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CHAPTER I

INTRODUCTION

When we look at many systems, either an individual, or an organization, or a world-wide state of human affairs, we see an impending crisis of instability, disorder, and turmoil, caused not only by changes in the state of things but also by changes in the rates of changes themselves.

Man finds himself faced with the task of managing the rate of change to keep things under his control. To perform this task, a manager must understand the processes leading to the loss of control and the processes which may be needed to contain disorder and avoid turmoil. Cybernetics, the science of communication and control (Wiener, 1954), provides him with the guidance required in controlling against undesirable or dangerous situations.

The concepts of management and cybernetics are very abstract and have been usually introduced to those who are interested in cybernetic concepts applied to management, especially university students, with little or no background on the topics through traditional media, such as face-to-face lecture and printed materials. However, several studies have shown that media can be used to teach abstract concepts, even more effectively.

It has been found that televised learning helped in the achievement of mathematics and science concepts (Wade, 1967). Schramm (1962) also found that 86.5% and 90.5% treatment

groups did as well as or better than conventional method groups in mathematics and in science, respectively.

Besides, Chu and Schramm reviewed "up to 1966, 207 published studies in which television teaching has been compared with conventional teaching. Of the 421 separate comparisons made in these studies, 308 showed no significant differences, 63 showed television instruction to be superior, and 50 found conventional instruction better" (1967, p. 6). This indicates that where there is a significant difference, it is likely for television instruction to be superior to conventional one.

Levie and Dickie (1973) found that although a sound film may be overloaded, it has been shown in several instances to produce more learning than either sound or picture separately.

On the same line, Fleming and Levie maintained that "more learning can occur where information is received concurrently in two modalities, e.g. vision and audition, vision and touch, than where received in only one modality" (1978, p. 107).

Among other media, sound-slide was chosen for this project since it is suitable for the objectives and is amenable to the necessary iterative revisions at reasonable cost (see 3.5).

This presentation does not pretend to determine whether it is possible to use audio-visual aids in teaching abstract concepts with efficiency. Nor does it try to prove that sound-slide is the best medium to introduce cybernetic thinking into management. It is our modest intention to

develop a sound-slide programme as an efficient medium to teach the topics under consideration. Therefore, the evaluation questions will determine to what degree after viewing the programme, the learner has achieved its objectives. In other words, after the programme has been presented, does the learner gain in knowledge of cybernetic concepts as applied to management?

In order that the learning gain as measured by a post-test be appreciable, the information must be provided appropriately and suitably.

1.1 Content

The content of the programme is four cybernetic concepts applied in management:

- the concept of mechanism,
- the concept of natural law,
- the concept of modelling,
- the concept of behaviour.

This programme deals only with concepts and principles, it requires "intermediary visuals" (Gropper, 1966).

1.2 Instructional Strategy

The overview part of the programme and the pretest serve as motivation devices to call for the learner's attention and to increase his sensivity to a learning situation (Pressey, 1926).

To avoid mere passive watching and force the learner to participate in the presentation, sectional questions are inserted and the learner is asked to answer these questions.

Then, feedback will be offered immediately (Skinner, 1954; Gagné & Briggs, 1974). This part also serves as spaced review (Coldevin, 1975). Together with the conclusion of the presentation, it will help increase the learner's retention (Hoban & Van Ormer, 1950).

As the presentation is an introductory module (presenting the cybernetic concepts in management), the information has been "crammed" (Mitchell, 1975) with the assumption that subsequent modules dealing with single concepts would go further in detail and would serve as "maintenance periods", which are to promote memorization. Tests and retests have been carried out to set the "crammed" information at the level bearable to the learner.

The context of this thesis-equivalent work has been described in this chapter. The next chapters will present the following:

Chapter 2: A Review of Related Research
Chapter 3: The Design of the Presentation
Chapter 4: Hypothesis
Chapter 5: Development Procedure and Preliminary results
Chapter 6: Final Evaluation
Chapter 7: Results
Chapter 8: Discussion and Conclusion

CHAPTER II

LITERATURE REVIEW

This project limits itself to the production of a sound-slide programme the purpose of which is to introduce the concepts of cybernetics applied to management. Therefore, emphasis is laid on the findings pertaining to:

- the topic under consideration: "Cybernetics applied to management",
- the medium,
- the strategy used.

2.1 Research on "Cybernetics Applied to Management"

The existing research literature on "cybernetics applied to management" is quite profused. The issue has become of such an importance that in recent years editors have chosen to publish selected works to provide convenient reference sources. Among these, The Cybernetic Theory of Decisions by J.D. Steinbruner (1974) discussed the role of cybernetics in the process of political decision making. Another book, Management Systems: Conceptual Considerations by Schoderbek, Kefalas, and Schoderbek (1975) stated the basic concepts and laws of cybernetics, and related them to the process of managing complex organizations. Discussing similar matters, Management: A Modern Approach by M.K. Starr (1971) paid more attention to models and their uses.

Speaking of models in the study of social system, Hagen (1962) opined that "each discipline slowly and stumblingly

rediscovered concepts concerning methods already discovered long ago in other disciplines". Those are the concepts of cybernetics already applied by many disciplines of technology. In order to avoid "stumblings", there is a need to go back to the fundamentals of cybernetics and derive therefrom the appropriate insights applicable to the kind of problem at hand.

Stafford Beer's works (1972, 1975) provided us with such necessary fundamentals and insights.

As for the application of cybernetics to the specific domains of management, several works have been published ranging from industrial management (Forrester, 1961) to business, administration, and economics (Meir, Newell, Pazer, 1969; Optner, 1965; Beckett, 1971; Haynes and Massie, 1961), education (Mitchell, 1975, 1976; Boyd, 1971, 1974; Smith & Smith, 1966), psychology, ecology (Tansky, 1976; Mackay, 1968), biology (Parsegian, 1970), sociology (Buckley, 1967, 1968), and others.

It appears from the above that it is high time to introduce the principle of cybernetics to the students of the various fields of management.

To date, in most cases, cybernetics as applied to management has been taught in the traditional way. Use of media so far is scarce, but has proved to be convincing. Particularly worth mentioning are: "Feedback bomb or balm" (Boyd, 1974), and "Managing complexity" (Elias, 1976). Scarcity of media for use in this domain was precisely one of the moti-

vations underlying this project.

2.2 Research on the Characteristics of the Medium

The selection of the media to be used is not less important than the preparation of information to be conveyed, because "the medium itself is more than a transmission belt" (McLuhan, 1964).

Allen (1968) found that there has been a dearth of definitive research pertaining to the use of audio-visual media in changing attitudes. Appropriate media for the meeting of specific educational objectives at the cognitive level of learning have been determined by Travers (1967), Gropper (1966), Gagné (1965), Allen (1967), and Briggs et al. (1967).

Chu & Schramm (1967) reported that moving pictures do not aid significantly more to learning than still visuals do, unless the continuity of action is an essential part of the learning task.

In a research work by Barrington (1972), it was even found that diagrams were significantly more effective in promoting learning than motion pictures.

When it came to the cost effectiveness of the medium, not to mention other advantages, sound-slide was preferred to videotape or film, (see section 3.5). Sound-slide has been found as a means of effecting an awareness and attitude change in high school students (Norfleet & Melton, 1971).

Research on the influence of colour vs. black and white proved that there was no significant difference where learning

was concerned, unless colour plays an essential part in identification (Schramm, 1972). However, in informal learning areas, Schaps & Guest (1968) reported a significant increase in recall of events caused by increased attendance as a consequence of "message attractiveness". Research also showed that stimulation and involvement increased in colour viewing (Scanlon, 1970; Kaneko, 1971). In addition, it was found that subjects preferred colour and that colour sometimes attracts more attention and contributes more to motivation (VanderMeer, 1954; Rosenstein & Kanner, 1961). Fleming & Levie (1978) mentioned colour and shape as stimulus novelty which have been shown to direct attention.

In this programme, colour was used to identify some specific details in visuals (key words and different parts of a diagram) as well as to make it more attractive and to provide numerous kinds of stimulus novelty. Black and white slides were used owing to the availability of resources.

Simplified representation using symbols and lines has been demonstrated by Swanson, Lumsdaine and Aukes (1956) to be superior in explaining functional interconnections of a system.

Apparently, the simplified representation of components permits focus of attention on the interconnections by eliminating distracting cues present when the components are realistically portrayed.

Fleming (1968) maintained that people ascribe cause-and-effect relations as well as before-and-after relations to

visual elements connected left-to-right by line, and the effect is strengthened by the use of arrows. Some humour has been added when it does not interfere with comprehension, as it may help attract attention, enhance source credibility, create a positive mood, and act as a reinforcer (Sternthal and Craig, 1973).

Dwyer (1970) found the use of visuals to be an important instructional variable in increasing student achievement. However, merely increasing the size of instructional illustrations by projecting them on a larger viewing areas does not automatically improve student achievement. Furthermore, adequacy and visibility of sensory design has been discussed by Ball and Byrnes (1960, pp.115-118). The designer did not use the "visibility meter", but he used trial-and-error to keep the letter size and spacing visible. He also kept the rate of reading at about 100 words per minute, which is suitable for a group in most cases.

Media have certain characteristics of their own, which influence the learner's attention, and according to many researchers, (Gagné, 1967; Gagné & Rohwer, 1969; Boyer & Seaborne, 1971) gaining and maintaining attention is one of the most essential conditions of learning.

2.3 Research on Instructional Strategy

The role of preinstructional overview has been considered by May and Lumsdaine (1958) as one of enhancing learning by orienting the student's attention to certain aspects of the presentation. The value of an overview in yielding consistent

and significant learning results was also found to be considerable by Rosenshine and Furst (1971).

Headings and sub-headings of sections can aid in the process of learning: students learning from a technical manual showed a marked improvement in their comprehension when typographic cues were used (Kalt & Barrett, 1973). Whether the material is arranged in a systematic, acceptable order influences the learner's achievement: research by Brown (1970) found that unstructured programmed sequences in mathematics affected more unfavourably lower ability learners than those of higher ability.

The findings of research on the effect of pretests on posttests are still inconsistent.

Most studies revealed that pretest effect have not been discernible (Hartley & Holt, 1970; Apter, Boorer, & Murgatroyd, 1971). In a study done by Welch and Walberg on 2200 students from 57 secondary schools, the researchers failed "to detect any significant pretest or sensitization effects" (1970, p. 613).

In some studies however, pretest effects have been discernible. Hartley, Holt, and Swain (1970) reported that subjects in treatment group scored higher than control subjects on posttest questions they have seen previously but not higher than control subjects on questions they have not seen.

In some others, pretests have been found to have an adverse effect on posttest performance. Lana (1966) in her study on vivisection opinion found that pretest had an

inhibitory effect on opinion change.

In this project, the pretest was used to measure the learner's pre-existing knowledge in order to evaluate the effectiveness of the programme. Should it affect the post-test performance by increasing student's sensitivity to the learning situation, (Pressey, 1926) or by increasing student's awareness of what was expected of him (Hartley, 1973; Warr, Bird, & Rackham, 1970), this effect could be minimized by mixing up the questions randomly for both pre-and posttests. The posttest was also split into two parts to check on retention. Learners did posttest one after viewing the first half of the programme. The second half was presented and tested after a delay of one week.

It is argued that behavioral objectives can help promote learning behavior. They provide learners with a clear goal that can be used to organize learning activities, permit learners to study more efficiently and reduce the time wasted on irrelevancies (Gagné, 1965), because what he must do in order to demonstrate his competence has been identified.

Mitchell (1975 a) however, pointed out that a problem arises when the absence of an overt demonstration of intended behavior is taken as evidence that nothing was learned. In any case, informing the learner of the objectives at least serves the purpose of preventing the learner from "getting entirely off the track" (Gagné & Briggs, 1974).

Lang (1977) reported that there was no significant difference between the viewing guide and the tape-only approach

at the .05 level under his experimental conditions. But Leytham and James (1973) found that programmed instruction teaching X-ray procedures to student nurses was more effective when used with an instruction guide which gave details of objectives, target population, level of teaching efficiency, method of presentation and questions and answers.

Research by Marchant (1971) and Marchant & Teather (1972) found that students viewing an interrupted presentation did better than those who viewed the same programme in one continuous session. All students received a pretest before the presentation was shown. One group received the posttest at the end of the presentation, while the other answered the relevant section of the posttest during each interruption.

This is supported by Leytham and James (1973) who suggested that "further improvement in teaching efficiency of a videotape can be brought about by presenting it to students in small "steps", with suitable pauses for responses and feedback...the necessary questions and feedback can be built into the recording".

Since sound-slide, among other media, is of a passive carrier (Gropper, 1976) that is, it is neutral with respect to the role of active practice or feedback, the programme must be designed in such a way that the learner is forced to interact with it (Bertou, 1972; Ausubel, 1968; Rothkopf, 1970). One of the ways to get learners involved in the presentation is to give them questions to answer. By this means, their performance is elicited. "Questions inserted frequently in instructional prose facilitate prose learning, particularly where the

questions follow the passage. The effect is large where the criterion test consists of the same questions, though there is sometimes a positive effect on new questions as well" (Fleming & Levie, 1978,p.135). However, correct answers should be given as feedback about performance for the learners to test and reinforce their knowledge as they proceed. There is evidence indicating that knowledge of results facilitates learning (Thorndike, 1932; Sassenrath & Garverich, 1965; Micheal & Maccoby, 1961; Silverman, 1972).

Recent research also indicates that immediate feedback of the correct answer usually produces better learning and retention than does delayed feedback (Silverman, 1972).

Inserted questions (and subsequent correct answers) after each single "step" give learners more opportunity to consider each section of the material before proceeding with the next (Marchant, 1971; Marchant & Teather, 1972). To some extent, this can be seen as a spaced revision, which was found to be more effective in holding the learner's retention than massed review (Reynolds & Glaser, 1964; Edwards & Mitchell, 1974).

Taking into account this evidence for effectiveness of pretests, typographic headlines, graphic overviews, immediate feedback, spaced review, readability of lettering, and humour, etc...in the process of learning, the designer used these in planning and producing the presentation. The instructional objectives were given in a briefing before the presentation. They were also stated in the "Instruction Guide" for the user's reference.

CHAPTER III

DESIGN OF THE PRODUCTION

This chapter will describe the factors considered in the design of the sound-slide presentation, namely target audience, goals and objectives, constraints, subject matter analysis, planning and production, and formative evaluation.

3.1 Target Audience

This programme was designed for all those who are interested in cybernetic concepts applied to management and especially University students who have little or no background regarding these topics and are taking courses the content of which are related to the topics under consideration, such as Introductory Business Management, and Educational Cybernetics courses...

3.2 Goals and Objectives

3.2.1 Goals

The programme aimed at:

- Presenting to learners an overview of the cybernetic nature of management.
- Introducing the concepts of mechanism, of natural law, of modelling, and of behavior, supported by various examples taken from different disciplines.
- Motivating the learners to think of management problems in cybernetic terms.

It laid emphasis on the concepts of cybernetics as a science governing management.

3.2.2 Objectives

The objectives of the programme, therefore, were formulated as follows:

After viewing the programme the learner would be able

- to define: mechanism, feedback, metasystem, model, behavior, homeostasis,
- to describe the effects of feedback mechanisms,
- to differentiate "positive" feedback from "negative" feedback, "isomorphic" model from "homomorphic" model,
- to state the law of "requisite variety".

3.3 Constraints

i) The population available for the evaluation of the programme was made up of students from different intact classes which met at different times. The individual population groups were so small that they could not be split randomly into Control and Treatment Groups. Furthermore, neither mixing up nor splitting the classes was permissible. Therefore, a Separate-Sample Pretest-Posttest design was used.

ii) The medium used had to be easily portable and easily available to users.

iii) There had to be a requisite variety of different visual representations (typographs, diagrams, real pictures) for the abstract concepts and principles. Also the ability to change or edit the visuals was considered as highly desireable.

iv) The concepts are dynamic process concepts whence motion is desirable (animation etc.).

v) But cost limitations were very severe.

3.4 Subject Matter Analysis

Subject Matter Analysis was carried out based on the two techniques "Documentation Analysis" and "Subject Matter Expert Interview" as described by Holden (1977) to generate the teaching points, and hence to determine the level of the enabling objectives according to Bloom's Taxonomy (1956, 1964). These objectives, then, were stated in Mager's (1962) style.

The following Table, Table 1: A classification of Cognitive Learning is the learning classifications derived from this analysis (see Table 1). It is realized that the attainment of a cognitive goal helps to raise the learner's interest and this promotes the achievement of higher cognitive goals.

3.5 Planning and Production

This programme was based mainly on Stafford Beer's work prepared for UNESCO in late 1969, (in Beer, 1972a) which is the expression of a philosophical thought at an abstract level. Therefore, the designer had to arrange it to make it suitable and accessible to the target audience. It was kept in general enough terms so that it remains valid in and applicable to any discipline.

The selection of the medium was carried out based on Holden's software and hardware matrices (1976). It was found that sould-slide videotape, and computer assisted instruction could be taken into consideration.

However cost constraints and the necessity for iterative

TABLE 1

A CLASSIFICATION OF COGNITIVE LEARNING

CONCEPT	TERMINOLOGY	CLASSIFICATIONS & CATEGORY	TRENDS & SEQUENCES	METHODOLOGY	PRINCIPLES & GENERALIZATIONS
Mechanism	-Feedback -Homeostasis -Mechanism	negative and positive feedbacks	effects of feedback mechanism: Negative feedback: Goal seeking process Positive feedback: Deviation amplifying process.	make a cybernetic homomorphic model and try out managerial decisions on it	Negative feedback stabilizes Positive feedback causes growth, blow ups or collapse
Natural Law	-Requisite Variety -Metasystem -Metalanguage -Natural law	Disturbance variety, control variety, and uncontrolled variety	System under control when disturbance variety is absorbed by control variety		only variety can counteract variety
Modelling	-Model -Block-diagram	Isomorphic and Homomorphic Models	Information reduces uncertainty		
Behavior	-Behavior				Prediction must be made and modified

revision precluded all but sound-slide.

The following decision chart detailed their characteristics, where SS represented Sound-slide, VT represehted Videotape, and CAI represented Computer Assisted Instruction (see Table 2). Referring to this chart, Sound-slide was selected as medium for the programme.

Other advantages of the medium were:

- it provides simultaneous visual and audio stimuli,
- it can be very easily and cheaply transferred onto videotape or videocassette.

With the intention of making the programme easy to understand, explanations and illustrations of notions and concepts were emphasized and a variety of examples taken from various fields of management activity was introduced.

The successive points treated were:

Section 1:

- The concept of mechanism
- The concept of natural law

Section 2:

- The concept of modelling
- The concept of behavior

with a brief introduction and conclusion.

Review questions were inserted at the end of each section.

The introduction presented an historical overview of Cybernetics and stated what the learner was expected to learn from the programme in order to gain his attention (May & Lumsdaine, 1958).

TABLE 2

CHARACTERISTICS OF THE SOUND-SLIDE VS VIDEOTAPE AND COMPUTER ASSISTED INSTRUCTION PROGRAMMES

CHARACTERISTICS	MEDIA		
	SS	VT	CAI
- Flexibility of visual	E	P	P
- Flexibility of sequence	E	G	G
- The ease with which complex diagrams can be shown	E	G	P
- Easy to edit	E	G	G
- Motivational value of colour	E	E	G
- Easy to handle	E	G	P
- Suitable for group	E	E	P
- Suitable for individual	E	E	E
- Reasonable cost	E	G	P
- Durability	E	E	E
- The presence of natural language	E	E	G
- Ability to show dynamic (moving) processes	P	E	G

CAI: Computer assisted instruction

SS: Sound-slide

VT: Videotape

E: Excellent

G: Good

P: Poor

The conclusion summarized the important points in the programme in a clear and concise manner, to give the learner an overall review of the problem, and hence, hopefully increase his retention (Hoban & Van Ormer, 1950; Thyne, 1966).

Each sectional review question was followed by a rest interval allowing the learner to respond. Then, the correct answer was provided as immediate feedback (Silverman, 1972; Sassenrath & Garverick, 1965), and as spaced revision (Reynold & Glaser, 1964; Edwards & Mitchell, 1974).

Voice was selected for clarity in expression. Narration was practiced twice on cassette recorder, in order to eliminate speech difficulties, as well as to find out the most suitable style and speed.

The rehearsed narration was synchronized with the visual draft, and presented to Narrator and Thesis Advisor. Revisions were made according to their advice, such as restructuring the introduction, and inserting cues to indicate the time allowed for learner's responses. Some paragraphs were also improved and rewritten in a spoken style. The programme was then recorded and tested.

3.6 Production Cost

The production cost of the programme was calculated as follows:

- Lettraset	$ 40.00
- Cardboard	$ 10.00
- Graphics and lettering	$120.00
- Cassette tapes	$ 4.00

- Film	$ 40.00
- Film development and framing	$ 26.00
- Typing	$ 50.00
TOTAL	$290.00

3.7 Formative Evaluation

It was then presented to an Educational Technology class, E.T. 606/506, of 28 subjects. Data collected were analyzed (see chapter 5: Development Procedure and Preliminary Results) and discussed. It was concluded that some information should be deleted and that the duration of 45 minutes was too long for one showing.

The content and the technique of presenting were, therefore, reconsidered.

Information was refined and rearranged to make two sections instead of four. Each section dealt with two concepts, and at the end of each section, there were review questions.

The two sections could be shown continuously or separately with a certain pause in between, to give the learner some time to internalize, hoping that retention would be thus increased.

Coldevin (1975) showed that spaced treatment (the review occurred at the end of each sub-unit with a five second pause between individual review statement presentation) was significantly more effective than either the summary (review occurs upon termination) or massed formats (similar to spaced review but without five second pause).

Pockrass (1960) also reported that increased learning

occurred when a 1 minute rest period was inserted into the midpoint of a 30 minutes programme to help facilitate the assimilation of the material.

The programme was then retested on two Behavioral Management classes. Data collected were analyzed to see whether the hypothesis was supported (see chapter 7: Results).

CHAPTER IV

HYPOTHESIS

In this chapter, we will define the variable and formulate the hypothesis for the summative evaluation.

4.1 Definition of Variable

Before stating the hypothesis, let us define the following variable:

Knowledge: refers to the ability to define, describe, differentiate among and state a coherent set of concepts and laws, and to apply them in a certain field.

4.2 Formulation of Hypothesis

Having defined the above variable, we can now formulate the hypothesis as follows:

- The programme and the pretest will result in a change in the knowledge of cybernetic concepts applicable to management, as measured by a criterion posttest.

4.3 Rationale for the Hypothesis

The rationale for the hypothesis in question lies in the following arguments:

a) Management being partly an art, partly a science, involves various elements of both subjective and objective nature. If the objective elements can be presented in a scientific and systematic way to be the underlying and integrating principles, they become more intelligible and intrinsically motivating (Mitchell, 1975a), thus more accessible and acceptable to the mind.

b) A large number of students have possibly been exposed to the science of cybernetics previously while studying or working in their own respective domains (Engineering, Education, Physical Science, Mathematics...). Chances are that they have been exposed to the similar principles and the similar lines of thought under different terminologies (Hagen, in Baker, 1973). This presentation can show them that the principles involved in any control system are actually the same and that the resulting processes are fundamentally similar. Therefore, the methodology applicable in one field can carry over to other fields, in this case, that of management.

c) In today ever "self-complicating" world, it is safe to assume that an engineer, an educator, a physician...will be, sooner or later during their professional career, called upon to assume managerial responsibilities, i.e. to manage their own system or even metasystem. Each of these individuals, knowingly or unknowingly, will have learned to apply the principles of cybernetics to their own fields of activity (Forrester, 1964). It would be great waste if this hardly and costly gained skills in one domain could not be put to use in the other. It was hoped that this programme would prove to be a modest contribution to the setting up of this useful connecting line.

CHAPTER V

DEVELOPMENT PROCEDURE AND PRELIMINARY RESULTS

The following parts will be treated in this chapter:

- Pilot trial of test instrument,
- Formative evaluation.

5.1 Pilot Trial of Test Instrument

After being constructed, the evaluation test was given to an Educational Cybernetics class at Concordia University in 1977.

Item analysis was made and some items were found to be answered randomly such as the question about choosing two homomorphic models among different models of a production distribution system and of the human cranofacial morphology.

These questions were discussed and revised to be more appropriate, and some others were omitted.

From this pilot group study, the approximate time required for students to do the test was also determined. It was about 25 minutes for the pretest and 20 minutes for the posttest, in average, about 60 seconds for one question.

5.2 Formative Evaluation

5.2.1 Population

The subjects for the formative evaluation were 28 Educational Technology students in an Educational Cybernetics class from Concordia University in 1978.

Their social classes and their IQ score were not available.

However, since the students have reached the 600 course level, they can be reasonably assumed as belonging to at least middle social and upper high IQ score classes.

Questionnaires were administered to control for the possibility that some subjects had been exposed to cybernetics and particularly to the material covered in this programme. It was found that no student had previous exposure. In this respect, the subjects can be considered as homogeneous.

5.2.2 Materials

The material used for this evaluation was the 45 minute length non-split version of the sound-slide programme with review questions and answers at the end of the programme.

5.2.3 Measuring Devices

The evaluation test and the questionnaire were especially designed for use in this project.

The evaluation test was used as pre- and post-tests, the results of which determined whether or not the hypothesis was to be rejected.

This test was composed of 23 multiple choice items and two Likert-scale items, those were:

Question: Do you think there is much in common between the methods for the control of machines and those for the control of people in an organization?

Answer: Nothing in common — — — — — much in common.

Question: Are you interested in reading books and articles on cybernetic approaches to management?

Answer: Not at all — — — — — very highly.

The questionnaire, consisting of 20 semantic differential items, was used to measure the learner's attitude towards the programme so that improvement could be made therefrom.

5.2.4 Results of the Evaluation Test

The data collected were coded and analyzed by computer, using t-test to compare the means of the pre- and post-tests, to determine the probability that the difference between them is a real difference rather than a chance difference (Popham, 1973; Tuckman, 1972). The following results were found at $p < .05$.

TABLE 3

Table of Mean Scores on Tests

(Educational Technology Student Group)

Test	Mean	Standard Deviation	t	df
pretest	13.11	2.85		
post test	19.61	2.91	12.60	.27

An item by item analysis using t-test was also carried out and gain scores for every single item were also calculated to find out which part of the programme the student learned least.

Gain score, which was a ratio of actual gain by possible gain were calculated using the following formula:

$$\text{gain score} = \frac{\text{posttest score - pretest score}}{\text{100 percent - pretest score}}$$

Where pretest and posttest scores were class correct answers, and 100 percent was highest gain score expected.

(Gale, 1975; McGuigan & Peters, 1964). A complete table can be found in Appendix D. As shown on this table, students gained least in the following questions:

- question 7 on Ashby's law of requisite variety,
- question 16 on Beer's suggestion to use cybernetics to find way to contain disorder,
- question 18 on the way they think of a good organization,
- question 19 on feedback mechanism,
- and question 24 on what they think about the relationship between control of machines and control of people as an organization.

The parts of the programme related to these questions were revised. Some information were simplified or removed. More explanation and more examples were added. The wording of the questions was also modified to make it clearer to students. Two more questions were also added to make the evaluation test capable of checking if the related objectives have been achieved. They were questions 11 and 20 (see Appendix C).

5.2.5 Result of the Evaluation Questionnaire

After the presentation, the evaluation questionnaire was handed out to students together with the posttest. It was suggested that the students complete the questionnaire before doing the posttest. The reason was that in this way, the students could provide a fresher feedback on the medium and they could hopefully have some minute to refresh before answering the posttest.

The collected data were analyzed; the percentage of students who gave favourable answers to different questions (range 3 to 5) concerning different aspects of the programme was calculated (see table 3 bis).

It was observed that:

a- The homogeneity of the population is acceptable in the sense that 100% students responded that they had never read the related material before. Besides, 86% of them answered that they had never or scarcely been exposed to cybernetics.

b- The programme was found to be useful by more than 96% of students.

c- 93% of students thought that sound-slide is suitable to convey the information. One student suggested that film would be preferable, one that videotape would be, one that sound only would be and two that printed matter would be better.

d- 100% of students showed that the number of topics covered were too many.

e- And more than 50% opined that the length of the programme was too long.

Based on the data analysis of the formative questionnaire, the content of the programme was revised. Some concepts, such as ultrastability, the variety amplifier, were omitted. The concepts of mechanism and of natural law were simplified and some more examples were added to make it easier to grasp. Furthermore, the programme was split into two sections. They

TABLE 3 bis

ITEM BY ITEM ANALYSIS OF THE QUESTIONNAIRE

ON THE EDUCATIONAL TECHNOLOGY STUDENT GROUP

QUESTIONS	RANGE	MEDIAN RATING	PERCENTAGE OF RESPONSE FROM 3 TO 5
1	2 - 5	3	82.14%
2	3 - 5	4	92.85%
3	2 - 5	4	82.14%
4	1 - 5	3.5	78.57%
5	3 - 5	5	100.00%
6	1 - 5	4	78.57%
7(a)	1 - 5	4	75.00%
7(b)	2 - 5	4	78.57%
8(a)	1 - 5	4	82.14%
8(b)	1 - 5	3.5	82.14%
9	3 - 5	5	100.00%
10	1 - 5	2.5	50.00%
11	1 - 5	4	89.28%
12	2 - 5	4	92.85%
13	2 - 5	4	89.28%
14	2 - 5	4	89.28%
15	1 - 5	5	96.43%
16	1 - 5	5	92.86%
18	1 - 4	1.5	32.14%
19	1 - 5	1	17.85%
20	1	1	.00%
21	2 - 5	4.5	92.86%

can be shown separately or together with some rest period in between, with the assumption that it would help facilitate learning. After the programme was revised, the evaluation test was revised accordingly. Finally, the test consisted of 22 multiple choice items. The two Linkert-scale items were changed to multiple choice to simplify the procedure of scoring. Among these test-items, 7 items related to the content of the first section of the programme made up posttest 1, the rest posttest 2.

The programme and the tests were exposed then to 58 management students at Concordia University in 1978 for final evaluation (see chapter 6).

CHAPTER VI

FINAL EVALUATION

The following factors will be specified in this chapter:

- Subjects
- Materials
- Evaluation devices
- Research design
- and variables

6.1 Subjects

58 Management students in two undergraduate Behavioral Management classes from Concordia University were the subjects for this experiment.

The social classes from which the subjects come, and their IQ scores were not available, but as for formative social evaluation population, they can be assumed to be of middle and upper IQ score classes. Formative questionnaire was also administered to control for the homogeneity of the population in regard to their exposure to the material covered in the programme.

6.2 Materials

The materials used for this final evaluation were the 30 minute length split version of the sound-slide programme. It was composed of two sections of 15 minutes each. Each section dealt with two main cybernetic concepts. At the end of each section, there were review questions and answers which were about six minutes long.

To make it easier for users, especially self-paced learners, an introduction guide has also been constructed, containing behavioral objectives, target population, method of presentation, and multiple choice questions and answers for reference. These questions were part of the evaluation test of this research.

However, during the evaluation, because the material was presented to intact classes (i.e. group paced), and because a procedural briefing on the behavioral objective was given by the designer who distributed the tests, the instruction guide was not used in the experiment. The instruction guide can be found in Appendix A.

6.3 Evaluation Devices

The evaluation devices used for summative purposes were the questionnaire and the evaluation test revised accordingly to the revision of the content of the programme. While pre-test was administered to students as a single test, posttest was divided into two: Posttest 1 and posttest 2, corresponding to section one and section two of the revised programme, respectively.

Evaluation pre- and post-tests were made up of multiple choice questions. As has been said, the results of such tests would determine whether or not the hypothesis was to be rejected.

The aim of the test was not to compare students to one another. Rather, it was to see if the programme works, therefore, reliability analyses are not reported as they are not

applicable to criterion items.

The questionnaire was used to determine the learner's appreciation of the programme; it was also used to see if correction made was in the correct direction. It was administered after the learner viewed section 2 of the programme and before the posttest 2. Students took about 10 minutes to complete this evaluation questionnaire. A copy of it can be found in Appendix B.

6.4 Research Design

It had been proposed that Post-Test-Only control group method of evaluation be used. However, it was changed to Separate-Sample-Pretest-Posttest Design, because, as mentioned in 3.3 (Constraints), the population in the different intact classes were too small to be divided into control and treatment groups. Even if the whole population could have been arranged to be available at the same time to make up a larger group, the designer would not have been allowed to mix them up and split them randomly into two groups.

This Separate-Sample-Pretest-Posttest-Design can be diagrammed as follows:

O_1 X O_2

O_3 X O_4

Where O_1 stands for the Pretest administered to group 1

O_2 stands for the Posttest administered to group 1

O_3 stands for the Pretest administered to group 2

O_4 stands for the Posttest administered to group 2

X stands for the presentation of the programme.

The influence of pretest on posttest scores has been discussed (Tuckman, 1972).

To attempt to control for its effects, the designer has shuffled the order of appearance of the items in the test as well as the order of multiple choice answers for each question.

Furthermore, in an attempt to minimize the magnitude of the pretest effect on posttest and of maturation, two different tactics have been used in the following two steps of the procedure:

Step 1: The pretest was administered to both groups. Then the first section of the programme was shown to them. After viewing it, they did the posttest 1 related to the content of this section.

Step 2: After one week, both groups viewed the second part of the programme and then posttest 2 was administered.

The delay of the posttest 2 one week after doing the pretest will hopefully control for the threat of single testing effect. Besides, different procedure for administering the tests together with the repetition of the One-Group-Pretest-Posttest Design can make it possible to control for history. (Tuckman, 1972).

6.5 The Variables

The variables were as follows:

a) Independent variables:

The sound-slide programme.

b) Dependent variables:

- student's scores on posttest.
- student's feedback (answers in questionnaire) on the

sound-slide programme's production variables.

c) Control variables:

- The length of the treatment.
- Previous background in cybernetics.

CHAPTER VII

RESULTS

This chapter reports the data obtained and the results of the data analysis.

7.1 Data Analysis of the Evaluation Test

The most general results are given in table 4.

TABLE 4

GAIN SCORES FOR THE WHOLE POPULATION OF 58 MANAGEMENT STUDENTS

TEST	MEAN	GAIN SCORE
Pretest A	3.00	
Posttest 1 (immediate)	6.41	0.85
Pretest B	7.71	
Posttest 2 (delayed 1 week)	12.80	0.70

1. Pretest A consists of 7 questions: 1, 4, 11, 15, 16, 19, and 20, corresponding to the 7 items of the posttest 1.
2. Pretest B consists of 15 questions: 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, 14, 17, 18, 21, and 22, corresponding to the 15 items of the posttest 2.
3. Both pretest A and pretest B made up the pretest, which was administered to the students in the beginning of session 1 before viewing the programme.

Due to the small sample size, a t-test has been used to compare the means of the tests to determine whether there was a statistically significant change in the students performance. The following results were observed (table 5):

TABLE 5

TABLE OF MEAN SCORES FOR TWO MANAGEMENT STUDENT GROUPS

GROUP	TEST	MEAN	STANDARD DEVIATION	t	df
GROUP 1					
Session 1	Pretest A	3.19	1.11		
	Posttest 1 (immediate)	6.42	.67	12.98	30
Session 2	Pretest B	7.84	1.67		
	Posttest 2 (delayed one week)	12.74	1.63	18.59	30
GROUP 2					
Session 1	Pretest A	2.81	1.21		
	Posttest 1 (immediate)	6.41	.69	14.60	26
Session 2	Pretest B	7.59	1.47		
	Posttest 2 (delayed one week)	12.85	1.54	12.26	26

1. $p < .05$

2. Pretest A and Pretest B: See footnote of Table 4.

An item by item analysis using a t-test was also carried out, and gain scores for every single item were also calculated (see page 27 for the formula).

Complete tables can be found in appendices E and F.

The results indicated that students in both groups showed a significant gain in knowledge.

The gain score was 1.00 (maximum possible) for the questions on the definition of mechanism (question 1), of behavior of a system (question 6), of metasystem (question 16), of model (question 18), and of feedback (question 19) in both groups.

For question 13 on the difference between isomorphism and homomorphism, it was 1.00 in group 1 and .93 in group 2.

The question on the difference between positive feedback and negative feedback acquired a gain score of .81 in group 1 and .74 in group 2 (question 15).

It was also observed that no students in either group could state the Ashby's law of requisite variety before viewing the programme. Some students answered "don't know it", "I have no idea", one even asked "who is Ashby?". However, all of them responded correctly on the posttest (question 11).

Referring to the same tables (appendices E and F), we can also see that a modest gain score was found for questions 4, 7, 14 and 22.

They were .28 (in group 1) and .47 (in group 2) for question 4 on the cat who corrects his balance in an unbalanced situation; .34 (in group 1) and .50 (in group 2) for question 7 on the way one thinks of a human body as a system; .44 (in group 1) and .13 (in group 2) for question

14 about the way one thinks of a good organization; and .24 in both groups for question 22 on the methods of control of machines and those for the control of people in an organization.

7.2 Data Analysis of the Evaluation Questionnaire

The evaluation questionnaire was administered after the students' viewing the programme and before their doing the posttest 2 to see if the programme had been improved.

The collected data were analysed; the percentage of students who gave favourable answers to different questions (from range 3 to range 5) concerning different aspects of the programme was calculated (see tables 6 and 7).

The two tables 6 and 7 indicate that:

a) As 100% students in both groups answered that they had never read the related material (question 20), and about 95% of students in both groups answered that they had never or scarcely been exposed to cybernetics before (question 19), the population could be considered homogeneous.

b) More than 96% of students in both groups considered that the programme was useful (question 21).

c) Since the designer intended to investigate if sound-slide is suitable to convey the message, one question on the suitability of sound-slide as a medium was asked (question 16). More than 90% of students in both groups responded favourably to this question. Two students suggested that film would be easier to

follow, one that printed matter would be, and one that conventional lecture would be better.

TABLE 6

ITEM BY ITEM ANALYSIS OF THE EVALUATION QUESTIONNAIRE ON THE MANAGEMENT STUDENT GROUP I.

QUESTIONS	RANGE	MEDIAN RATING	PERCENTAGE OF RESPONSE FROM 3 TO 5
1	1 - 5	3	84%
2	2 - 5	4.5	100%
3	2 - 5	4	90%
4	1 - 5	4.5	99%
5	3 - 5	3	86%
6	2 - 5	4	93%
7	2 - 5	3.5	80%
8	1 - 5	4	94%
9	3 - 5	4.5	98%
10	1 - 5	4.5	95%
11	2 - 5	4	87%
12	2 - 5	4	90%
13	2 - 5	4.5	92%
14	2 - 5	5	100%
15	1 - 5	4.5	98%
16	1 - 5	4.5	91%
18	1 - 4	4.5	91%
19	1 - 5	1	04%
20	1	1	00%
21	2 - 5	4	96%

TABLE 7

ITEM BY ITEM ANALYSIS OF THE EVALUATION QUESTIONNAIRE ON THE MANAGEMENT STUDENT GROUP 2

QUESTIONS	RANGE	MEDIAN RATING	PERCENTAGE OF RESPONSE FROM RANGE 3 TO 5
1	2 - 5	3.5	85%
2	3 - 5	4	100%
3	1 - 5	4.5	86%
4	2 - 5	5	98%
5	1 - 5	3	93%
6	2 - 5	4.5	99%
7	1 - 5	4	88%
8	2 - 5	4.5	89%
9	2 - 5	4.5	98%
10	2 - 5	5	98%
11	1 - 5	4	85%
12	2 - 5	4.5	95%
13	1 - 5	5	95%
14	3 - 5	5	100%
15	2 - 5	5	98%
16	1 - 5	4.5	92%
18	1 - 5	4.5	95%
19	1 - 4	1	06%
20	1	1	00%
21	2 - 5	4.5	97%

CHAPTER VIII

DISCUSSION AND CONCLUSION

In this chapter, the results of the evaluation test and the evaluation questionnaire will be discussed and some conclusions will be made.

8.1 Discussion:

8.1.1 The Evaluation Test

The results of the data analysis revealed that 85% of students in both groups exhibited high gains, and almost all of them found the programme interesting and beneficial.

In general, the gain scores were higher in questions closely related to the content of the programme i.e. in questions where the students were asked to define and to discriminate the main cybernetic concepts, and to state the law of requisite variety (questions 1, 3, 6, 8, 10, 11, 12, 15, 17, 18, and 19).

More students answered correctly to questions about the parts of the programme which are either illustrated with examples, or presented with simplified visual illustrations using symbols and lines (questions 1, 3, 6, 12, 16, and 19), especially, where humour was added to visual cue (questions 3, 6, and 11).

Besides, it was also found that the questions for which the gain scores were high were those related to the information included in the review question and answer sections of the presentation.

The students did not answer well those questions which require some inference from the knowledge acquired (questions 2, 4, 7, 14, and 22) as well as the question related to those parts of the programme where the above techniques were not applied rigorously (question 20).

The modest gain score for these questions was predictable, as these questions were not intended to bear on the content of the programme. Rather, the intention was to find out whether or not any change occurred in the students' way of thinking of cybernetics as applied to problem solving. The intention was not to measure directly the objectives, but to give eventual indications for the designing of the successive modules.

The preceeding discussion was based on gain scores. By studying the data analysis using t-test to compare the means of pretest and posttest (appendices E and F), it was observed that except for questions 4 and 7, where the t-values were low for both groups, and for question 2 and 14, where the t-values were low for group 2, there was a significant change in the knowledge of basic cybernetic concepts applicable to management. Referring back to table 4 (page 37) we see that the gain score for immediate posttest 1 (85%) was higher than that of the delayed posttest 2 (70%). This agrees with the finding of J. Luiten, W. Ames, and G. Ackerson that "the average advance organizer study shows a small, but facilitative effect on learning and retention" (1980, p. 217). However, a gain score of 70%

was enough to indicate that the students learned from the programme. In other words, the hypothesis "the programme and the pretest will result in a change in the knowledge of cybernetic concepts applicable to management as measured by a criterion posttest" cannot be rejected.

8.1.2 The Evaluation Questionnaire

Some students who viewed the programme reported as its weak points the following:

- "Information is hard to follow at some points during the presentation".
- "Too much theory orientation".
- "It is too choppy. A film would be smoother, easier to follow".

However, the results of the evaluation questionnaire indicated that students in both groups found the production variables of the programme (length, quality of visuals and sound, matching of visuals and sound) appropriate.

8.1.3 The Split Version Vs the Non-Split Version

Referring to Appendix G, we see that in general, gain scores on the final evaluation test (gives to the management groups) were higher than those on the formative evaluation test (given to the educational group). Especially, in items 1, 10, 11, 12, 15, 18, and 19 (numbered as for the final evaluation test) both management groups acquired gain scores almost twice as high as those acquired by the educational one. This indicates that the split version of the programme produced more learning than the non-split version.

8.2 Conclusion

Due to the fact that the sample population was drawn from different disciplines and different course level, it is possible that the results can be generalized as indicating that the programme could be used to introduce cybernetic concepts as underlying principles in management for both undergraduate and graduate university students.

Moreover, it could be inferred from the results that sound-slide is suitable paedagogically and budgetarily as a medium for the presentation of the topic under consideration.

APPENDIX A

INSTRUCTION GUIDE (AS USED)

I- "An Introduction to Cybernetic thinking in Management" is a set of 120 2" X 2" colour slides with the narration on cassette in two parts of 15 minutes each.

II- Objectives:

After viewing this programme, the learner would be able

-to define mechanism, feedback, metasystem, model, behavior, homeostasis,

-to describe the effects of feedback mechanism,

-to differentiate "positive" feedback from "negative" feedback, "isomorphic" model from "homomorphic" model,

-to state the law of "requisite variety".

III- Audiences:

1- Those who are interested in cybernetic concepts applied to management,

2- University students.

No background required.

IV- Suggestions for group and individual uses:

1- For group use:

It is suggested that the programme be stopped after each section for discussion of the concepts just covered. This will give learners a period for assimilation. The list of questions offered does not pretend to exhaust all possible problems.

2- For individual use:

Each section terminates with some review questions, try to answer them briefly in the pause reserved. After each section, complete the final test questions. Test items are listed at the end of this guide. Correct answers are also offered. Check your answers against them and review the material for each item you have missed.

V- Test items: (see appendix C)

VI- Correct answers:

(Do not attempt to see this page before answering all questions).

Posttest 1

1	b
2	c
3	b
4	c
5	only variety can destroy variety
6	b
7	b

Posttest 2

1	d
2	d
3	a
4	b
5	d
6	a
7	c
8	c
9	d
10	c
11	a
12	d
13	b
14	a
15	c

APPENDIX B

FORMATIVE EVALUATION SECTION

In the following pages, we have listed a series of descriptive scales. Based on the presentation, we would like you to place a check mark in the space in each item that best describes how you feel about the programme.

Here is how you use the scales.

If you feel that the programme is very closely related to one end of the scale, you would place your check mark as follows:

Strong __X__ _____ _____ _____ _____ Weak

or

Strong _____ _____ _____ _____ __X__ Weak

If you feel that the programme is slightly related to one end as opposed to the other end (but not really neutral), you would place your check mark as follows:

Strong _____ __X__ _____ _____ _____ Weak

or

Strong _____ _____ _____ __X__ _____ Weak

If you consider the programme to be neutral on a scale, you would place your check mark in the middle space of that scale:

Good _____ _____ __X__ _____ _____ Bad

Please make each item a separate and independent judgement. Thank you for your cooperation in this study.

1) Does this programme meet your objectives?

Not at all _____ _____ _____ _____ _____ Perfectly

If NOT, please specify the reason and your objectives here:

2) Information is:

Poor _____ _____ _____ _____ _____ Excellent

3) Is the information clear?

Clear _____ _____ _____ _____ _____ Obscure

If NOT, please specify the unclear part:

4) Is the sequence easy to follow?

Difficult _____ _____ _____ _____ _____ Easy

5) Is the number of topics covered appropriate?

Too few _____ _____ _____ _____ _____ Too many

If TOO MANY, what could be deleted?

6) Is the emphasis given to the topics appropriate?

Appropriate _____ _____ _____ _____ _____ Inappropriate

7) Are test items easy?

Easy _____ _____ _____ _____ _____ Difficult

8) Are test items ambiguous?

Ambiguous _____ _____ _____ _____ _____ Clear

9) How is the relationship of the test items to text?

Close _____ _____ _____ _____ _____ No relationship

Please specify No Relationship Items, if any.

10) Is the length of the programme reasonable?

Reasonable _____ _____ _____ _____ _____ Unreasonable

If Unreasonable, please specify if it is Too Short or Too Long:

11) The programme is:

Boring _____ _____ _____ _____ _____ Interesting

12) The quality of the graphics used is:

Poor _____ _____ _____ _____ _____ Excellent

13) The sound is:

Excellent _____ _____ _____ _____ _____ Poor

14) Does the audio match the visual?

Perfectly _____ _____ _____ _____ _____ Weakly

15) You paid attention to the programme:

Frequently _____ _____ _____ _____ _____ Scarcely

16) Do you think sound-slides is suitable for this presentation?

Unsuitable _____ _____ _____ _____ _____ Suitable

If Unsuitable, please recommend another medium:

17) What faculty are you in?

18) Have you been exposed to management theory before?

Never _____ _____ _____ _____ _____ Many times

19) Have you been exposed to Cybernetics before?

Frequently _____ _____ _____ _____ _____ Never

20) Have you studied or read "Management in Cybernetic Terms" by Stafford Beer?

Carefully _____ _____ _____ _____ _____ Never

21) Does this programme help you know more about Cybernetics?

Not at all _____ _____ _____ _____ _____ Very much

APPENDIX C

EVALUATION TEST

For the following multiple choice questions, please select the statement that appears to you to be the most suitable answer.

*1) Definition of Mechanisms of a system:

a) The elementary components of a system.

b) The elementary components that can function by themselves according to a certain rule.

c) The structures of the system, together with the rules governing their behaviour.

d) The channels of communication between various components of a system.

2) In this complex world of modern business and government, there is a growing need for skills to solve managerial problems. Do you think of this as:

a) A need for applying mathematics to management to help handle complex situations?

b) A need to develop a science of management that will serve as underlying structure to the profession of management?

c) A need for more managers with better intuitive judgement?

d) A need for more managers with practical experience?

3) The following <u>is</u> true about homomorphic and isomorphic models:

a) They mean the same thing.

b) Homomorphics are models useful to the designer, isomorphics are not.

c) Homomorphics are simplified to represent only the essential varieties, isomorphics match every variety of the real thing.

d) None of the above.

4) A cat walking on the roof senses that he may fall, corrects his balance and keeps on walking erect. Do you think of this as:

a) The cat being of itself a stable creature?

b) The cat hating to fall, so he proceeds carefully?

c) The cat being a self-regulatory mechanism?

d) The off-balance sensation being fed-back, enables the cat to adjust position accordingly?

5) The following is <u>not</u> true about model:

a) It is a fac-simile of the system.

b) It is an instrument to help man easier access to the comprehension of his system.

c) There can be several different models representing the same system.

d) The most common technique to plan models is block-diagram.

6) Definition of behavior of the system:

a) Its degree of stability.

b) The time it takes to reach equilibrium.

c) The value of the variables of interest, once the system has reached final equilibrium.

d) The way the variables of interest vary, when the system receives perturbations, foreseen or unforeseen.

7) You think of the human body as:

a) A set of separate sub-systems with some degree of autonomy (a sore foot does not affect vision).

b) An integrated whole which is made up of various sub-systems but is well coordinated to serve a common purpose (to sustain life and reproduction).

c) A set of sub-systems very closely related (blood troubles affect digestion, vision, breathing, and other body functions).

d) A set of separate sub-systems interacting on one another (without vision, feet cannot walk).

8) The manager makes use of his model to:

a) Calculate or predict the system's present behavior.

b) Predict future behavior under various perturbations.

c) Find ways to keep his system under control in view of future perturbations.

d) All of the above.

9) Which is most important for good management?

a) Discipline and punctuality.

b) Consistency in rules and decisions.

c) Appropriate communication and feedback.

d) Resourcefulness of the manager.

10) In view of this present situation of human global affairs, Stafford Beer proposes that the task of management must be:

a) To predict those changes and find ways to get along with them.

b) To attempt to revise some existing mechanisms in

order to avoid the impending loss of control.

c) To create new policies to enable mankind to survive in spite of the crises, since they are unavoidable.

d) To work at metasystemic level to find ways to contain the forthcoming explosive crises.

*11) State Ashby's Law of Requisite Variety.

12) For management systems, the model form most commonly used is the block-diagram, composed of boxes and lines, where:

a) Boxes represent varieties, lines represent control.

b) Boxes represent control, lines represent activities.

c) Boxes represent activities, lines represent communication and information.

d) Boxes represent information, lines represent activities and control.

13) Do you think of Cybernetics as:

a) Obscure or illusory?

b) A helpful way of seeing things?

c) A collection of mathematical tools?

d) A religion?

14) Do you like to think of a good organization as:

a) A train, in which the force needed to move forward comes from its head, the locomotive?

b) A set of sub-groups related to one another according to a given structure, with orders flowing from the top down the line to the lowest level, and information

feedback flowing in the opposite direction?

c) A set of sub-groups working together under the command and control of the head man in order to achieve a given goal?

d) A set of sub-groups interlocked together by flows of information, personnel, money, equipment, and as a whole, aiming at achieving a specific goal?

*15) Feedback can be positive or negative. The following is true:

a) Negative feedback generates target-seeking action, positive feedback causes the system to learn from its past experience.

b) Both kinds of feedback cause the system to have target-seeking action.

c) Both kinds of feedback cause the system to diverge from its initial condition.

d) In management, positive feedback always causes undesirable effects.

*16) "Metasystem" refers to:

a) A system not clearly definable, thus unmanageable.

b) A system involving elements beyond human understanding, thus unmanageable.

c) An overcomplicated system with too much information, thus difficult to manage.

d) A system over-and-above the system itself, and better informed, thus implying a different kind of language and different of logic.

17) Today's world is at the brink of exploding crises: Overpopulation, pollution, inflation, threat of nuclear war, to mention but a few. The managerial solution to this situation is to:

a) Predict those changes and find ways to get along with them.

b) Revise some existing mechanisms in order to avoid the impending loss of control.

c) Invent the future and work at metasystemic level to find ways to contain the forthcoming explosive crises.

d) Try to adapt to the circumstances as they happen.

18) Definition of a model:

a) A faithful representation of the system itself in every detail.

b) A mathematical, or graphical, or literary description of the system representing all communication channels.

c) A formal account of the system, identifying how it works and representing all variables of interest.

d) A representation of the system, general enough, so the reader does not get lost in detail.

*19) The most important mechanism in Cybernetics is Feedback, which is:

a) Output compared to input.

b) Input compared to a given reference.

c) Output compared to a given reference.

d) The view we take of the output and we bring back to

those elements of the system which govern the nature of the output.

*20) The maintenance of human body temperature involves:

a) Negative feedback?

b) Positive feedback?

21) Are you interested in reading books and articles on cybernetic approaches to management?

a) Highly.

b) Not at all.

c) Undecided.

d) Somewhat.

22) Do you think there is much in common between the methods for the control of machines and those for the control of people in an organization?

a) No.

b) Yes.

All items with * belong to Posttest 1.

APPENDIX D

ITEM BY ITEM ANALYSIS OF THE EVALUATION TEST ON THE EDUCATIONAL TECHNOLOGY STUDENT GROUP, USING t-TEST WITH SIGNIFICANCE LEVEL $p < .05$ AND DEGREE OF FREEDOM $df = 27$

ITEM	TEST	MEAN	σ	t VALUE	GAIN SCORE
1	pre	.46	.50		
	post	.78	.41	3.10	.57
2	pre	.57	.50		
	post	.82	.39	2.55	.58
3	pre	.14	.35		
	post	.50	.50	3.04	.44
4	pre	.42	.50		
	post	.78	.41	3.38	.63
5	pre	.42	.50		
	post	.89	.31	4.83	.81
6	pre	.28	.46		
	post	.64	.48	3.04	.50
7	pre	.35	.48		
	post	.53	.50	1.72	.28
8	pre	.78	.41		
	post	.96	.18	1.98	.83
9	pre	.25	.44		
	post	.64	.48	3.66	.52
10	pre	.35	.48		
	post	.67	.47	3.57	.50

APPENDIX D (CONTINUED)

ITEM BY ITEM ANALYSIS OF THE EVALUATION TEST ON THE EDUCATIONAL TECHNOLOGY STUDENT GROUP, USING t-TEST WITH SIGNIFICANCE LEVEL $p < .05$ AND DEGREE OF FREEDOM $df = 27$

ITEM	TEST	MEAN	σ	t VALUE	GAIN SCORE
11	pre	.32	.47		
	post	.92	.26	6.45	.89
12	pre	.67	.47		
	post	.92	.26	2.26	.78
13	pre	.64	.48		
	post	.92	.26	3.28	.80
14	pre	.64	.48		
	post	.92	.26	3.28	.80
15	pre	.32	.47		
	post	.75	.44	3.95	.63
16	pre	.42	.50		
	post	.60	.49	1.30	.31

APPENDIX D (CONTINUED)

ITEM BY ITEM ANALYSIS OF THE EVALUATION TEST ON THE EDUCATIONAL TECHNOLOGY STUDENT GROUP, USING t-TEST WITH SIGNIFICANCE LEVEL $p < .05$ AND DEGREE OF FREEDOM $df = 27$

ITEM	TEST	MEAN	σ	t VALUE	GAIN SCORE
17	pre	.67	.47		
	post	.78	.41	1.14	.33
18	pre	.60	.49		
	post	.60	.49	.00	.00
19	pre	.85	.35		
	post	.89	.31	.57	.25
20	pre	.32	.47		
	post	.75	.44	3.57	.63
21	pre	.82	.39		
	post	.92	.26	1.80	.60
22	pre	.78	.41		
	post	.92	.26	1.68	.67
23	pre	.67	.47		
	post	.89	.31	2.71	.67
24	pre	.75	.44		
	post	.82	.39	1.44	.29
25	pre	.67	.47		
	post	.82	.39	2.12	.44

APPENDIX E

ITEM BY ITEM ANALYSIS OF THE TEST ON THE MANAGEMENT STUDENT GROUP 1, USING t-TEST WITH SIGNIFICANCE LEVEL $p < .05$ AND DEGREE OF FREEDOM $df = 30$

ITEM	TEST	MEAN	σ	t VALUE	GAIN SCORE
1	pre	.78	.43		
	post 1	1.00	.00	2.96	1.00
2	pre	.68	.47		
	post 2	.84	.37	1.98	.50
3	pre	.55	.51		
	post 2	.97	.18	4.65	.93
4	pre	.65	.49		
	post 1	.74	.45	.83	.28
5	pre	.39	.49		
	post 2	.81	.40	3.76	.69
6	pre	.93	.30		
	post 2	1.00	.00	1.79	1.00
7	pre	.71	.46		
	post 2	.81	.40	1.14	.34
8	pre	.81	.40		
	post 2	1.00	.00	2.68	1.00
9	pre	.78	.42		
	post 2	.90	.30	1.68	.55
10	pre	.10	.30		
	post 2	.87	.34	10.14	.85
11	pre	.00	.00	secure memory	
	post 1	1.00	.00	dump disabled	1.00

APPENDIX E (CONTINUED)

ITEM BY ITEM ANALYSIS OF THE TEST ON THE MANAGEMENT STUDENT GROUP 1, USING t-TEST WITH SIGNIFICANCE LEVEL $p < .05$ AND DEGREE OF FREEDOM $df = 30$

ITEM	TEST	MEAN	σ	t VALUE	GAIN SCORE
12	pre	.77	.42		
	post 2	1.00	.00	2.95	1.00
13	pre	.58	.50		
	post 2	.81	.40	2.52	.55
14	pre	.48	.51		
	post 2	.71	.46	2.53	.44
15	pre	.32	.47		
	post 1	.87	.34	4.89	.81
16	pre	.55	.51		
	post 1	1.00	.00	4.97	1.00
17	pre	.19	.40		
	post 2	.93	.25	9.29	.91
18	pre	.35	.49		
	post 2	.97	.18	6.89	.95
19	pre	.39	.49		
	post 1	.97	.18	6.44	.95
20	pre	.52	.51		
	post 1	.84	.37	3.78	.66
21	pre	.23	.42		
	post 2	.61	.49	3.50	.49
22	pre	.32	.47		
	post 2	.48	.51	1.98	.24

APPENDIX F

ITEM BY ITEM ANALYSIS OF THE TEST ON THE MANAGEMENT STUDENT GROUP 2, USING t-TEST WITH SIGNIFICANCE LEVEL $p < .05$ AND DEGREE OF FREEDOM $df = 26$

ITEM	TEST	MEAN	σ	t VALUE	GAIN SCORE
1	pre	.59	.50		
	post 1	1.00	.00	4.23	1.00
2	pre	.74	.45		
	post 2	.86	.36	1.36	.42
3	pre	.51	.51		
	post 2	1.00	.00	4.91	1.00
4	pre	.81	.40		
	post 1	.90	.32	.81	.47
5	pre	.30	.46		
	post 2	.63	.49	2.79	.47
6	pre	.67	.48		
	post 2	1.00	.00	3.60	1.00
7	pre	.78	.42		
	post 2	.89	.32	1.36	.50
8	pre	.85	0.36		
	post 2	1.00	0.00	2.13	1.00
9	pre	.67	.48		
	post 2	1.00	.00	3.60	1.00
10	pre	.18	.40		
	post 2	.96	.19	7.98	.95
11	pre	.0	00		
	post 1	1.0	secure	memory, dump disabled	1.00

APPENDIX F (CONTINUED)

ITEM BY ITEM ANALYSIS OF THE TEST ON THE MANAGEMENT STUDENT GROUP 2, USING t-TEST WITH SIGNIFICANCE LEVEL $p < .05$ AND DEGREE OF FREEDOM $df = 26$

ITEM	TEST	MEAN	σ	t VALUE	GAIN SCORE
12	pre	.67	.48		
	post 2	1.00	.00	3.60	1.00
13	pre	.52	.51		
	post 2	.78	.42	2.27	.54
14	pre	.70	.46		
	post 2	.74	.45	.37	.13
15	pre	.26	.47		
	post 1	.81	.40	4.51	.74
16	pre	.41	.50		
	post 1	1.00	.00	6.15	1.00
17	pre	.15	.36		
	post 2	1.00	.00	12.23	1.00
18	pre	.15	.36		
	post 2	.81	.40	7.21	.78
19	pre	.26	.45		
	post 1	.93	.27	7.21	.90
20	pre	.48	.51		
	post 1	.78	.42	2.53	.58
21	pre	.44	.51		
	post 2	.74	.48	2.30	.54
22	pre	.26	.48		
	post 2	.44	.51	1.73	.24

APPENDIX G

COMPARISON OF GAIN SCORES ON FORMATIVE EVALUATION TEST (NON-SPLIT VERSION) WITH THOSE ON FINAL EVALUATION TEST (SPLIT VERSION)

ITEM NO.		GAIN SCORE		
		FINAL		
FINAL	FORMATIVE	GROUP 1	GROUP 2	FORMATIVE
1	1	1.00	1.00	.57
2	21	.50	.42	.60
3	11	.93	1.00	.89
4	19	.28	.47	.25
5	10	.69	.47	.50
6	13	1.00	1.00	.80
7	17	.34	.50	.33
8	14	1.00	1.00	.80
9	22	.55	1.00	.67
10	15	.85	.95	.63
11	7	1.00	1.00	.28
12	12	1.00	1.00	.78
13	23	.95	.90	.67
14	18	.44	.13	.00
15	3	.81	.74	.44
16	8	1.00	1.00	.83
17	20	.91	1.00	.63
18	9	.95	.78	.52

APPENDIX G (CONTINUED)

COMPARISON OF GAIN SCORES ON FORMATIVE EVALUATION TEST (NON-SPLIT VERSION) WITH THOSE ON FINAL EVALUATION TEST (SPLIT VERSION)

ITEM NO.		GAIN SCORE		
		FINAL		
FINAL	FORMATIVE	GROUP 1	GROUP 2	FORMATIVE
19	2	.95	.90	.58
20	4	.66	.58	.63
21	25	.49	.54	.44
22	24	.24	.24	.29

Formative Evaluation Test was given to the Educational group.

Final Evaluation Test was given to the two Management groups.

Item 11 (corresponding to 7) and item 20 (corresponding to 4) are reported to complete the table. However, 11 and 7 (as well as 20 & 4) concerned different aspects of the same concept. They are not identical.

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