational studies in learning theories.

The strategy for the design of the media presentation, as it is described by Cavert, focusses strongly on decisions, which are appropriate to material with instructional objectives. The motivational and attitudinal nature of the mediated materials produced, called for a somewhat different strategy in mediation. The strategy used expands into the field of communication, and visual perception and formed the basis to the encoding process of the information which was mediated into the video presentation. This encoding strategy is presented in Chapter 3.

1.8 Frame of Reference

The course in fluid power control systems had been taught by the same professor during the 4 previous years. It was found that only minor changes in the academic content of the course were necessary, primarily in areas where new developments in the field of fluid-power control called for expansion of the topic. Given the time-slots allotted to the course and the number of students registered, and the personal preference of the professor, it was decided to maintain the lecture format, supplemented with laboratory sessions. Furthermore, to give context to the academic content to be taught in the course, it was decided to include practical applications, such as simulated case-studies.

Chapter 2

The Educational Design and Curriculum for the Course in Fluid Power Control Systems

This chapter presents the educational design and final curriculum of the course in Fluid Power Control Systems, as it is presently used, after it was implemented following the trial year in which this study was conducted. During the study, it was found that new developments in fluid-power control, diverse course-objectives, the large variety of educational resources available to today's fluid-power control education, and the introduction of the use of case studies, called for a redefinition of the existing curriculum, of which the video presentation of the present thesis-equivalent is a integral part.

2.1. Profile of the Target Audience

A typical member of the target audience is a full-time student studying at the University undergraduate level, in the Mechanical Engineering Department. The student enrolled in the program three years ago and is approaching the completion of his or her studies. The student is between 20 and 30 years of age. He or she has previously followed courses in fluid dynamics and control systems. Although a full knowledge of the behavior of fluids and an understanding of concepts in control systems has been acquired, he or she had only a brief introduction to the theoretical and practical aspects of fluid power control systems. By the nature of previous studies, a learned preference for the development of intellectual abilities in the comprehension and application of knowledge has developed. The student has had previous experience with the use of libraries, and is familiar with the conventions used in lectures, with supplementary laboratory sessions.

2.2 Nature of the Educational Environment

2.2.1 Time

The course in Fluid Power Control Systems, is given over a 13-week period. Lecture periods are 3 hours per week and the laboratory sessions are given on alternate weeks for a 3-hour period. The students are expected to devote time outside regular lecture hours to study, preparation for the laboratory sessions, and work on take-home assignments.

2.2.2 Laboratory Space

For practical experience, a laboratory space with specialized experimentation equipment is available. Beside the laboratory sessions, as scheduled in the curriculum, the students will have access to the laboratory for individual experimentation. Furthermore, a space with drawing boards as "design office" is made available to the students. Following the assignments, the students will have access in the "design office" to supporting technical information as well as a video-tape playback unit for review.

2.2.3 Knowledge Resources

The students are expected to use a wide variety of resources available to them. The University libraries give access to all major academic discipline areas. The fluid power control laboratory has worked together with industry for several years, and many contacts outside the academic environment have been made. Specialized literature, as well as industrial catalogs, and technical designs in the field of fluid power control are to hand in the laboratory.

2.2.4 Professional Personnel

Both part-time, and full-time laboratory personnel are available to the students for assistance and consultation.

2.3 Entry Level of Learner Needs

Students are required to have successfully completed the courses in Fluid Mechanics I and Fundamentals of Control Systems, as pre-requisites to Fluid Power Control Systems, which is classified in their study-program as an optional or elective course. Thus, it could be expected that the individuals of the target population had developed an awareness of, and an interest in concepts of fluid-power control systems. Although they were expected to have developed an understanding of these concepts, it is assumed that their contact with the environment of practical use of what has been learned, has been limited. This lack of 'real world' experience hinders their further, affective development in appreciation, values, and adjustment (Balabanian, Note 1; Woods, 1972).

2.4 Goals, Strategy and Structure

2.4.1 Goals and Strategy

Following the frame of reference, the description of the target population and educational environment, and the definition of the entry level of learner needs, the goals or educational objectives are presented. This follows the convention as described by Cavert (1974). As mentioned in the introduction, the professor of the course felt most comfortable with the procedures as they were applied by Lloyd and Ketchum (1981). Based on Bloom's Taxonomy of Educational Objectives (Bloom et al., 1956), Lloyde and Ketchum suggest the use of a two-dimensional, content-objective matrix (see Appendix A). In this matrix, one will find on the Y-axis the academic content of the course, and on the X-axis the cognitive educational objectives. Although the educational objectives in the affective and psycho-motor domain are of importance, Lloyd and Ketchum consider only the cognitive domain in this matrix. Not only are the affective and psycho-motor objectives relatively difficult to deal with in an orderly fashion, but Lloyd and Ketchum also stress the importance of the use of an efficient and effective method to accommodate engineering educators in the use of the educational design.

In Appendix A, the matrix is given, representing the course content and the cognitive objectives. The Fluid Power Control Systems course covers four main topics:

1. Hydraulic Systems I
2. Hydraulic Systems II
3. Dynamic Analysis of Hydraulic Systems and Advance Design Techniques
4. Pneumatic Systems

The course content is carefully planned in such a way, that the students could be expected to arrive gradually at the system design stage. Each main topic follows the same pattern, from an introduction of components, their schematic representations, functions, their symbols as used in designs, basic mathematic representations, actual hardware, to sizing and circuit design. From the matrix in Appendix A, it can be noted that the educational objectives follow a pattern from lower-level cognitive objectives to higher-level cognitive objectives.

Following the evaluation of the educational objectives through the matrix presented in Appendix A, the terminal course objectives are formulated in three parts, as recommended by Mager (1962):

1. Students completing the course must have acquired an understanding of the area of fluid power control systems, and what the technology embraces; the place fluid-power control systems have in the field of engineering in general and in particular the role of automation in a

modern society. Furthermore, the students must be able to identify, select and design basic fluid power control systems and be able to present these in a professional manner.

2. The students are provided formal lectures, which include hardware examples of components and actual system designs. The students are required to obtain the textbook and additional readings, and prepare themselves for the lectures. They have access to pneumatic and hydraulic experimentation units and during laboratory sessions, laboratory personnel are at hand.

3. During the semester, home assignments are given, including the design, the selection and sizing of components, and presentation of specific systems. These are graded in compliance with selected aspects outlined in the home assignments. Laboratory design projects are assigned to small groups of students, which are graded as to their compliance with accepted industry standards. A closed-book final examination is given to evaluate the students' comprehension and application of design calculations, selection and sizing of components, and presentation of alternative designs.

2.4.2 Structure

The curriculum in its final form, can be found in Appendix B . It covers the full 13-week semester. Besides the four main topics mentioned above, it includes in addition:

- Course Introduction and Introduction to Fluid Power Control

- Fluid Flow Fundamentals, which is considered a review of previous student learning

- Phenomena Affecting Performance of Hydraulic Systems

- Review/Consultation, following the end of the formal lectures and handout of the last design assignment

In addition to the course structure, the curriculum presented in Appendix B, schedules the use of educational resources. Many of the comprehensive educational materials made available by Festo Didactic, are used throughout the course to introduce actual hardware and system designs.

The curriculum calls for three take-home assignments. Assignment II and III are case studies. These case studies are presented in the context of video-taped segments portraying a real engineering problem situation in industry, where the student is asked to take up the problem where the professional in the case left off.

Chapter 3

The Encoding Strategy and Production Design

3.1 Introduction to the Encoding Strategy

The strategy in design of the video segments is based on four sequential steps developed from the information-processing approach to the study of perception (see figure 3-1). Characteristic to television, as a communication medium, is its ability to transfer audio and visual information simultaneously. The visual effectiveness is largely dependent on the ability of the viewer to perceive visual cues through the eye, and to translate these into meaning through the brain. In their 'Statement of Theory' in "Human Behavior from the Transactional Point of View", Kilpatrick et al. define "meaning" as "a result of the transactions between a full range of percepts and the perceiver's past experience"(1952). As explained by Toch and MacLean (1962) :

> Each perception is the beneficiary of all previous perceptions; in turn, each new perception leaves its mark on the common pool. A percept is thus a link between the past, which gives it its meaning, and the future, which it helps to interpret. Perception, in other words, is a form of learning.

Perception is a process (Bettinghaus, 1960), and can be defined as a dynamic flow of perceptual acts. Essentially, this strategy sequences the encoding design steps, in order to arive at a consistency in flow of perceptual acts by the perceiver. Consequently, these design steps follow a pattern of a low level of coding to a higher level of coding, to allow for visual recognition and identification (Haber, & Hershenson, 1972). The level of coding is defined as the extent to which the perceiver has to draw upon past experience through stored information in memory (Neisser, 1967). The effective performance level of the perceiver throughout a sequence of steps, is expected to follow cognitive and affective performance levels as described by Bloom (1956) and Krathwohl, Bloom, and Masia (1956). The communication model, used in this thesis-equivalent, is Williams' "Information Transmission System for the Evoking Creativity Through the Design or Use of Instructional Media" (Williams, 1966)(see figure 3-2). In the following section the objectives are given of each of the encoding steps and their representational characteristics.

3.2 Encoding Steps

In the following section, the four steps of the encoding strategy as it was used in this thesis-equivalent, are represented.

3.2.1 Perceptual Construction Step

In this first step of design, information is represented visually in such a way

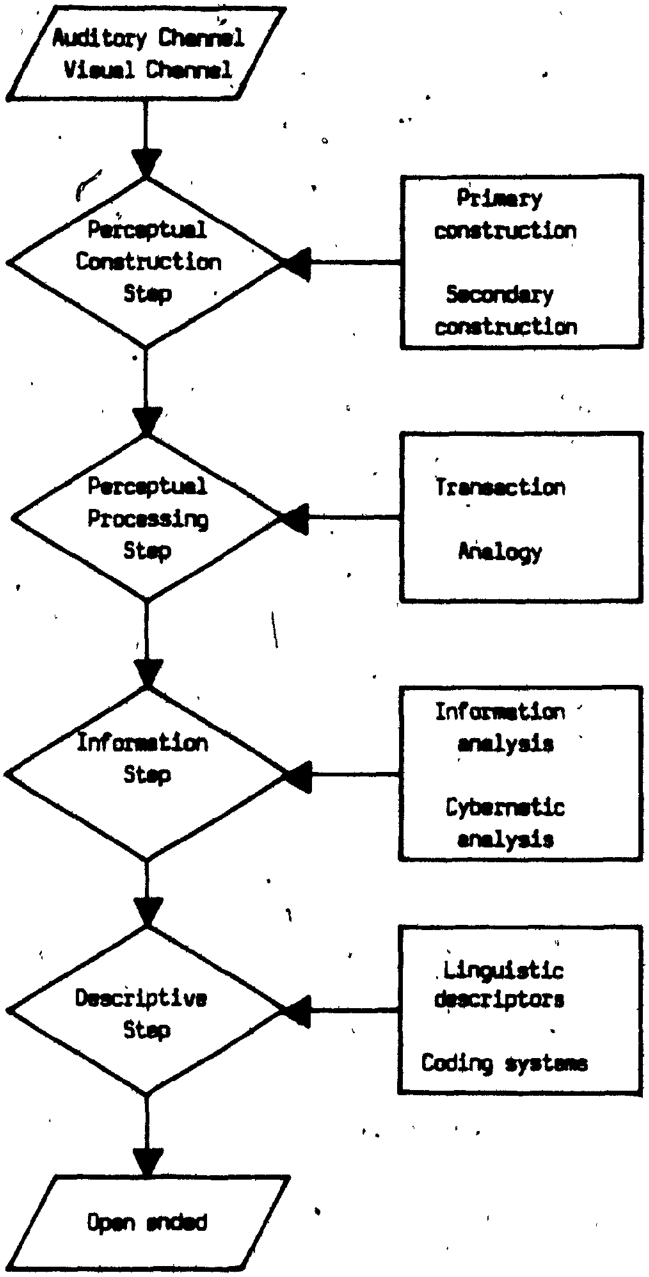


Figure 3-1. Encoding Strategy for the Mediation of Problem Solving Assignments in a Mechanical Engineering Course.

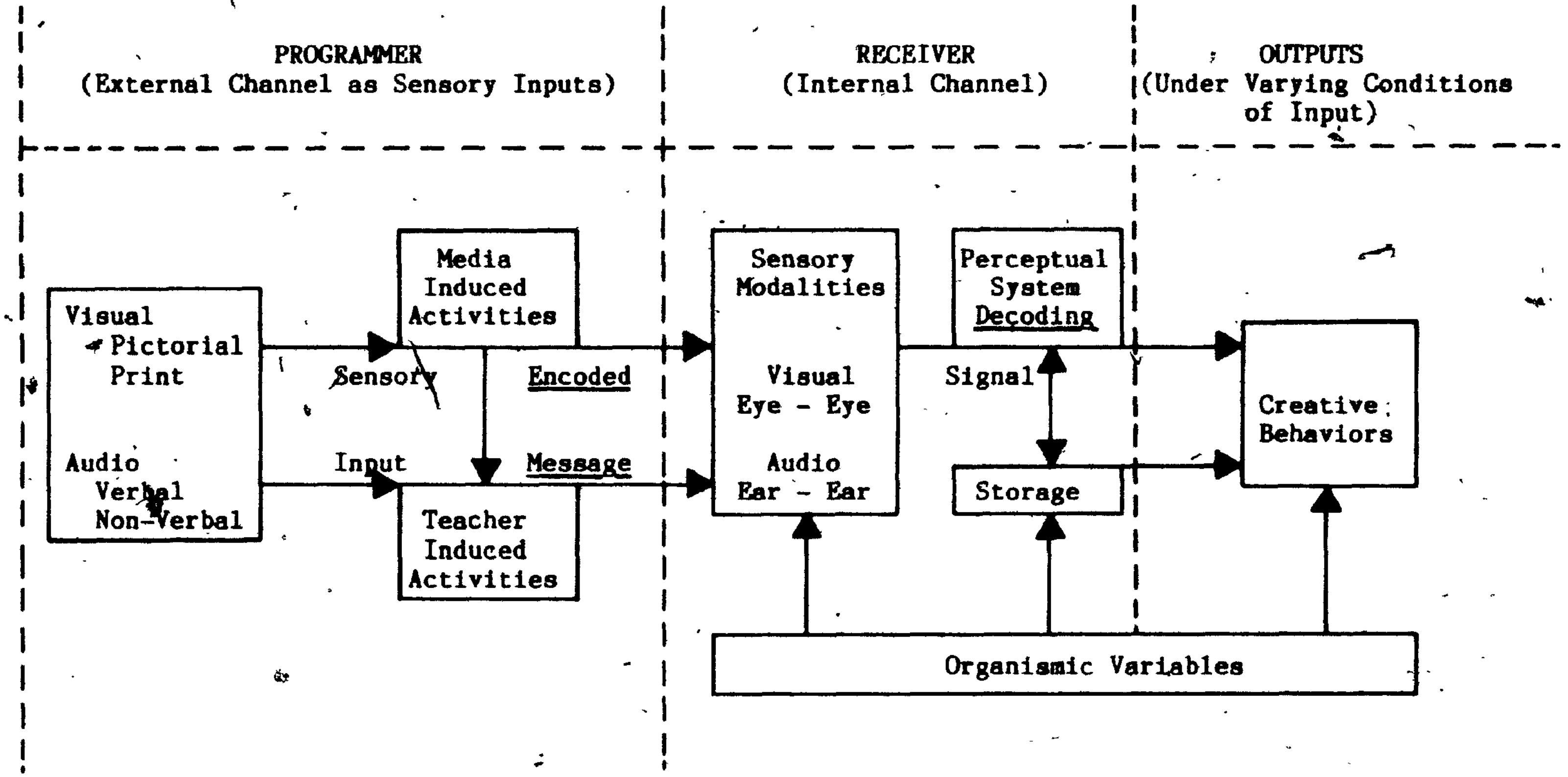


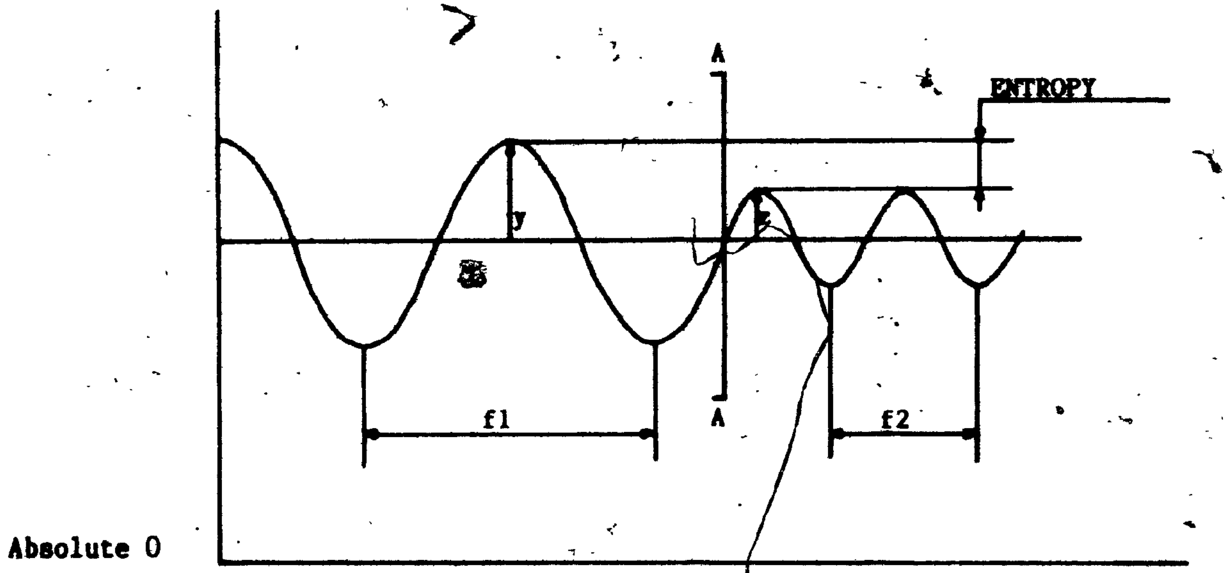
Figure 3-2. Information Transmission System for the Evoking Creativity Through the Design or Use of Instructional Media (From 'Creativity: Theoretical and Practical Considerations for Media' by Frank E. Williams. In C. W. Tayler & F. E. Williams (Eds.), Instructional Media and Creativity. Copyright 1966 by John Wiley & Sons, N.Y.).

that it is perceived as closely as possible to what is generally believed to be reality; this allows for recognition through perceptual observation, and facilitates the formation of meaning through access to prior experience. Inherent to the visual medium, is its loss of information through the use of a coding system, which in the case of video, is of an electronic and optical nature.The medium, in other words, filters some of the information. This filter (A-A; figure 3-3) causes loss of information defined as entropy of the medium. Furthermore, the effect of filtering can result in a change of information frequency, which in turn causes a loss of resolution in perception (f2-f1; figure 3-3). Characteristic of the design in this encoding step is to minimize these medium-induced effects. Consequently, in encoding the visual information, all image dimensions are kept closely within the parameters of un-distorted retinal projection. These 6 dimensions are defined by Haber and Hershenson (1972) in the sensory organisation of visual perception as:

x, y,	X- and Y-axis / 2D Object element
s,	Station point / Spatial element
I,	Luminance / Light intensity element (contrast)
λ,	Chroma / Color element
t,	Time / Physical- and Mental-time elements

The objective of this step is to allow for primary and secondary construction of abstractions (Neisser, 1967), and the transaction between visual percept and one's past experience should be facilitated.

Characteristic representations of this step in the video-tape segments produced, are:



Result filter AA:Entropy = Amplitude y - Amplitude z

Loss of Resolution = Frequency f1 - Frequency f2

Figure 3-3. Media Induced Transmission Loss of Information .

(NOTE: the use of 'system' in the presentation sections refers to a fluid power control system, as it is used in this thesis-equivalent).

- Survey of location
- Survey of user
- Survey of production facility
- Survey of products
- Survey of purpose of the system, and its environment

3.2.2 Perceptual Processing Step

In this step, information is transferred in such a way, as to allow for a full "transaction" (Dewey, & Bentley, 1949). In the transactional approach to visual perception, the perceptual process emerges as a dynamic fusion involving cues from the environment, assumptions, and action. The process is one in which cues from the environment are related to assumptions, giving rise to perceptions which are "prognostic directives" for action (Kilpatrick, 1952). Action based on perception has its consequences in relation to purpose, which are reflected in the modification of assumptions and/or the bringing into play of different assumptions. The material in this step is characterized by its centering on the learner's assumptions, brought about by selection of the information pattern given. This step in the design of visual information transfer is of a mechanical nature, it is dynamic and analytical. Whenever possible, these "prognostic directives" will follow an analogy between the information transferred and the receiver's closest emotional world, his or her human organism and bodily functions.

Characteristic elements to this design step in the video-tape segments produced, are:

- An overall, global visual presentation of purpose of the system
- A detailed, elemental visual presentation of purpose of the system
- An analogy of purpose of the system to emotional world experiences

3.2.3 Information Step

The previous step focuses on the alteration of (unconscious) assumptions, and the formation of "prognostic directives" for action. The aim within this step is the visual transfer of data, and the formation of meaning. The affective educational objective is positive valuing and logical organization of the information transferred. This step requires of the perceiver to become actively involved with the learning process. The visual and auditory stimuli evolve around an analysis of the functions of elements, relevant to the information transferred, as well as to the process in control and communication, between these elements (action-reaction).

Characteristic elements to this design step in the video-tape segments produced, are:

- Identification of all elements of the system
- Identification of functions of all elements of the system

- Low-level coded description of function of all elements of the system
- Identification of interaction between the elements of the system
- Low-level coded description of interaction between the elements of the system

3.2.4 Descriptive Step

The purpose of this step in the encoded information transfer is to achieve a bridging between the established auditory and visual coded formation of meaning, and other coding systems. This step is of a descriptive nature, and introduces the relationship of the information transferred to general accepted academic disciplines. The use of coding systems, appropriate to these disciplines, permits at this stage the use of a low level of 'perceptual reality', and a high level of coding. Examples of such coding systems are mathematical, chemical, and mechanical descriptors.

Characteristic elements to this design step in the video-tape segments produced, are:

- High-level coded description of purpose and function of system, such as specifications of the system.
- High-level coded description of purpose and function of the elements of the system, such as specifications in sizing and sequential design.

3.3 Production Design

3.3.1 Introduction

In partial fulfillment of this thesis-equivalent, and according to the requirements following the curriculum as it is outlined in Chapter 2, two short video segments were produced.

The first segment was of a descriptive nature. It introduced problem assignment II using a documentary style.

The second segment was a case-study introduction to problem assignment III and was intended as such, to simulate a real engineering problem-situation in industry.

3.3.2 Assignment II

Assignment II was related to the design of a hydraulic motion-system for a light aircraft simulator. The intent of the video-tape segment was to introduce the students to (1) the field of air-flight simulation in general, (2) new developments leading to the design of light aircraft simulators in specific, (3) the requirements of, and actual hardware involved in the motion-systems used for large aircraft simulators, and (4) the specific requirements which should be taken into consideration for the design of a motion-system for light aircraft simulators.

The video-taped documentary-style introduction was used with Assignment II, conform the curriculum. Assignment II is given in Appendix F.

A treatment for the video segment was written. This treatment (see Appendix D) was given as printed introduction to assignment II for control to group II and III.

The treatment was further visually developed, into a synopsis, conform the four steps of the strategy, as previously described in Chapter 3. This synopsis is given in Appendix E, and presents:

(1) A global introduction to air-flight simulation, the training of aircraft pilots, and the production facilities at Canadian Aviation Electronics.

(2) A global as well as a more detailed visual presentation of the different elements, characteristic to air-flight simulators.

(3) Presentation of the different motions required, identification of the elements of the motion system, their functions, and the interaction between them.

(4) Specific technical considerations and requirements for the design of a motion-system for light aircraft simulators.

The documentary-style nature of this video-tape segment, implied the use of on-location shot-lists. The actual script, was developed during off-line editing. The segment, in its final form is 6 minutes 26 seconds.

3.3.3 Assignment III

Assignment III was related to the design of an automated testing facility for the testing of wafer check valves. The intent of the video-tape segment was to introduce the students to (1) an industrial problem situation, (2) the need for a satisfying solution to the problem, (3) an insight to the environment in which the problem arose, (4) and the considerations which should be given to a possible solution of the engineering problem, specific to the environment of use.

This case-study type video-taped introduction was used with Assignment III, conform the curriculum in Chapter 2. The assignment itself, is given in Appendix J.

Again, a treatment was developed, which was the basis for the synopsis and was used as printed introduction for group III for control (see Appendix G).

Using a case-study style approach in the design of the introduction, simulating a real engineering problem in industry, and following the four steps of the design strategy, the synopsis was developed (see Appendix H), and presents:

(1) A global introduction to the need to improve the present testing system of the wafer check valves, and an insight to the industrial situation.

(2) A global as well as a more detailed insight to the actual testing facility, and the requirements for testing the valves.

(3) Identification of all elements of a testing facility for wafer check valves, their functions, and interactions.

(4) Technical requirements, to be considered in the design of a automated testing facility for wafer check valves, as well as requirements specific to the pneumatic control system.

In the production of this segment, actual engineers in the field were asked to role-play a part. The on-location schedule used, is given in Appendix I. The video segment, in its final form is 14 minutes.

Chapter 4

Production Evaluation

The following account outlines the formulation of the hypotheses and the definition of the variables as well as the description of the procedures as they were carried out for the purpose of evaluation of the production.

4.1 The Evaluation Question

As the purpose of this thesis-equivalent was to develop educational materials to stimulate creative thinking processes by increasing directed motivation and cultivating a more positive attitude towards productive problem-solving behaviors, the evaluation questions were stated as follows:

1. Does a video-taped introduction to an engineering problem assignment result in a more productive problem-solving behavior of the student, than a similar printed introduction to the assignment?

2. Is there a significant difference between a video-taped descriptive introduction and a video-taped case-study introduction of an engineering problem, in the productive problem-solving behavior of engineering students?

4.2 Definitions

In the formulation of the hypotheses, the following definitions of the concepts were used:

Problem assignment: Problem assignment, in this context, refers to the assignment of an engineering problem in the field of fluid-power control, in which the student is expected to respond in a professional manner with a solution to the problem.

Video-taped introduction: refers, in this context, to a video-tape segment introducing a fluid-power control problem assignment. The video-tape segment is expected to provide the students with at least the information necessary for them to comprehend the full scope of the problem.

Productive problem-solving: refers to the response behavior of the students in solving the problems given in the assignments. Productive problem-solving is characterized, according to Jackson and Messick's "four criteria of a creative product", by four response properties, (1) unusualness, (2) appropriateness, (3) transformation, and (4) condensation.

Attitude and motivation: refers, in this context, to the students' attitude and motivation towards productively solving the assigned problems, and is assessed through the students' responses given in a 35-item Semantic Differential test.

Printed introduction: refers, in this context, to a written introduction to an engineering problem in the field of fluid-power control, in which the student is expected to respond in a professional manner with a solution to the problem.

Level of simulation: Level of simulation, in this context, refers to a descriptive versus a case-study presentation of an engineering problem in the video-tape introduction to the problem assignment.

4.3 Hypotheses

With the above definitions in mind the hypotheses were formulated as follows:

H1

At different levels of simulation, a video-taped introduction to a fluid-power control problem assignment has a significant effect on the problem-solving behavior of the student, in respect to unusualness in design process, over a similar printed introduction

H2

At different levels of simulation, a video-taped introduction to a fluid-power control problem assignment has a significant effect on the problem-solving behavior of the student, in respect to appropriateness of design content, over a similar printed introduction

H3

At different levels of simulation, a video-taped introduction to a fluid-power control problem assignment has a significant effect on the problem-solving behavior of the student, in respect to transformation in problem solutions, over a similar printed introduction

H4

At different levels of simulation, a video-taped introduction to a fluid-power control problem assignment has a significant effect on the problem-solving behavior of the student, in respect to condensation of design arguments, over a similar printed introduction

4.4 Rationale for the Hypotheses

The theoretical justification for the hypotheses is based on the introduction of a 'sense of reality', to allow for adequate conditions of sensory contact with the 'the real world', and the formation of meaning (Norberg, 1953; Kilpatrick, e.a., 1952). Furthermore, findings by Boud and Pearson (1979) on the use of film as 'trigge[illegible]ports the use of an audio-visual medium for change in affective learning.

4.5 Subjects

The subjects for this study consisted of a total of 28 students, who were enrolled in the course in Fluid Power Control Systems during the winter term of 1984, as part of their Undergraduate studies in Mechanical Engineering at Concordia University in Montreal.

4.6 Measuring Instruments

Two measuring instruments were used. One was based on the assessment of productive problem solving behaviors of the subjects (I) and the other on the subjects' motivational and attitudinal assessment following a semantic-differential format (II).

4.6.1 Measuring Instrument (I)

This measuring instrument is based on Jackson and Messick's "four criteria of a creative product" (1965). Jackson and Messick describe four major response properties as criteria for productive problem solving behavior: (1) unusualness, (2) appropriateness, (3) transformation, and (4) condensation. The judgmental standards associated to these response properties are, respectively, (1) norms, (2) context, (3) constraints, and (4) summary power (see Figure 4-1). A 4-item 7-point rating scale based on these criteria was applied as

Predisposing Cognitive Styles	Personal Qualities	Response Properties	Judgemental Standards	Aesthetic Responses
Tolerances of incongruity, of inconsistency, etc	Original	Unusualness	Norms	Surprise
Analytic and intuitive	Sensitive	Appropriateness	Context	Satisfaction
Openminded	Flexible	Transformation	Constraints	Stimulation
Reflective and spontaneous	Poetic	Condensation	Summary power	Savoring

Figure 4-1. Criteria of Productive Problem Solving Behaviors. (From: The Person, the Product, and the Response; conceptual problems in the assesment of creativity, Jackson & Messick, 1965)

measurement instrument during the course of the study in the assessment of productive problem-solving behavior(see Appendix K, Measuring Instrument I). For reasons of internal validity of the measurement instrument, the use of two or more raters and the use of the Kendall Coefficient of Concordance were considered. The measurement instrument, however, would be applied by the course instructor and consistency in rating procedure had to be considered paramount, in conformity with the higher education system.

4.6.2 Measuring Instrument (II)

This Semantic Differential test was used to assess the student's emotional response towards each of the assignments used during the course of study. Basic to this measuring instrument are thirty-five 7-point scales, each of which is independently described by a pair of adjectives. The span of most of these scales is between an unfavourable and a favourable pole, and the direction of the scales are randomized (see Appendix L, Measuring Instrument II).

This measuring instrument was used in a study by Bolton and Adderley (1978) in the assessment of student motivation during the development of industrial case-studies for an electrical engineering course. A similar instrument was originally used by Musgrave and Smithers (1971) for a study in student reactions to teaching methods. Bolton and Adderley adapted those scales, not suitable for the assessment of motivation, by more suitable scales that had been used elsewhere by Hughes (1970) and Osgood (1964).

The measuring instrument was checked for internal consistency and a

Cronbach reliability coefficient of 0.90 was obtained. All scales were found to be equally reliable statistically.

4.7 Evaluation Design

For the purpose of evaluation in this study, a 3 x 3 factorial regression design was used (see Figure 4-2). Treatment (X) was a test in the form of a problem assignment with three levels, assignment I, assignment II, and assignment III. The moderator in this design (Y) was the format used in the introduction of the assignments. The moderator had 3 levels, a printed introduction, a video-taped descriptive introduction and a video-taped case-study introduction to the assignments (See figure 4-3 for the distribution of the moderator variables over groups and assignments). Although the students were not randomly assigned to the three groups specifically for the purpose of this study, but by virtue of their scheduled laboratory sessions, the groups could be expected to be equivalent. Control for invalidity through history, selection, and maturation was applied through assignment 1 as pre-test (X1) with $p < 0.05$.

G1 = X1 Y1 01 X2 Y2 02 X3 Y3 03
G2 = X1 Y1 04 X2 Y1 05 X3 Y3 06
G3 = X1 Y1 07 X2 Y1 08 X3 Y1 09
-------> T1 ------> T2 ------> T3 --

Figure 4-2. Evaluation Design

Analysis of Variance with repeated measures was used for between-groups main effects, between-tests main effects and Analysis of Covariance for main interaction effects between groups and tests.

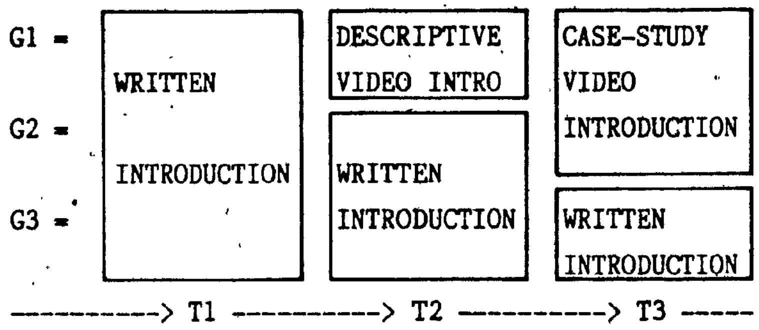


Figure 4-3. Distribution of the Moderator Variables

4.8 Variables

The variables were identified as follows:

4.8.1 Independent variables:

- Problem assignment I (X1),
- Problem assignment II (X2),
- Problem assignment III (X3).

4.8.2 Dependent variables:

- Productive problem-solving assessment (O s1),
- Semantic-differential test (O s2).

4.8.3 Moderator variables

- Printed introduction to problem assignment (Y1),
- Video-taped descriptive introduction to problem assignment (Y2),
- Video-taped case-study introduction to problem assignment (Y3).

4.8.4 Control variables:

- Time-span between treatments (T1,T2,T3),
- Student's previous academic achievement in fluid-power control systems,
- Terminal course objectives.

Chapter 5

Results

5.1 Data Collected

The three goups used for the purpose of evaluation of this study, were previously assigned according to their laboratory session schedule (G1, G2, and G3). The three assignments were assigned, respectively, in week 5, week 9, and week 12, according to the time-table as outlined in the curriculum in Appendix B (T1, T2, and T3). Assignment I, which had a printed introduction to the problem, was the same for all three groups, and used as pre-test for control of between-group differences. Group I viewed a video-taped descriptive introduction to problem assignment II (Y2) and a video-taped case-study introduction to problem assignment III (Y3). Group II was given a printed introduction to problem assignment II (Y1) and viewed the same video-taped case-study introduction to problem assignment III (Y3). Group III had in all three cases a printed introduction to the problem assignments (Y1).

The assessment of productive problem-solving behavior (measurement instrument I) was applied by the course instructor on the students' work for design process, design content, problem solution and summary of design

	PROCESS	M1	M2	M3	S1	S2	S3
1	Assignment I	4.13	4.37	4.43	1.15	0.99	0.88
2	Assignment II	4.35	3.79	3.40	0.75	0.84	0.73
3	Assignment III	3.93	3.25	3.00	0.65	1.48	1.52
	N =	10	8	10			

Table 5-1. GROUP MEANS AND STANDARD DEVIATIONS FOR THE ASSESSMENT OF PROCESS IN ASSIGNMENTS I, II AND III

	CONTENT	M1	M2	M3	S1	S2	S3
1	Assignment I	4.41	3.41	3.79	0.93	1.37	0.67
2	Assignment II	4.15	2.83	2.81	1.59	0.95	1.34
3	Assignment III	4.70	3.63	3.75	1.07	0.92	0.79
	N =	10	8	10			

Table 5-2. GROUP MEANS AND STANDARD DEVIATIONS FOR THE ASSESSMENT OF CONTENT IN ASSIGNMENTS I, II AND III

	SOLUTION	M1	M2	M3	S1	S2	S3
1	Assignment I	4.23	4.50	4.43	0.98	1.03	0.63
2	Assignment II	4.30	3.79	3.35	0.86	0.83	0.71
3	Assignment III	4.45	4.63	2.90	0.93	0.89	1.47
	N =	10	8	10			

Table 5-3. GROUP MEANS AND STANDARD DEVIATIONS FOR THE ASSESSMENT OF SOLUTION IN ASSIGNMENTS I, II AND III

	ARGUMENTS	M1	M2	M3	S1	S2	S3
1	Assignment I						
2	Assignment II	3.40	2.58	2.91	1.20	0.55	1.16
3	Assignment III	4.10	4.03	2.58	1.05	0.78	1.07
	N =	10	8	10			

Table 5-4. GROUP MEANS AND STANDARD DEVIATIONS FOR THE ASSESSMENT OF ARGUMENTS IN ASSIGNMENTS I, II AND III

	STATEMENT	M1	M2	M3	S1	S2	S3
1	Varied	4.9	5.0	4.2	1.2	1.7	2.2
2	Efficient	4.7	5.1	4.5	1.1	1.2	1.6
3	Intimate	4.2	4.7	4.5	1.0	1.4	1.6
4	Helpful	4.7	5.6	5.0	1.8	1.1	1.6
5	Relaxed	4.6	4.1	4.1	1.0	1.5	2.2
6	Realistic	5.4	5.7	5.6	1.0	0.9	1.2
7	Challenging	4.5	5.6	5.5	1.1	1.0	1.0
8	Pleasant	4.8	4.8	4.2	0.9	1.4	1.8
9	Meaningfull	4.2	5.4	5.3	1.5	1.0	1.4
10	Difficult	4.5	5.0	4.2	0.9	0.9	1.3
11	Clear	4.8	4.9	5.1	1.5	1.2	1.5
12	Encouraging	5.1	5.1	5.1	1.1	1.2	1.3
13	Wise	4.6	4.8	4.4	1.1	0.9	1.4
14	Exciting	4.8	5.2	4.7	0.9	0.9	1.6
15	Relevant	5.5	5.6	5.1	0.9	1.0	1.1
16	Active	4.8	5.2	4.6	1.0	1.3	1.7
17	Precise	4.7	4.8	5.0	1.0	1.3	1.5
18	Satisfying	4.8	4.6	4.2	1.1	1.7	1.9
19	Important	5.4	5.8	5.3	1.0	1.5	1.6
20	Profound	4.4	4.9	4.8	0.8	1.1	1.1
21	Good	5.3	5.6	4.9	0.9	1.5	0.9
22	Friendly	5.2	4.7	4.5	1.0	1.2	1.0
23	Interesting	4.6	5.8	5.5	0.8	1.5	1.4
24	Laborious	4.9	5.4	4.7	0.9	1.2	1.6
25	Warm	4.1	5.1	4.8	0.8	1.3	1.1
26	Stimulating	4.6	5.2	4.7	1.0	1.2	1.6
27	Fair	5.1	5.0	4.5	1.0	2.1	1.3
28	Successful	5.4	5.4	5.0	0.8	1.8	1.3
29	Useful	5.6	5.5	5.2	0.9	1.1	1.1
30	Hasty	3.7	3.8	4.6	0.8	1.3	1.3
31	Flexible	4.1	4.4	4.3	1.1	1.6	1.0
32	Rewarding	4.9	5.1	4.7	1.3	1.1	1.3
33	Intellectual	5.1	5.2	4.1	0.7	1.7	1.9
34	Unrestricted	3.8	4.4	3.8	1.3	1.7	1.0
35	Purposeful	5.7	5.8	4.9	0.9	1.2	1.8
	N =	10	8	10			

Table 5-5. GROUP 1 RESPONSES TO THE SEMANTIC DIFFERENTIAL TEST IN RESPECT TO COURSE ASSIGNMENTS I, II AND III.

	STATEMENT	M1	M2	M3	S1	S2	S3
1	Varied	4.0	3.9	4.3	1.7	1.5	1.7
2	Efficient	4.4	4.4	4.3	1.1	1.7	1.7
3	Intimate	3.4	3.5	4.6	1.0	1.3	1.0
4	Helpful	4.9	5.0	4.9	1.6	1.3	1.8
5	Relaxed	4.2	3.7	3.8	1.0	1.6	1.2
6	Realistic	4.7	5.3	5.2	2.0	1.8	1.3
7	Challenging	4.4	4.8	5.9	1.7	1.1	1.2
8	Pleasant	4.6	4.5	4.8	1.4	1.8	1.2
9	Meaningfull	5.3	5.1	4.8	1.1	1.4	1.4
10	Difficult	4.1	5.2	5.0	1.2	1.0	1.4
11	Clear	4.7	4.4	5.1	1.5	1.8	0.9
12	Encouraging	4.9	3.8	4.7	1.4	1.6	1.3
13	Wise	4.4	4.6	4.3	1.7	0.7	1.3
14	Exciting	4.4	4.3	4.4	1.1	1.5	1.6
15	Relevant	4.8	5.4	5.2	1.5	1.3	1.4
16	Active	4.0	4.4	4.7	1.4	1.1	0.7
17	Precise	5.3	5.1	5.4	1.3	1.8	0.5
18	Satisfying	5.1	3.8	4.8	1.5	1.8	1.0
19	Important	4.4	5.3	5.8	2.0	1.3	1.2
20	Profound	4.9	4.3	4.7	1.0	0.7	0.7
21	Good	5.1	4.3	4.9	0.7	1.1	1.4
22	Friendly	4.4	4.2	5.1	0.8	0.8	0.8
23	Interesting	5.0	5.2	5.0	1.3	1.5	2.1
24	Laborious	4.5	5.3	5.4	1.3	1.0	1.5
25	Warm	4.0	3.8	3.9	1.2	1.4	1.3
26	Stimulating	5.1	4.4	4.6	1.5	1.7	2.2
27	Fair	4.0	3.6	4.9	1.2	1.6	0.7
28	Successful	4.8	4.4	4.7	1.2	1.7	1.2
29	Useful	5.6	5.1	5.6	1.2	1.7	1.5
30	Hasty	4.3	4.6	4.6	1.6	1.5	1.6
31	Flexible	5.0	4.5	4.1	1.3	1.5	1.5
32	Rewarding	4.6	4.3	4.3	1.7	1.3	1.8
33	Intellectual	5.2	5.1	5.6	1.2	1.0	1.3
34	Unrestricted	4.4	4.6	4.2	1.0	1.4	1.3
35	Purposeful	5.7	4.8	5.7	0.8	1.5	1.3
	N =	10	8	10			

Table 5-6. GROUP 2 RESPONSES TO THE SEMANTIC DIFFERENTIAL TEST IN RESPECT TO COURSE ASSIGNMENTS I, II AND III

	STATEMENT	M1	M2	M3	S1	S2	S3
1	Varied	4.4	5.3	4.2	1.0	1.5	1.6
2	Efficient	4.9	3.9	4.4	1.4	2.1	1.6
3	Intimate	4.0	4.0	4.0	1.2	1.4	1.1
4	Helpful	5.4	4.8	4.4	1.6	1.6	1.5
5	Relaxed	3.4	3.0	3.3	1.4	1.8	1.2
6	Realistic	5.5	5.9	5.8	1.4	1.1	1.2
7	Challenging	5.6	5.5	5.4	1.4	1.5	1.1
8	Pleasant	4.4	3.7	4.1	1.7	1.8	1.5
9	Meaningfull	5.5	5.1	4.1	1.0	1.3	1.6
10	Difficult	4.3	5.4	5.1	1.4	0.9	1.0
11	Clear	4.0	4.2	4.8	2.1	1.5	1.0
12	Encouraging	3.9	3.7	3.8	2.0	1.3	0.9
13	Wise	5.3	5.1	4.2	1.0	1.2	1.6
14	Exciting	4.4	5.1	4.3	1.1	0.7	1.4
15	Relevant	5.7	5.0	5.0	1.0	1.3	1.7
16	Active	4.4	4.8	5.1	1.2	1.4	1.1
17	Precise	4.1	4.4	5.7	1.9	1.9	1.0
18	Satisfying	4.1	4.0	3.8	1.7	1.6	1.3
19	Important	5.7	5.5	4.4	1.2	1.5	1.8
20	Profound	4.4	4.4	4.8	1.1	1.1	1.2
21	Good	4.9	4.4	4.1	0.9	1.5	1.6
22	Friendly	3.8	3.9	4.3	1.9	1.2	1.1
23	Interesting	4.9	5.5	4.4	1.3	1.5	1.5
24	Laborious	5.7	5.8	5.1	0.7	1.2	1.9
25	Warm	4.5	4.3	3.9	1.3	1.3	1.6
26	Stimulating	4.1	4.8	3.8	1.3	1.2	1.6
27	Fair	5.3	4.5	3.8	2.1	2.1	1.6
28	Successful	5.2	4.6	4.1	1.6	1.8	1.4
29	Useful	5.7	5.5	4.3	1.2	1.1	1.7
30	Hasty	4.8	5.3	4.7	1.5	1.3	1.7
31	Flexible	4.6	4.1	3.8	0.9	1.6	1.6
32	Rewarding	4.6	4.8	4.2	1.4	1.1	1.3
33	Intellectual	5.2	5.1	4.3	1.0	1.7	1.3
34	Unrestricted	3.6	3.5	4.1	1.1	1.7	1.5
35	Purposeful	5.4	5.1	4.3	1.0	1.2	1.7
	N =	10	8	10			

Table 5-7. GROUP 3 RESPONSES TO THE SEMANTIC DIFFERENTIAL TEST IN RESPECT TO COURSE ASSIGNMENTS I, II AND III

arguments, except for problem assignment I, where a summary of design arguments was not applied. Given the nature of this assignment, it was decided that this aspect to the assessment was not appropriate, and would not add significantly to the validity of the pre-test.

The means and standard deviations of the assessment of productive problem-solving are found in tables 5-1 to 5-4 for, respectively, Process, Content, Solution, and Arguments.

After completion of each of the assignments, the students were asked to complete the semantic-differential test (Measuring Instrument II).

The means and standard deviations of the results are given in tables 5-5, 5-6, and 5-7, for groups I, II, and III, respectively.

5.2 Data Analysis

A T-test was used to examine group differences at Assignment I (pre-test) and at $p > 0.05$, no significant differences in 'process', 'content' and 'solution' between groups were found (see table 5-8).

For each of the four response properties in the assessment of productive problem-solving behaviors, an Analysis of Variance with repeated measures was used for between-groups main effects, between-tests main effect and an Analysis of Covariance for main interaction effects between groups and tests. The results of the assessment of productive problem-solving behavior are given in graphics 1, 2, 3, and 4, Appendix M.

For process and content of design, there were no significant changes over the course of the three assignments between groups (with p = 0.05 taken as the limit of acceptability). The result from the Analysis of Covariance for problem solution showed that the interaction was significant, with F(4,50)=3.68 and p < 0.02. For summary of design arguments, the interaction was found significant, with F(2,25)=3.81 and p < 0.05 .

The large number of variables (35) in the semantic-differential test, and the relatively small number of students in each group (10, 8, and 10) posed a problem to the internal validity of this part of the evaluation programme. It was decided to group principal factors according to a similar study by Bolton and Adderly (1978). In their study, following a Varimax rotation with Kaiser normalisation for factor analysis, they selected 5 principal factors using the Kaiser criterion supported by the Scree test. Table 5-9 shows the variables that account for the five major factors. These factors carried high loadings from the variables which related to, respectively, <u>relevance and usefulness</u>, <u>flexible</u>, <u>difficult</u>, <u>interesting</u>, and <u>pleasant</u> (Bolton & Adderley, 1978). Again, for each of the five response properties, an Analysis of Variance with repeated measures was applied for between-groups main effects, between-tests main effects and an Analysis of Covariance for main interaction effects between goups and tests. The means and standard deviations of each factor are given in tables 5-10 to 5-14. The results of the semantic differential tests are given in graphics 5, 6, 7, 8, and 9, Appendix M. It was found that there was a significant change between

PRE-TEST : ASSIGNMENT I / TEST GROUP 1 / CONTROL GROUP 3

	M1	M3	S1	S3	df	t
PROCESS	4.13	4.43	1.15	0.88	18	0.66
CONTENT	4.41	3.79	0.93	0.67	18	1.71
SOLUTION ARGUMENTS	4.23	4.43	0.98	0.63	18	0.54

N = 20

PRE-TEST : ASSIGNMENT I / TEST GROUP 2 / CONTROL GROUP 3

	M2	M3	S2	S3	df	t
PROCESS	4.37	4.43	0.99	0.88	16	0.14
CONTENT	3.41	3.79	1.37	0.67	16	0.77
SOLUTION ARGUMENTS	4.50	4.43	1.03	0.63	16	0.18

N = 18

Table 5-8. PRE-TEST GROUP MEANS, STANDARD DEVIATIONS AND t-VALUES

Factor	1	2	3	4	5
Intimate					0.50
Helpful	0.72				
Meaningful	0.82				
Difficult			0.68		
Clear		0.50			
Exciting				0.66	
Relevant	0.83				
Important	0.84				
Friendly					0.65
Interesting				0.55	
Laborious			0.72		
Warm					0.80
Stimulating				0.67	
Useful	0.79				
Flexible		0.81			
Intellectual				0.27	
Unrestricted		0.80			
Purposeful	0.84				
Eigenvalues	12.60	3.40	1.80	1.40	1.30

Table 5-9. Factor Analysis of Responses to Semantic Differential Test (From: *The Development and Evaluation of Industrial Case Studies to Support a New Laboratory Course in Electrical Engineering*, Bolton & Adderley, 1978).

	USEFULNESS	M1	M2	M3	S1	S2	S3
1	Assignment I	5.1	5.2	5.5	0.6	1.1	0.9
2	Assignment II	5.5	4.8	4.7	0.9	1.1	1.0
3	Assignment III	5.7	5.4	4.4	1.0	1.0	1.6
	N =	10	8	10			

Table 5-10. GROUP MEANS AND STANDARD DEVIATIONS OF THE SEMANTIC-DIFFERENTIAL TEST FOR THE FACTOR USEFULNESS

	FLEXIBLE	M1	M2	M3	S1	S2	S3
1	Assignment I	3.4	3.7	3.2	0.9	0.9	0.9
2	Assignment II	5.1	4.2	4.1	0.8	1.2	0.5
3	Assignment III	4.9	4.8	4.1	1.0	0.9	1.1
	N =	10	8	10			

Table 5-11. GROUP MEANS AND STANDARD DEVIATIONS OF THE SEMANTIC-DIFFERENTIAL TEST FOR THE FACTOR FLEXIBLE

	DIFFICULT	M1	M2	M3	S1	S2	S3
1	Assignment I	4.6	4.2	5.0	0.8	1.0	0.5
2	Assignment II	5.3	5.3	5.6	0.9	0.9	1.0
3	Assignment III	4.6	5.2	5.2	1.1	1.4	0.9
	N =	10	8	10			

Table 5-12. GROUP MEANS AND STANDARD DEVIATIONS OF THE SEMANTIC-DIFFERENTIAL TEST FOR THE FACTOR DIFFICULT

	INTERESTING	M1	M2	M3	S1	S2	S3
1	Assignment I	4.9	5.1	4.6	0.5	0.8	0.9
2	Assignment II	5.3	4.6	4.8	0.9	1.1	1.2
3	Assignment III	5.1	5.2	4.1	0.8	1.1	1.2
	N =	10	8	10			

Table 5-13. GROUP MEANS AND STANDARD DEVIATIONS OF THE SEMANTIC-DIFFERENTIAL TEST FOR THE FACTOR INTERESTING

	PLEASANT	M1	M2	M3	S1	S2	S3
I	Assignment I	4.8	4.6	4.2	0.5	0.7	1.0
2	Assignment II	4.8	4.2	4.1	0.8	0.6	0.9
3	Assignment III	4.3	3.9	4.1	1.1	0.9	0.6
	N =	10	8	10			

Table 5-14. GROUP MEANS AND STANDARD DEVIATIONS OF THE SEMANTIC-DIFFERENTIAL TEST FOR THE FACTOR PLEASANT

groups over the course of the three assignments in 'Usefulness/Relevance' and 'Interesting' with F(4,50)=2.78 and F(4,50)=2.93 , where in both cases $p < 0.05$. With $p = 0.05$ taken as the limit of acceptability, there were no significant changes found in interaction between groups and tests for 'Flexible', 'Difficult' and 'Pleasant'.

The productive problem-solving assessment by the course instructor was applied in complete separation from the grading of the students' work. For the purpose of the discussion which is to follow, these grades, assigned to each of the students' works, were analysed using the same Analysis of Variance and Covariance. With $p = 0.05$ as the limit of acceptability, there were no significant interaction effects found as far as the students' 'academic achievements' were concerned (see graphic 10, Appendix M).

Chapter 6

Conclusions

6.1 Discussion

An analysis of the data shows no significant difference in the students' overall academic achievements during the course. In assessing the productive problem-solving behaviors of the students in this study, it is also not demonstrated in terms of statistical significance, that the introduction of the problem assignments through the video segments had induced a more unusual process or more appropriate content response to the problem assignments. Furthermore, this particular study does not show a statistically significant change in productive problem-solving behaviors, nor in increased motivation or change in attitude, between a descriptive video-tape introduction and a case-study format video-tape introduction to engineering problem assignments.

The results obtained in this study, however, do indicate that the video-taped introductions to the problem assignments, had a more positive effect on increased student motivation and cultivated a more positive student attitude towards productive problem-solving, than the printed presentations.

The work of the students, who were introduced to the problem assignments through the video segments, demonstrated significantly more transformation in their solution to the problem, and more condensation in their arguments in the design. When asked to record their emotional response to the assignments in the semantic-differential tests, these students indicated that they found them significantly more helpful, meaningful, relevant, important, useful and purposeful (factor usefulness), as well as exciting, interesting, stimulating and intellectual (factor interesting). The responses given to the remaining variables in the semantic-differential tests, indicated statistically that the students felt the assignments equally clear, flexible, unrestricted, difficult, laborious, intimate, friendly, and warm, independently of the type of introduction received. These variables account for the factors flexible, difficult and pleasant, which does not exclude the possibility of an increased productive problem-solving behavior in students who were introduced to the problem assignment through a video-tape segment, since these factors are not considered to be significant to productive problem-solving behaviors.

Given the statistical results of the assessment of the students' academic achievements on completion of the course, the findings further indicate that there was no statistically significant difference in "at least the information necessary, for the students to comprehend the full scope of the problem", between the video introductions and their corresponding printed introductions (definition of the moderator variables).

This implies that the video segments were properly designed as far as their information-transfer function is concerned. However, no in-depth evaluation of the design aspects of the segments was conducted. Students were asked, to give their comments on the assignments in addition to the semantic-differential tests. A number of unsolicited comments from the students on the design and content of the video segments were received, of which some reported:

> "... the videotape instruction on this assignment provided a good basic understanding of the purpose and the problem of the assignment..."
>
> "... the video introduction provided for more of an interest for the assignment..."
>
> "... the video tape gave a practical vision of the assignment.... it gave us a reason to prove something for ourselves towards the industry... "

And concerning the assignments in general, such comments were recorded as:

> "...very practical..."
>
> "...very interesting..."

There are some considerations that should be taken into account in reviewing the results of this study.

The study was conducted in the course of the subjects' actual course-work, and this prohibited the use of a true-experimental design in the evaluation program. Although the pre-test did not identify a significant difference between the entry level of the three experimental groups, the researcher's responsibility to maintain an acceptable educational environment during the course of the project inhibited the use of a random-selection process for allocation of the subjects. This situation is a perpetual feature of studies in course improvements, and accounts for a pseudo-experimental evaluation design. It must also be recognized that these sample groups were relatively small, and this factor may have had a negative effect on the statistical significance of the results. Furthermore, in respect to the Semantic Differential test, it must be noted that the lack of English proficiency of some of the foreign students could have had a negative effect on the validity of the test.

In the design of the curriculum, many pre-established parameters resulted in a pre-determined 'frame of reference' and 'nature of the educational environment'. This meant, that lecture and laboratory time had to be scheduled in concordance with current University policies and practices, and that learning theories, such as discovery learning and the use of the spiral curriculum, were not taken into consideration.

Another element in the evaluation of the results of this study, is the nature of the overall educational environment. Learning through case-studies is not a widely used educational practice in higher education of engineers, and the effectiveness of such an approach, could very well depend on the learned work-habits and study-behaviors of the students. Similarly, the acquired perceptual behaviors of the students may have resulted in a certain resistance to the introduction of this type of audio-visual stimulus material. It is not unlikely, that subsequent use of video-tape introductions to engineering problem assignments could have a significantly increased effectiveness in students' productive problem solving behaviors, over the results of this study.

Although related research, as mentioned in this study, suggests a long-term effect as well, the evaluation programme in this study includes only the short-term effects achieved on students' behavior in productive problem-solving, by the use of video-taped introduction to problem assignments.

6.2 Conclusions

Given the results of this study, and considering the preceding discussion, it can be concluded that:

- hypthesis H1 should be rejected and that, at different levels of simulation, a video-taped introduction to a fluid-power control problem assignment does not have a significant effect on the problem-solving behavior of the student, in respect to unusualness in design process, over a similar printed introduction;
- hypothesis H2 should be rejected, and that at different levels of simulation, a video-taped introduction to a fluid-power control problem assignment does not have a significant effect on the problem-solving behavior of the student, in respect to appropriateness of design content, over a similar printed introduction;

- hypothesis H3 should be accepted and that, At different levels of simulation, a video-taped introduction to a fluid-power control problem assignment does have a significant effect on the problem-solving behavior of the student, in respect to transformation in problem solutions, over a similar printed introduction;

- hypothesis H4 should be accepted and that, At different levels of simulation, a video-taped introduction to a fluid-power control problem assignment does have a significant effect on the problem-solving behavior of the student, in respect to condensation of design arguments, over a similar printed introduction.

And furthermore, that there was evidence that:

- there was no significant difference in the students' productive problem-solving behaviors between the use of a descriptive and a case-study simulation approach in the video-taped introductions to the problem assignments,

- the use of the video segments as an introduction to the problem assignments in this course, resulted in an increased directed motivation and a more positive attitude towards productive problem-solving.

No in-depth evaluation was conducted of the design of the video segments, but on the basis of the data collected in regard to the students' academic achievements, as well as unsolicited comments by the students, it can be concluded that both video segments:

- did transfer "at least the information necessary, for the students to comprehend the full scope of the problem",

- did transfer "at least the information necessary", for the students to exhibit increased productive problem-solving behaviors.

6.3 Recommended Future Use

The experiment was conducted within the parameters of the existing academic curriculum and the established educational environment. Consequently, a relative small sample was available for evaluation and the evaluation programme itself was limited to short-term effects only. Although the use of the video introductions had a significant effect on the behavior of the students in this fluid-power control systems course, it is not considered justifiable to derive general conclusions, because of the pseudo-experimental nature of the evaluation programme in this study.

The study does indicate, though, that future use of these short video introductions, in which the educational objective is primarily of a motivational and attitudinal nature, could be instrumental to the growth of purpose and direction in the cognitive learning behaviors of students in engineering education.

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Appendix A

Course Content and Cognitive Objectives

MECH C463/- FLUID POWER CONTROL I

	Knowledge									Comprehension			Application	Analysis			Synthesis			Evaluation	
	of specifics		of ways and means of dealing with specifics					of universals and abstractions													
	Knowledge of terminology	Knowledge of specific facts	Knowledge of conventions	Knowledge of trends and sequences	Knowledge of classifications and categories	Knowledge of criteria	Knowledge of methodology	Knowledge of principles and generalizations	Knowledge of theories and structures	Translation	Interpretation	Extrapolation	Application	Analysis of elements	Analysis of relationships	Analysis of organized principles	Production of a unique communication	Production of a plan, or proposed set of operations	Derivations of a set of abstract relationships	Judgements in terms of internal evidence	Judgements in terms of external evidence
CONTENT	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
INTRODUCTION TO FLUID POWER CONTROL																					
FPC Systems Hydraulic/Pneumatic	X										X										
History				X	X																
Unique Features +/-			X									X									
Illustrate Examples											X	X	X	X							
FLUID FLOW FUNDAMENTALS																					
FPC related Fluid Mechanics basics																					
-pressure	X	X			X		X	X	X												
-flow	X	X			X		X	X	X												
-power	X	X			X		X	X	X												
-flow losses	X	X			X		X	X	X												
Incompressible vs Compressible Fluids		X			X																
TRANSMISSION MEDIA																					
Hydraulic Fluids	X	X			X	X															
Air	X	X			X	X															
HYDRAULIC SYSTEMS I																					
a) Components I																					
:pumps	X		X		X		X	X	X												
:motors	X		X		X		X	X	X												
:actuators	X		X		X		X	X	X												
:valves,etc	X		X		X		X	X	X												
b) Circuit Library				X		X	X	X		X	X	X	X								
c) Circuit Design										X	X	X	X	X	X	X					
d) Design Examples																					
:methodology of design													X	X	X	X					
:practical applications																X	X	X	X	X	X
e) Assignment I										X	X	X	X	X	X	X	X	X	X	X	X

MECH C463 - FLUID POWER CONTROL																					
	Knowledge									Comprehension			Application	Analysis			Synthesis			Evaluation	
	of specifics		of ways and means of dealing with specifics					of universals and abstractions													
	Knowledge of terminology	Knowledge of specific facts	Knowledge of conventions	Knowledge of trends and sequences	Knowledge of classifications and categories	Knowledge of criteria	Knowledge of methodology	Knowledge of principles and generalizations	Knowledge of theories and structures	Translation	Interpretation	Extrapolation	Application	Analysis of elements	Analysis of relationships	Analysis of organized principles	Production of a unique communication	Production of a plan, or proposed set of operations	Derivations of a set of abstract relations	Judgments in terms of internal evidence	Judgments in terms of external evidence
CONTENT	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
HYDRAULIC SYSTEMS II																					
a) Components II																					
:servovalve -anatomy	X		X		X		X	X	X												
-valving element	X		X		X		X	X	X												
:stepper motor	X		X		X		X	X	X												
:accessories (filtration)	X		X		X		X	X	X												
b) Circuit Library				X		X	X	X		X	X	X	X								
c) Circuit Design										X	X	X	X	X	X	X					
d) Design Examples																					
:methodology of design													X	X	X	X					
:practical applications														X	X	X	X	X	X	X	X
DYNAMIC ANALYSIS OF HYDRAULIC SYSTEMS AND ADVANCED DESIGN TECHNIQUES																					
a) Introduction (Purpose)	X	X			X	X		X	X												
b) Linear vs Non-linear Approach	X		X		X	X		X													
c) Modelling																					
-components	X		X		X		X	X	X												
-system				X		X	X	X		X	X	X	X								
-computer simulation				X		X	X	X		X	X	X	X								
d) Design Examples											X	X	X	X	X	X					
e) Assignment II													X	X	X	X	X	X	X	X	X

MECH C463 - FLUID POWER CONTROL II

	Knowledge									Comprehension			Application	Analysis			Synthesis			Evaluation	
	of specifics		of ways and means of dealing with specifics					of universals and abstractions													
	Knowledge of terminology	Knowledge of specific facts	Knowledge of conventions	Knowledge of trends and sequences	Knowledge of classifications and categories	Knowledge of criteria	Knowledge of methodology	Knowledge of principles and generalizations	Knowledge of theories and structures	Translation	Interpretation	Extrapolation	Application	Analysis of elements	Analysis of relationships	Analysis of organized principles	Production of a unique communication	Production of a plan, or proposed set of operations	Derivations of a set of abstract relationships	Judgements in terms of internal evidence	Judgements in terms of external evidence
CONTENT	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
PHENOMENA AFFECTING PERFORMANCE OF HYDRAULIC SYSTEMS																					
a) Effects real world on design process																					
-Viscosity		X		X		X					X	X	X								
-Leakage		X		X		X					X	X	X								
-Heat generation		X		X		X					X	X	X								
-Contamination		X		X		X					X	X	X								
-Aeration		X		X		X					X	X	X								
-Cavitation, noise		X		X		X					X	X	X								
-Flow forces, Hydraulic lock		X		X		X					X	X	X								
INTRODUCTION TO PNEUMATIC SYSTEMS																					
a). Introduction (role of pneumatics)																					
-pneumatics vs hydraulics	X	X	X	X			X														
-analog vs sequential	X	X	X	X	X	X															
PNEUMATIC SYSTEMS																					
a) Components III																					
:valves (logic)	X		X		X		X	X	X												
:actuators	X		X		X		X	X	X												
:sensors, etc	X		X		X		X	X	X												
b) Circuit Library																					
e) Sequential Circuit Design										X	X	X	X	X	X	X					
f) Design Examples																					
:methodology of design													X	X	X	X					
:practical applications																X	X	X	X	X	X
g) Assignment III										X	X	X	X	X	X	X	X	X	X	X	X
REVIEW/CONSULTATION																					
Design Review																					

Appendix B

Curriculum

MECH CA83 - FLUID POWER CONTROL sCUF

WEEK	TOPIC	CONTENT	EDUCATIONAL MATERIALS	EDUCATIONAL RESOURCE
1	COURSE INTRODUCTION	Course Organization/Administration Course Objectives & Outline		
	INTRODUCTION TO FLUID POWER CONTROL	FPC Systems Hydraulic/Pneumatic History Unique Features +/- Illustrate Examples	Examples I,II & II Assorted Components	Overhead Projector Festo Hydraulics Unit Festo Pneumatics Unit
2	FLUID FLOW FUNDAMENTALS	Review FPC related Fluid Mechanics basics -pressure -flow -power -flow losses Incompressible vs Compressible Fluids	Viscosity Meter Fluid Examples	Overhead Projector
	TRANSMISSION MEDIA	Hydraulic Fluids Air		
3	HYDRAULIC SYSTEMS I Components & System Design	Components based on Example I :pumps :motors :actuators :valves,etc Schematic * Function * Symbol * Basic math * Actual hardware Sizing	Example I Assorted Components I TCPS - pump/motor TCPS - valves	Overhead Projector Festo Hydraulics Unit Festo TCPS Unit
4		Circuit Library Start of Circuit Design	Example I Design Symbols Assorted Components	Festo Hydraulics Unit White Board Overhead Projector
5		Design Examples Methodology of Design	Example I Design Symbols Assorted Components I Polarized Slide	Festo Hydraulics Unit White Board Overhead Projector Polarized Overhead Pro:
		Practical Applications		
	TAKE HOME ASSIGNMENT	Assignment I	Handouts	

MECH C483 - FLUID POWER CONTROL ACUR

WEEK	TOPIC	CONTENT	EDUCATIONAL MATERIALS	EDUCATIONAL RESOURCE
6	HYDRAULIC SYSTEMS II Components & System Design	Components based on Example II *servovalve -anatomy -valving element *stepper motor *accessories (filtration)	Example II Assorted Components II TCPS - spool valve	Overhead Projector Hydraulics Unit II Festo TCPS Unit
	Schematic * Function * Symbol * Basic math * Actual hardware			
		Circuit Library -positional servo -velocity servo -force servo	Design Symbols	White Board
7		Design Examples Methodology of Design	Example II Design Symbols Assorted Components II	Hydraulics Unit II White Board Overhead Projector
		Practical Applications		
8	DYNAMIC ANALYSIS OF HYDRAULIC SYSTEMS AND ADVANCED DESIGN TECHNIQUES	Introduction (Purpose) Linear vs Non-linear Approach Modelling -components -system -computer simulation		Overhead Projector
9		Design Examples	Design Symbols	Overhead Projector White Board
	TAKE HOME ASSIGNMENT	Assignment II	Tape 'Airflight Simulation' Handouts	Video Playback Unit
10	PHENOMENA AFFECTING PERFORMANCE OF HYDRAULIC SYSTEMS	Effects real world on design process -Viscosity -Leakage -Heat generation -Contamination -Aeration -Cavitation, noise -Flow forces, Hydraulic lock		Overhead Projector

MECH CA83 - FLUID POWER CONTROL sCUR

WEEK	TOPIC	CONTENT	EDUCATIONAL MATERIALS	EDUCATIONAL RESOURCE
11	INTRODUCTION TO PNEUMATIC SYSTEMS	Introduction (role of pneumatics) -pneumatics vs hydraulics -analog vs sequential	Example III Assorted Components III Design Symbols (Pneumatics)	Overhead Projector Festo Pneumatics Unit White Board
	PNEUMATIC SYSTEMS Components & System Design	Components based on Example III :valves (logic) :actuators :sensors, etc		
	Schematic * Function * Symbol * Basic math * Actual hardware			
12		Sequential Circuit Design -circuit vs programmer (philosophy)	Example III Design Symbols (Pneumatics) Assorted Components III	Festo Pneumatics Unit White Board Overhead Projector
		Design Examples -Methodology of Design		
		Practical Applications		
	TAKE HOME ASSIGNMENT	Assignment III	Tape 'Ritepro Automation' Handouts	Video Playback Unit
13	REVIEW / CONSULTATION	Design Review	Design Symbols (Hydraulics) Design Symbols (Pneumatics)	Overhead Projector White Board

* EXAMPLE I - Festo Hydraulics Unit with 2-speed circuit

** EXAMPLE II - Festo Hydraulics Unit with servo - lab exercise

*** EXAMPLE III - Festo Pneumatics Unit with 3-cylinder sequential circuit

- Transparent Component Projector System (TCPS)
- Polarized Overhead Projector (POP)

Appendix C

Assignment I - Pre-test

CONCORDIA UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING
MECH 463 - FLUID POWER CONTROL
MECH 606 - ANALYSIS AND DESIGN OF HYDRAULIC CONTROL SYSTEMS

HOME ASSIGNMENT #1

Due in: February 28, 1984

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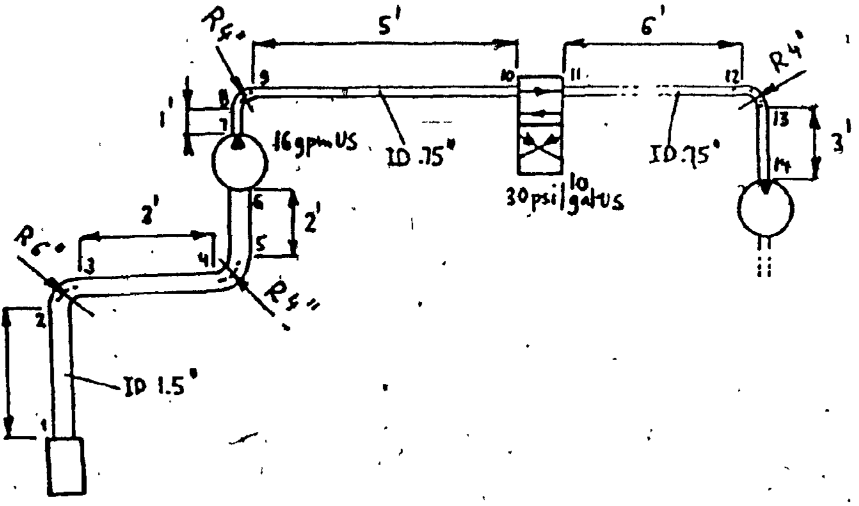
1. Establish the pressure drops between points 1 & 6 and 7 & 14 of the hydraulic power supply system shown. (Oil kinematic viscosity ν = 21 cs, oil specific gravity s = 0.85).



2. A conveyor transports logs from a chute to the saw mill. The speed of the conveyor is 50 ft/in per minute, diameter of the drive drum is 18 in. The pull load of the drum is estimated to be 750 lbs. It is proposed to drive the drum with hydraulic motor (direct drive). A manual control of start and stop is required. The working pressure is 1500 psi. Estimated duty cycle - operation: pause = 4:1.

a) draw a circuit diagram

b) select and size the motor, pump, electric motor and reservoir, assuming the efficiencies according to the selected types. Neglect pipe and valve losses.

3. Design a hydraulic press system for the following specifications:

1m rapid advance at 0.5 m/s, opposing force 1000N

0.5m slow advance at 1 cm/s, opposing force 50,000N

20s dwell, opposing force 75,000N

1.5m rapid return at 0.6 m/s, opposing force 1500N

30s pause, zero opposing force

a) draw a circuit diagram

b) select and size the system components

c) discuss at least one alternative solution

Appendix D

Printed Introduction to Assignment II

Introduction to Airflight Simulation.

The training of aircraft pilots is becoming increasingly more complex and demanding. Aircraft are becoming more sophisticated and safety precautions are constantly being refined and improved. With the high operating costs of aircraft for actual in-flight training, flight simulation is a well established practice in both civil and miltary aviation. Modern simulators create an almost perfect illusion of real flying at a fraction of the operating cost of an aircraft, and with 100% safety. High fidelity simulation systems can create in-flight situations and conditions, that on a real aircraft would be too difficult and dangerous to produce. Today's high-fidelity simulation systems are designed to create an environment, which makes even the most experienced pilot believe he is flying a real plane.

To create an exact replica of the cockpit, original aircraft parts are used. Every switch and instrument is where the pilot expects to find it, and controls operate accurately. A highly elaborate visual system is used for visual cues. The images are generated entirely by a computer and displayed on a set of tv screens which the pilot sees from his windows. The computer creates images of actual airports, each with its own distinguishing landmarks.

The feel of e.g. a sudden burst of acceleration at take off, is primarily achieved by accurate reproduction of motion cues. These high-fidelity simulators make use of a 6 degrees of freedom motion system. This motion sytem is capable of creating all the movements found on the ground and in-flight, requiring roll, pitch, jaw, longitudinal, lateral and heave at very high frequences. This is done by six independent high performance electro-hydraulic servo-actuators. Each servo-actuator is a complex closed-loop control system consisting of a hydraulic jack, electro-hydraulic servovalve, and a series of feedback devices. An electronic controller and interface with the simulator's main computer facility enables the simulation of flight motion, such as air turbulence, and engine and rotor vibration.

For the training of light aircraft pilots, these highly sophisticated simulation systems are of course much too costly. But, with the recent dramatic improvements in micro-processor capabilities, it is also feasible to build cost effective simulators for training in light aircraft. . The motion system for such a light aircraft simulator, will need to incorporate a much less expensive hardware configuration. One measure might be to reduce the system's dynamic requirements which allows for less expensive servo-actuators. Furthermore, the number of degrees of motion freedom could be decreased to three, to produce only roll, pitch and yaw. To be able to generate certain high frequency motion cues, such as those experienced during turbulence or stall, employment of inexpensive seat and controls-shakers can be considered.

Appendix E

Synopsis for the Video-tape Introduction to Assignment II

Assignment 1: Airflight simulation

INTERIOR: PILOTS IN AIRFLIGHT SIMULATOR

It's the closest you can get to flying, without actually getting of the ground.

EXTERIOR: AIRFLIGHT SIMULATORS & PLANES

Flight simulation is as vital to air traffic as the planes themselves. Duplicating real situations with uncanny accuracy, it trains crews to cope with the staggering complexity of airtransport of today.

EXTERIOR: AIRFLIGHT SIMULATOR

Modern simulators create an almost perfect illusion of real flying at a fraction of the operating cost of an aircraft. But it's not just the cost that prohibits flight training on real planes. High-fidelity simulation systems can create in-flight situations and conditions, that are almost impossible and downright dangerous to recreate in flight. Such as an engine fire, or a tricky landing approach....

EXTERIOR: TRICKY LANDING APPROACH

A hair-raising moment, but one that today's highly trained crews can take in their stride.

STOCKSHOTS: EARLY PLANES AND BLUE BOX SIMULATOR

We've come a long way in flight training since the early days of flying: the days of the famous Link trainer or blue box, the first ever flight simulator. It was an instrument trainer used in the Second World War and for many years after that. The Blue Box was developed by Edwin Link from an airplane ride in his amusement park. With his dials and switches, the instructor controlled the instrument indicators inside the blue box.

INTERIOR / EXTERIOR: PILOTS GETTING READY FOR TAKE OFF

Today's high-fidelity simulation systems are designed to create an environment, which makes even the most experienced pilot believe he is flying a real plane.

This Hercules C130 military transport simulator is built by Canadian Aviation Electronics in Montreal, one of the world leaders in airflight simulation. Its high-fidelity motion system and the use of the latest in visual technology, make CAE's simulators among the most advanced.

EXTERIOR: LIGHT AIRCRAFTS

For the training of light aircraft pilots, these highly sophisticated simulation systems are of course much too costly. But, with the recent dramatic improvements in micro-processor capabilities, it is also feasible to build cost effective simulators for training in light aircraft.

INTERIOR: CONCORDIA UNIVERSITY LIGHT AIRCRAFT SIMULATOR

Such development is on its way with an extensive research programme at Concordia University in co-operation with CAE.

INTERIOR: MANUFACTURING PLANT CAE

CAE designs and produces flight simulators for every type of commercial jet aircraft available today. It manufactures the entire machine, from the wooden mold on which the fiberglass body is built, to the electronic brain that runs the system.

The crew compartment is built from the frame out. To create an exact replica of the cockpit, original aircraft parts are used. Every switch and instrument must be where the pilot expects to find it, and controls must operate accurately.

INTERIOR / EXTERIOR: VISUAL SYSTEM AIRFLIGHT SIMULATOR

A highly elaborate visual system is used for visual cues. Image boxes on top of the simulator cockpit project the scenes which the pilot sees from his windows. The images are generated entirely by a computer which converts digital data into visual information. The resulting images are displayed on a set of tv screens which the pilot then sees as airport lights and runway markings. The computer creates images of actual airports, each with its own distinguishing landmarks.

But the compartment must not only look,

EXTERIOR: PLANE TAKING OFF

but feel real....

The feel of a sudden burst of acceleration at take off, is primarily achieved by accurate reproduction of motion cues.

STOCKSHOTS: CLOSE UP MOTION SYSTEM BLUE BOX

In his blue box, Edwin Link used bellows to copy the pitch, r[illegible] and turn of a plane.

INTERIOR MOTION SYSTEM LARGE SIMULATORS

CAE pioneered in the development of a 6 degrees of freedom motion system. This motion sytem is capable of creating all the movements found on the ground and in-flight.

INTERIOR: DETAILED MOVEMENTS OF MOTION SYSTEM

Roll.., pitch.., yaw.., and longitudinal, lateral and heave at very high frequencies.

INTERIOR: DETAILS HYDRAULIC SYSTEMS

This is done by six independent high performance electro-hydraulic servo-actuators. Each servo-actuator is a complex closed-loop control system consisting of a hydraulic jack, electro-hydraulic servovalve, and a series of feedback devices. An electronic controller and interface with the simulator's main computer facility enables the simulation of flight motion, such as air turbulance, and engine and rotor vibration.

This motion system would be much too costly for the light aircraft simulator.

INTERIOR: LABORATORY WORK ON CONCORDIA UNIVERSITY SIMULATOR

The Concordia-CAE simulator will need to incorporate a much less expensive hardware configuration. One measure might be to reduce the system's dynamic requirements which allows for less expensive servo-actuators. Furthermore, the number of degrees of motion freedom could be decreased to three, to produce only roll, pitch and yaw. To be able to generate certain high frequency motion cues, such as those experienced during turbulence or stall, employment of inexpensyve seat and controls-shakers can be considered.

HISTORIC FLIGHT, MODERN LARGE SIMULATORS, CONCORDIA SIMULATOR, LIGHT AIRCRAFTS

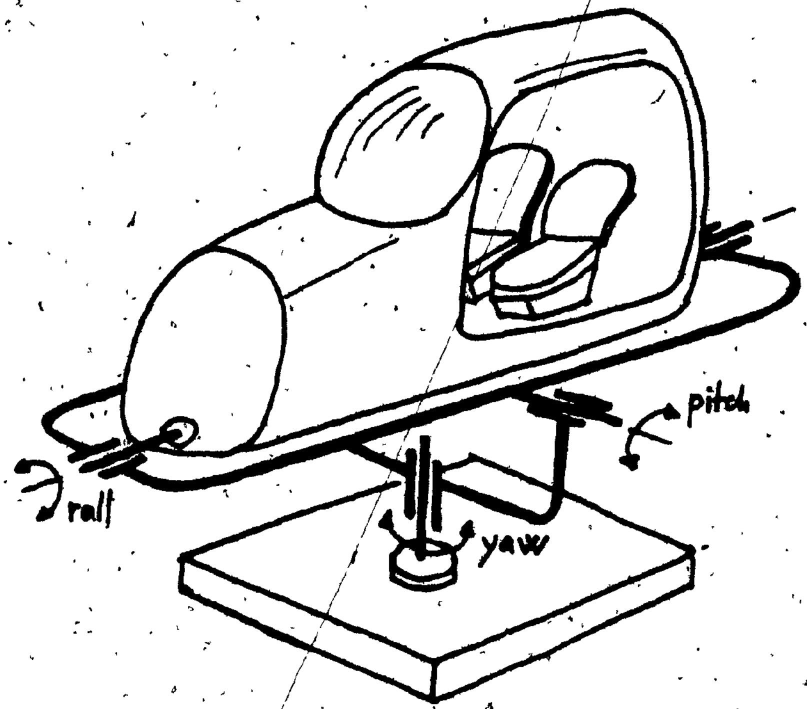
We have come a long way since Edwin Link introduced his simulator. The Phase Three simulator of CAE, virtually eliminates the need for in-flight training. And at Concordia, the engineers of tommorow, are bringing airflight simulation to the light aircraft pilots of today.

Appendix F

Assignment II

You are a consultant associated with the Concordia-CAE light aircraft simulator. Your assignment is to design a hydraulically driven, 3-axis, gimbal type motion-cue system. Guided by the schematics and specification values given below, design a suitable electro-hydraulic servoactuator mechanism including the associated circuitry and size it. Use of static calculations will suffice, however, your design should be as complete as possible. Justify your design concepts and decisions.

axis	roll	pitch	yaw
displacement (deg)	± 60	± 30	± 45
velocity (deg/sec)	135	90	60
acceleration (deg/sec^2)	150	135	120
moment of inertia (kg-m^2	100	180	200



Appendix G

Printed Introduction to Assignment #[illegible]

RITEPRO

Ritepro Inc. manufactures valves and fittings for the petroleum, petro-chemical, and industrial markets. In the course of the last several years, they have installed a large number of computer numerical-controlled machines. This enabled them to machine parts that before would have been almost impossible to make, and it has as well upgraded the quality and finish of their check valves.

The manufacturing of their check valves is now to a large extend automated. However, each valve needs to be individually tested for certification. To let the air trapped in the valve cavity bleed out, the valves are tested in horizontal position. A seat test and shell test are done consecutively, which is very time-consuming. Furthermore, there is an extensive set-up time for the different sizes and pressure classes.

In the past, this testing procedure has been very satisfactory. However, with the increased productivity, it is very desirable to shorten the set-up time and shorten the testing procedure through automation and possibly running both tests simultaneously.

Appendix H

Synopsis for the Video-tape Introduction to Assignment III

Synopsis

A representative of a technical consultation office in fluid power control systems, receives a call from the general manager of PLANT Inc.

As the general manager explains over the phone, there is a current need to optimize a particular system in one of their production-lines. According to his description of the problem, it seems likely to be within the consultant's field of work, and it is agreed upon that consultation needs to be considered. A visit to PLANT is arranged, and the consultant summarizes the following schedule for the day:

9.00	Meeting with general manager. General introduction to the plant, the product-line, and operation of the production facility. The general manager explains their policy for the next few years, in regards to the PLANT's future developments. He gives a short analysis of the past, and identifies the reasons behind the demand for a new system.
10.00	Meeting the R & D engineer of the plant. They walk through the plant to a design office. The engineer will give a global, overall overview of the present operation of the SYSTEM. He then identifies specific considerations for a new design of the SYSTEM, the expected improvements as they relate to the product standards, as well as the reason to involve the consultant, and what they

expect. This brings them to discuss the possible clues to the improvement of the system, based on the experience the engineer has with the present system. For his explanations, the engineer will make use of a simplified graphic representation of the system, from which we will cut forth and back to the actual system in the plant.

11.00 They walk back through the plant to the reception area. Both the general manager, and the engineer are present. The consultant summarizes the meetings, and explains his next strategy (back at his office, analysis of the present system, identification of problem area, drawing up a spec-sheet, and eventually design of a new system).

Consultant's office

Transition to office. Back at the office, a simulation has been set up (Festo practice unit). With a second consultant engineer he identifies all elements, and analyses their functions (include flash-backs). Those elements, crucial to the operation of the system, and the design of the new system, are further discussed, using graphic materials and mathematical examples. A specification sheet is drawn up for the new system, and some possibilities in design for this new system may be suggested.

Appendix I

Schedule and Location Requirements Assignment III

Schedule and Location Requirements CASE STUDY

** Morning day 1 **

Meeting with the general manager. General introduction to the plant, the product-line, and operation of the production facility. The general manager explains the policy of the plant's development for the future in light of economical aspects. He gives a short analysis of the past, and identifies the reasons behind the demand for a new system.

- LOCATION: Office
- SHOOTING TIME: 3 hrs
- REQUIREMENTS: General manager, Consultant.

Introduction to R & D engineer/ Consultant summarizes the meetings as he leaves the plant (general manager included).

- LOCATION: Reception area
- SHOOTING TIME: 2 hrs
- REQUIREMENTS: Consultant, general manager, R & D engineer

** Afternoon day 1 **

The Consultant, and the R & D engineer are walking through the plant to an engineering design office.

Include walking back, to main office.

- LOCATION: Production area in plant. General shots of activities included.
- SHOOTING TIME: 4 hrs
- REQUIREMENTS: Consultant, and R & D engineer (3 hrs).

** Morning day 2 **

Meeting with the R & D engineer in his design office. The engineer will give a global, overall overview of the present operation of the system, using either a graphic representation or schematic of the system. He then identifies specific considerations for a new design of the system, the expected improvements as they relate to the product standards, as well as the reason to involve the Consultant. This brings them to discuss some of the possible clues to the improvement of the system, based on the experience the engineer has with the present system.

- LOCATION: Design office of engineer
- SHOOTING TIME: 4 hrs
- REQUIREMENTS: Consultant, and R & D engineer.
- REMARKS: Graphic representation of system

Entrance of Consultant into main office building.

- LOCATION: Outside main office building, include plant's name
- SHOOTING TIME: 1/2 hrs
- REQUIREMENTS: Consultant.

** Afternoon day 2 **

Visual description of present system, to be included with graphic representation.

- LOCATION: System in operation
- SHOOTING TIME: 4 hrs
- REQUIREMENTS: Access to, and to some extend, control over the operation of the system.

Appendix J

Assignment III

CONCORDIA UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING
MECH 463 - FLUID POWER CONTROL
MECH 606 - ANALYSIS AND DESIGN OF HYDRAULIC CONTROL SYSTEMS

HOME ASSIGNMENT #3 Due in: April 24, 1984

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1. As a consultant for Ritepro Inc., you are required to design a pneumatic sequential control for a semi-automatic testing system. The purpose of the system is to test the Ritepro wafer type swing-disc check valves (see Fig. 1) for leakage.

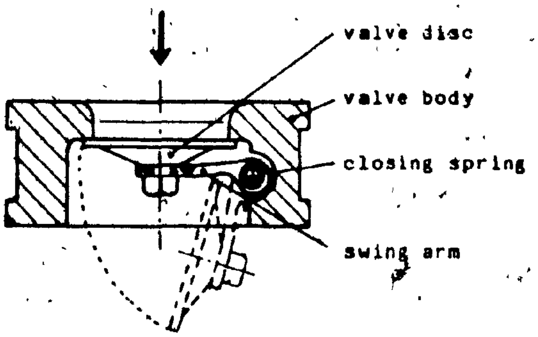

Fig. 1 Wafer-Type Swing Disc Check Valve

The layout of the proposed testing system is shown in Fig. 2. It consists of the station 1 for testing of disc/seat leakage (view A-A), the station 2 for testing of body leakage (view B-B) and the transfer system, shown in the centre of the figure.

The disc/seat test (station 1) is performed as follows: The valve is clamped to the test table (hydraulic cylinder D), the disc is partially open(cylinder E) and the valve body is filled with low pressure water (valve V1) opened for a fixed time T1. This is followed by closing the valve disc and pressurizing the valve with high pressure water (valve V2) for a duration of T2 = 1 min., during which time visual inspection for seat leakage is performed.

The body test (station 2) follows a similar procedure. The valve is clamped between the test table and the bell-shaped cover (hydraulic cylinder F), filled with water (valves V4 and V6) and pressurized for 1 min. (valve V5). Again, possible leakage is detected visually.

The transfer system consists of 2 continuously operating conveyors and 5 pneumatic cylinders moving the check valves between the conveyors and the test stations.

The full test sequence is given in the sequence table shown in Fig. 3.

You are required the following:

a) Design a suitable pneumatic sequential circuit based on the "memory chain" method.

b) Based on a critical evaluation of the proposed system suggest any improvements or modifications you may consider feasible. Your suggestions may concern the accommodation of various check valve sizes, testing pressures, etc., as well as ideas, which will increase the level of testing automation.

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2. Using the cascade method, design a pneumatic sequential circuit driving 3 double acting cylinders A, B, C. The following sequence is required: $A^+ C^+ B^+ C^- A^- B^-$

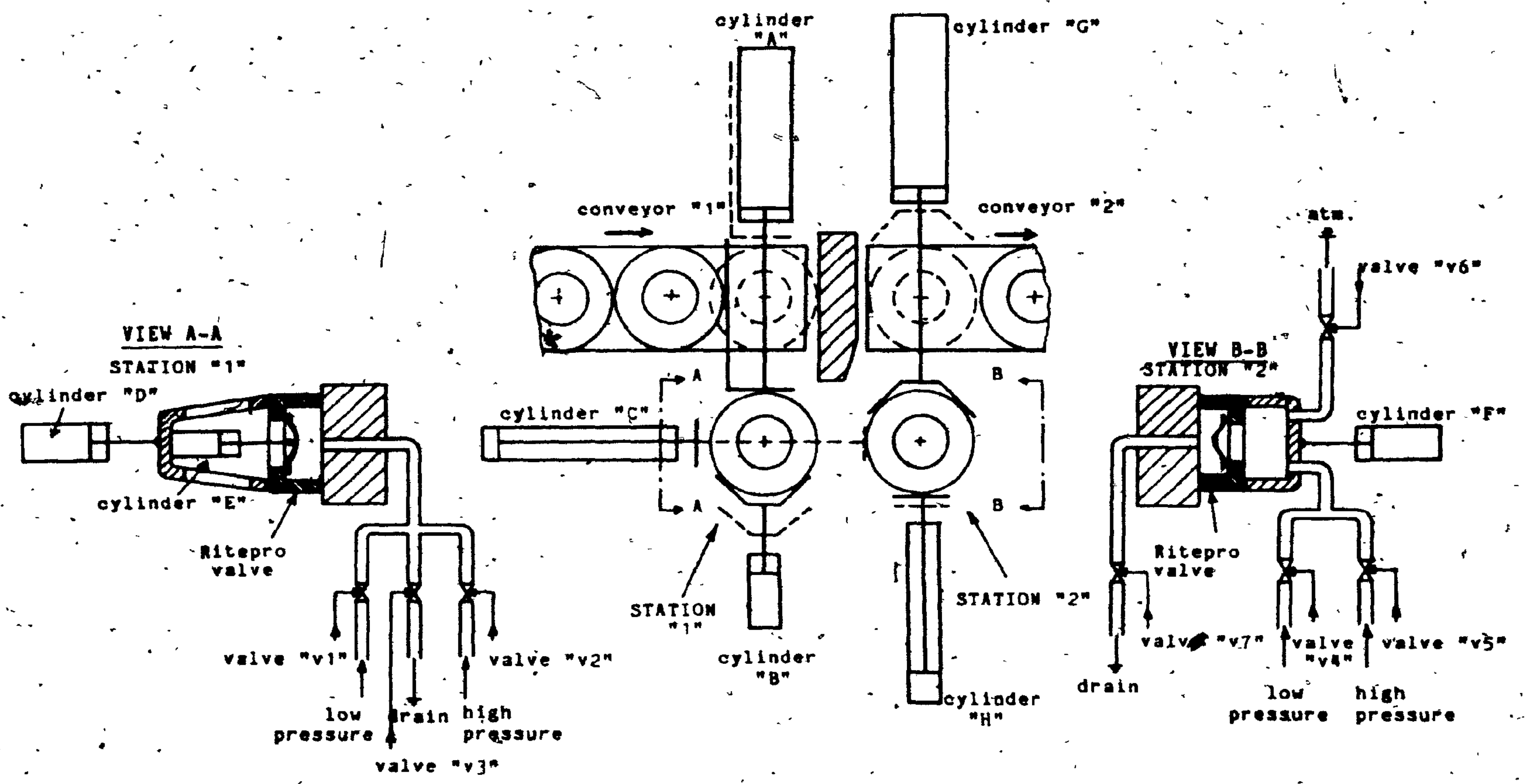

Fig. 2 - - Test System Layout

Fig. 3 - System Sequence Table

COMMAND, STEP #	CYLINDERS								VALVES							TIMERS	
	A	B	C	D	E	F	G	H	V1	V2	V3	V4	V5	V6	V7	T1	T2
0(reset)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	⊕*	⊕	-	-	-	⊕	⊕*	-	-	-	-	-	-	-	-	-	-
2	+	+	-	⊕*	⊕	+	+	⊕*	-	-	-	-	-	-	-	-	-
3	+	+	-	+	+	+	+	+	⊕	-	-	⊕	-	⊕	-	⊕*	-
4	+	+	-	+	⊖*	+	+	+	⊖	-	-	⊖	-	⊖	-	⊖	-
5	+	+	-	+	-	+	+	+	-	⊕	-	-	⊕	-	-	-	⊕*
6	+	+	-	⊖*	-	+	+	⊖*	-	⊖	⊕	-	⊖	⊕	⊕	-	⊖
7	⊖*	⊖	-	-	-	+	⊖*	-	-	-	⊖	-	-	⊖	⊖	-	-
8	-	-	-	-	-	⊖*	-	-	-	-	-	-	-	-	-	-	-
9	-	-	⊕*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	⊖*	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NOTES: (i) in reset position (step 0) all cylinders are retracted, all values are closed and all timers are reset, station 1 is unloaded, station 2 is loaded with check valve

(ii) + cylinder-extend or valve-open or timer-start
- cylinder-retract or valve-close or timer-reset

(iii) * commands, upon which completion next step is to be initiated

(iv) cylinders D & H are hydraulic operating with high pressures, however the above table is concerned with commands only

Appendix K

Measuring Instrument I

APPENDIX M : 'MEASUREMENT INSTRUMENT (I)'

Student no :
Treatment no :

ASSESSMENT OF PRODUCTIVE PROBLEM SOLVING

Design PROCESS	cliche	1_____1_____1_____1_____1_____1_____1 Unusualness	innovative	Surprising
Design CONTENT	nonsense	1_____1_____1_____1_____1_____1_____1 Appropriateness	sense	Satisfactory
Problem SOLUTION	traditional	1_____1_____1_____1_____1_____1_____1 Transformation	new perspective	Stimulating
Summary of Design ARGUMENTS	incoherent	1_____1_____1_____1_____1_____1_____1 Condensation	coherent	Pleasing

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Appendix L

Measuring Instrument II

L.1 Cover Letter

CONCORDIA UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

MECH 463 - FLUID POWER CONTROL

During the course, you have had 3 assignments. Some were given as case studies. A case study is an engineering problem in industry, where you where asked to take up where the professional in the case left off. Furthermore, some of you were introduced to these assignments through video segments.

To help us evaluate the use of these types of problem assignments for further development of Engineering courses, we want you to express how you felt about, and worked on these assignments.

You are asked to make a judgement by putting a ring around one number on a scale,

for example, each point on a scale like this:

Easy 1 2 3 4 5 6 7 Difficult

would be interpreted like this:

1	2	3	4	5	6	7
extremely easy	too easy	slightly easy	about right	slightly difficult	very difficult	extremely difficult

If you feel the assignment is slightly difficult you would circle number 5 thus:

Easy 1 2 3 4 (5) 6 7 Difficult

It is important to make each item a separate judgement. Work fairly quickly through the forms because it is your first impressions about the items we want. On the other hand, please do not be careless because we want your true impressions.

YOU ARE REQUIRED TO SUBMIT THIS EVALUATION QUESTIONAIRE
WITH YOUR ASSIGNMENT # 3.

Your answers will NOT affect your course assessment in ANY way. Your name, which will be kept in complete confidence, is essential for statistical purposes.

REMEMBER:

1) Be sure to ring ONE number on Every scale - Do not omit any.
2) Do not ring more than one number on a single scale.
3) Do not hide your true feelings - by trying to give an answer that you think will please us.

L.2 Example Measurement Instrument II

NAME: **ID #:**

The purpose of this survey is to find out how <u>you felt</u> about

Home Assignment # 2: 3) Design of the Concordia-CAE Light Aircraft Simulator Motion System.

Please indicate if you have had a written introduction ☐

or a video tape introduction ☐

to the problem.

Please put a ring around ONE number on EVERY scale below.

Repetitive	1	2	3	4	5	6	7	Varied
Efficient	1	2	3	4	5	6	7	Inefficient
Intimate	1	2	3	4	5	6	7	Remote
Helpful	1	2	3	4	5	6	7	Obstructive
Relaxed	1	2	3	4	5	6	7	Tense
Realistic	1	2	3	4	5	6	7	Artificial
Challenging	1	2	3	4	5	6	7	Non-challenging
Pleasant	1	2	3	4	5	6	7	Unpleasant
Meaningless	1	2	3	4	5	6	7	Meaningful
Easy	1	2	3	4	5	6	7	Difficult
Confused	1	2	3	4	5	6	7	Clear
Discouraging	1	2	3	4	5	6	7	Encouraging
Wise	1	2	3	4	5	6	7	Foolish
Exiting	1	2	3	4	5	6	7	Dull

Relevant	1	2	3	4	5	6	7	Irrelevant
Passive	1	2	3	4	5	6	7	Active
Vague	1	2	3	4	5	6	7	Precise
Frustrating	1	2	3	4	5	6	7	Satisfying
Important	1	2	3	4	5	6	7	Unimportant
Superficial	1	2	3	4	5	6	7	Profound
Bad	1	2	3	4	5	6	7	Good
Hostile	1	2	3	4	5	6	7	Friendly
Interesting	1	2	3	4	5	6	7	Boring
Effortless	1	2	3	4	5	6	7	Laborious
Cold	1	2	3	4	5	6	7	Warm
Stimulating	1	2	3	4	5	6	7	Wearying
Fair	1	2	3	4	5	6	7	Unfair
Successful	1	2	3	4	5	6	7	Unsuccessful
Useless	1	2	3	4	5	6	7	Useful
Leisurely	1	2	3	4	5	6	7	Hasty
Rigid	1	2	3	4	5	6	7	Flexible
Rewarding	1	2	3	4	5	6	7	Unrewarding
Intellectual	1	2	3	4	5	6	7	Unintellectual
Restricted	1	2	3	4	5	6	7	Unrestricted
Purposeful	1	2	3	4	5	6	7	Aimless

COMMENTS ON THESE ASSIGNMENTS:

L .3 Follow Up Letter

CONCORDIA UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

MECH 463 - FLUID POWER CONTROL

During the course, you have had 3 assignments. Some were given as case studies. A case study is an engineering problem in industry, where you where asked to take up where the professional in the case left off. Furthermore, some of you were introduced to these assignments through video segments.

To help us evaluate the use of these types of problem assignments for further development of Engineering courses, we sent you a few weeks ago a questionaire.

As of the moment of this writing, we have not yet received your completed copy of the questionaire. Could you please fill out your copy and get this to Lena as soon as possible. If you did not receive the questionaire, you can obtain a copy from Lena as well.

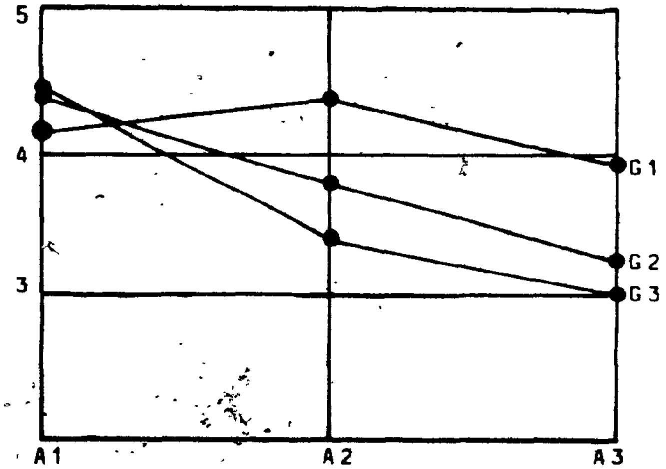
It is essential for evaluation purposes, that we receive ALL questionaires back, and again, your answers will NOT affect your course assessment in ANY way.

Thanks for your co-operation,

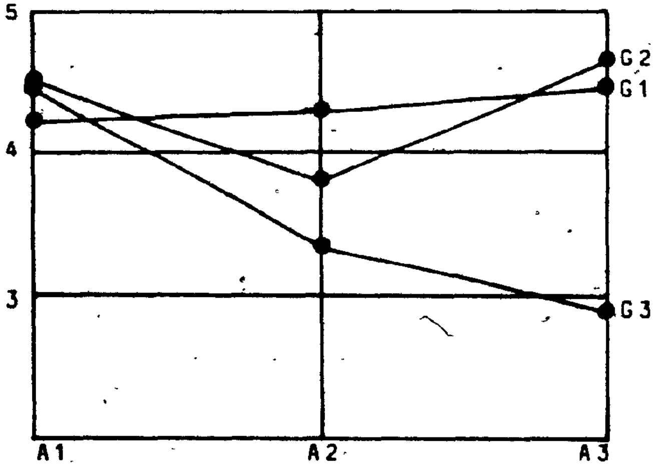
Joost Davidson

Appendix M

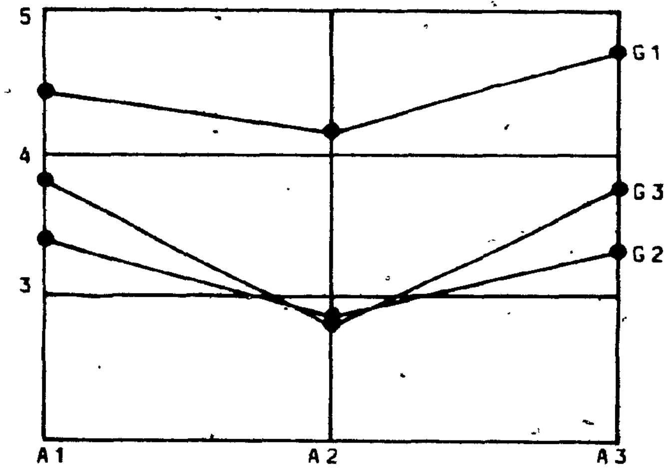
Statistical Analysis



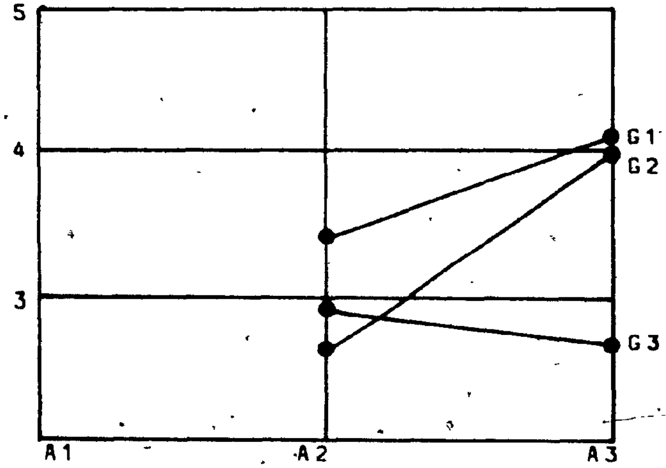
Graphic 1. PROCESS (No Significance)



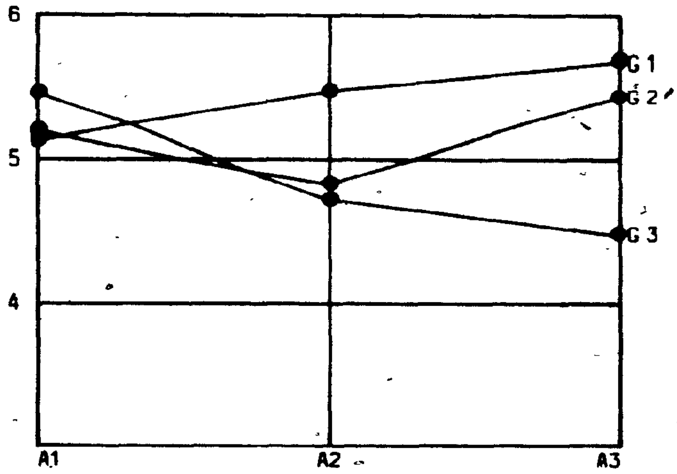
Graphic 2. SOLUTION (sig, F(4,50) = 3.68;p<0.05)



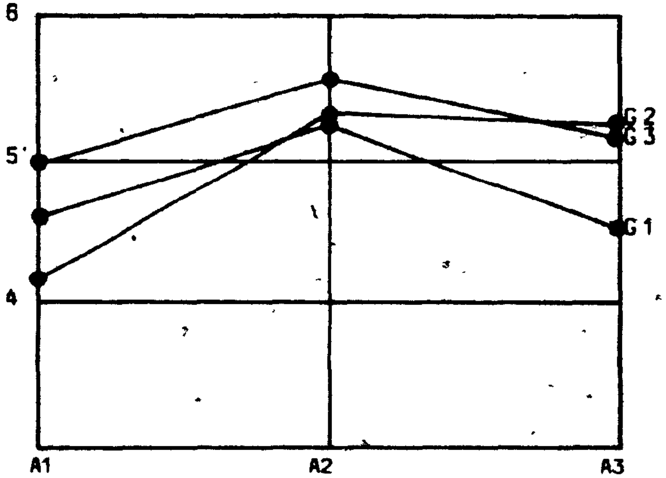
Graphic 3. CONTENT (No Significance)



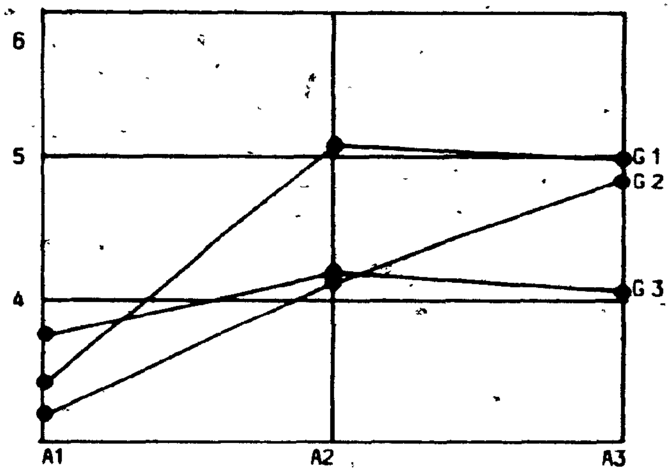
Graphic 4. ARGUMENTS (sig, F(2,25) = 3.81;p<0.05)



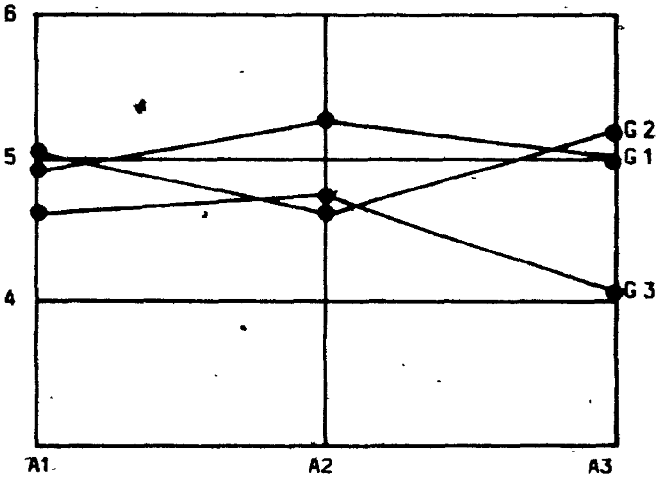
Graphic 5. USEFUL/RELEVANCE (sig, F(4,50)=2.78;p<0.05)



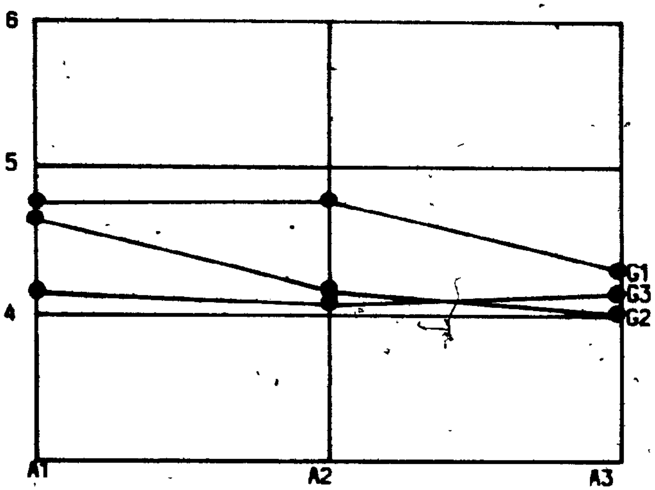
Graphic 6. DIFFICULT (No Significance)



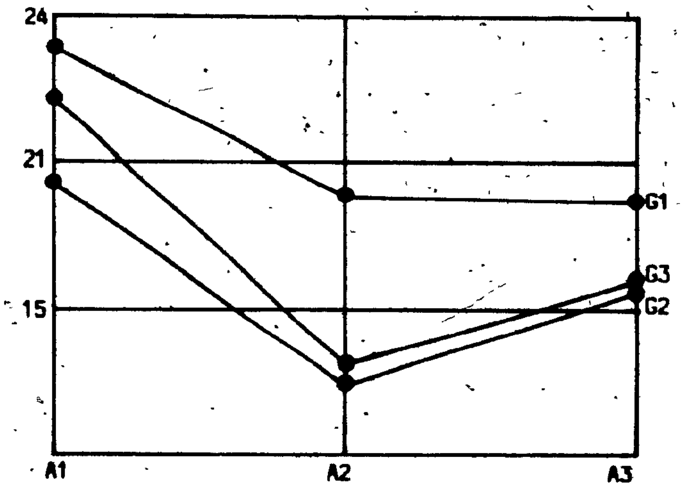
Graphic 7. FLEXIBLE (No significance)



Graphic 8. INTERESTING (sig, F(4,50)=2.93;p<0.05)



Graphic 9. PLEASANT (No significance)



Graphic 10. COURSE GRADES (No Significance between Groups)

Appendix N

Production and Evaluation Requirements

N.1 Production Requirements

- Portable camera unit, including Sony DXC 6000, BVU 110, technical support equipment, portable light kits, grip equipment, filters, gels, spun, etc.
- Editing suite 3/4", including time base corrector, graphics camera, downstream key, special effects generator, audio facilities.
- Sound studio facilities
- Studio sound stage, including lighting equipment.
- Festo Fluid power control learning units, including Festo Didactics demonstration unit
- Festo Didactics graphics, and instructional materials.
- Polaroid SX 70

N.2 Evaluation Requirements

- Design-office space in Hall building, Concordia University.
- Video playback unit, preferable with random access capability.

N.3 Production and Evaluation Budget

- Video tape 3/4" $ 450.00
- Computer graphics 60.00
- Copyright clearance for music 75.00
- Graphic materials 60.00
- Audio tape/filter gels/spun/gaffers tape/etc 100.00
- Script and story board materials 50.00
- Professional narration service 150.00
- Transportation 100.00
- Production of questionnaires 35.00

TOTAL $1080.00