ABSTRACT
                A joint research project in educational techniques,
which was conducted by the University of Waterloo and the IBM
Corporation, explored the use of color television with random-access
videotape under computer control. At the end of the three-year
project, papers were solicited from all COMIT (Computerized
Multi-Media Instructional Television) participants, and 12 of the 15
professors who had authored courses submitted papers. A
representative sample of seven papers was presented at a one-day
COMIT Symposium, some accompanied by videotaped demonstrations that
illustrated the teaching techniques used. In order to provide as
complete a record of the project as possible, all 12 of the papers
from participants are included in this volume (grouped, where
possible, by subject), as well as comments by the project director
and the coordinator from IBM, and a summary of the pedagogical lessons
learned from COMIT. Courses described include environmental
engineering, survey design, advanced calculus, organic synthesis,
biology, human movement, ice hockey practice, football, leisure
experience, history of art, and English. The appendix contains the
schedule for the COMIT Symposium with the names of the speakers.
(Author/JEG)

PROCEEDINGS OF A SYMPOSIUM ON

COMIT

COMPUTERIZED MULTI-MEDIA INSTRUCTIONAL TELEVISION

THURSDAY, 6 APRIL, 1978

Symposium Editors:

Gordon C. Andrews
Chairman, Computers in Education Committee

Christopher K. Knapper
Teaching Resource Person

UNIVERSITY OF WATERLOO, WATERLOO, ONTARIO N2L-3G1, CANADA

In September 1974, the IBM Corporation approached the University
of Waterloo with a proposal for a joint research project in educational
techniques which would explore, in particular, the use of colour tele-
vision with random - access video-tape under computer control. The pro-
posal was referred by Dr. T.A. Brzustowski, Vice-President (Academic),
to the Computers in Education Committee (CEC) for evaluation and comments.
After some negotiation between UW and IBM, the project began officially
in January 1975 with the name COMIT (for Computerized Multi-media Instruc-
tional Television), with Dr. J.B. Moore, Associate Professor of Management
Science, as COMIT Project Director and with E.O. Elkeer representing IBM.

The Computers in Education Committee maintained an informal contact
with COMIT during its three years of operation and, as the termination
date (15 April 1978) approached, members of the Committee volunteered to
assist in disseminating the knowledge obtained from the project. An
editorial sub-committee was appointed and papers were solicited from all
COMIT participants. Twelve of the fifteen professors who had participated
in COMIT as "course authors" submitted papers and a representative sample
of seven papers was selected for presentation at a one-day COMIT Symposium
held on Thursday, 6 April, 1978. Some of the Symposium presentations were
accompanied by video-taped demonstrations that illustrated, effectively,
the teaching techniques used.

In reviewing the submitted papers for publication in this volume,
the editors felt an obligation to produce as complete a record of the
project as possible, while maintaining an acceptable standard of content
and format. Not all of the papers submitted conformed to the specifica-
tions in the Call for Papers and, in some cases where it was not feasible
to return papers to their authors for revision, the editors arranged for
re-typing and made some minor modifications and condensations. The re-
sulting volume is believed to be a fairly complete record of the COMIT
Project as described by the participants. This volume should not, how-
ever, be mistaken for the formal report of the project which will be pre-
pared by the COMIT Project Director and readers who want more information
should contact the Director.

The papers which follow are arranged in a rather arbitrary order.
The comments of the Director and the IBM Coordinator are first, followed
by the papers from twelve of the course authors (grouped, where possible,
by subject), followed by a concluding paper by Dr. C.K. Knapper, the
University of Waterloo's Teaching Resource Person, summarizing the peda-
gogical lessons learned from COMIT. The appendix contains the schedule
for the COMIT Symposium, showing the Symposium speakers.

Gordon C. Andrews
Christopher K. Knapper

6 July, 1978

TABLE OF CONTENTS

AN OVERVIEW OF THE COMIT PROJECT

by

John B. Moore

Associate Professor of Management Science

COMIT Project Director

University of Waterloo

Abstract: This communication describes the prime objectives
of the COMIT research project, highlights the major
accomplishments, and provides a subjective evaluation of the
benefits and costs of multi-media computer-aided-instruction.

Introduction:

The acronym COMIT, standing for Computerized Multi-media Instructional
Television, was chosen to identify a major research project in computer-
assisted learning (CAL) which was undertaken jointly by the University
of Waterloo and IBM at the University of Waterloo. The project began
in January 1975 and the research was completed in March 1978.

The main goal of the research was to integrate the educational
technologies of television and CAL into a single delivery system. The
objective was to determine whether the combined technologies would result
in a learning vehicle which would have significant advantages over
either educational television or conventional CAL.

The responsibility of IBM was to develop the unique hardware
interfaces and software, that of the University to provide the application
(courseware) to be used in the experiments.

It was decided at the outset to include as many audio-visual
functions in the experimental system as was reasonably possible, subject
to the requirements that the audio-visual hardware components should be
commercially available and that existing CAL authoring languages should
be used. (The languages necessarily were augmented with commands to
control the audio-visual devices.) The following functional components
were selected and synthesized into a working terminal system:

6

- a standard SONY colour television receiver

- a standard 3270 keyboard with upper/lower APL character set and a 5th programmable character set

- a sonic pen with a dismountable pickup which provided a 220 by 330 grid of addressable (detectable) points on the screen surface and capability for off-screen detects

- a facsimile printer for obtaining hard copy output of screen displays

- direct access to video tape segments

- direct access to audio tape segments

- direct access to a video disk which could store 550 35mm slides

- colour graphics under pen, keyboard or program control.

All video output appeared on the television screen and audio output was presented through earphones.

The system consisted of four terminals with the above capabilities connected to a System 7 minicomputer which in turn was channel-connected to the University's System/370 Model 158. The courseware was resident in the 158 and the System 7-158 protocol was similar to that used for a 3270 control unit. The System 7 controlled all the audio-visual library devices and generated and stored the colour graphics.

Two major programming languages were used for authoring: a modified version of IIS and an enhanced form of APL.

The Experiments:

Initially, thirty professors were contacted and given the opportunity to participate voluntarily in the project. From this group fifteen authors became involved and entered the process of topic selection, construction of learning objectives, detailed presentation design, and implementation. The content in most cases covered approximately three to four hours of lecture material. The selection of the pedagogy (drill and practice, tutorial, simulation, information retrieval, etc.) was left to the author. Each author (professor) worked closely with one of the proj analysts and coding was done by twelve students hired on a full time

basis. The subject matter varied immensely. Subject areas included biology, English, poetry, water pollution, calculus, football, statistics, volleyball, organic chemistry, geography, leisure studies, theory of interest, accounting, hockey, biomechanics, and fine arts. Approximately half used a tutorial presentation; the others were mixtures of simulation, drill and practice and information retrieval. The resulting models took students anywhere from one hour to nine hours to complete. Over 570 students participated in the experiments and this usage involved upwards of 2000 hours of terminal time spread over 15 months.

Evaluation:

In four experiments, the class was divided into two groups - a control group was taught the material in the usual lecture fashion - and an experimental group took the same material using the COMIT system. In the other experiments, either the whole class (or team in the case of the volleyball, football and hockey modules) or a selected subset of the class used the research system. Six of the experiments were run more than once.

Results:

The University had three questions to which it was hoped the research would provide the answers:

First - Do students learn better with multi-media CAL? In all four experiments where direct comparisons were made, the students using the system had slightly higher average scores on post-tests than the students in the lecture group. The differences in each case were not statistically significant. No rigorous attempt was made to measure changes in affective behaviour of the COMIT students. However, a questionnaire given to students after completing the computer session showed generally positive attitudes to this form of learning.

Second - Can resources be saved using a multi-media terminal? The pre-project conjecture was that the richness of the terminal environment would allow realistic simulations of laboratory experiments to be conducted, thus providing potential savings in lab equipment. No firm conclusion was reached because no well-controlled experiments were done.

Nonetheless, students participated willingly in the laboratory simulations, and the information retrieval program used with the art history slides had a high utility. In three instances (theory of interest, history of leisure and statistics) significant amounts of professor time were saved once the respective modules were operational. Against the potential savings must be weighed the increased costs required for computer and audio-visual specialists, computer time and author development time.

Third - What is the potential of multi-media CAL for extramural education? It is in this area that perhaps the greatest potential benefits lie. With the advent of microcomputers, low cost terminals, video disks and cheap mass storage, the use of multi-media CAL becomes definitely feasible for home education, correspondence programs, remedial learning and special education. Such uses make it possible to spread the high capital cost of courseware development over many independent users. Without such uses the problem of justifying a multi-media CAL system for in-house use only is much more difficult.

Some Lessons Learned:

In terms of ability to enhance conventional CAL with multi-media attributes, the following list is arranged in order of decreasing priority of function: graphics, colour, slides, tapes (audio and video). This ranking represents a consensus of the views of the project personnel. Experience taught us also that good response time was vital for modules in which all student input was done with the pen. Pen resolution and calibration is extremely important when two or more detectable areas are close together. Also, production of audio-visual materials was and is a very time-consuming process relative to coding. In some instances we chose to omit a potentially valuable tape segment because of the production factors involved.

Conclusions:

The COMIT project must be considered an overall success in that almost without exception, the original objectives of the research were achieved. Aside from the observations made previously, the truth of

9

the following three statements was substantiated by the experiences in the project:

    1. CAL can use multi-media effectively but it is not essential for good CAL.

    2. Good CAL requires a team effort. The author is the most important team member.

    3. Technology is not the limiting factor in CAL development.

The papers which follow provide the individual viewpoints of most of the fifteen participating professors. They are well worth reading.

COMIT: EXPERIENCES AND OBSERVATIONS

by

Eileen O. Elkeer

Advisory Education Representative

IBM COMIT Project Coordinator

IBM Canada Limited

Abstract: This paper was prepared from the activities of a Joint Study undertaken by IBM Canada Limited and the University of Waterloo. The study was given the Acronym COMIT (for Computerized Multi-media Instructional Television) and the objective of the study was to determine the value of an interactive, computer-driven multi-media teaching terminal based upon television technology. A few of the experiences and observations are recorded in this paper.

Introduction:

COMIT was a truly unique and leading-edge system based on TV technology. It was the first known system with a standard colour TV set used as the basis of a terminal with the range of multi-media that was available to the teacher and student. The multi-media included randomly-accessible motion sequences, randomly-accessible audio segments, still images, a pen with tablet for pointing or digitizing, programmable colour and line graphics.

Fifteen modules or course segments were implemented utilizing a cross-section of the media. They represented all six UW faculties and employed a variety of teaching and learning techniques. The students' comments about their experiences and reactions, as well as their learning achievements, indicate that this type of terminal is a workable learning tool. The professors' experiences indicate that this type of system is a valuable teaching resource. COMIT posed no constraints on subject matter, teaching style or learning mode. In fact, tutorial mode was more readily implementable than in traditional CAI.

Over 550 students used the system for over 1900 student hours studying one of the fifteen modules. All classes that ran pre-tests and post-tests found a slight positive advantage in favour of the COMIT students. The increment is not statistically significant, but the trend is encouraging and rewarding for unique research hardware and first time authors of CAI.

The use of multi-media expands the range of topics that can read-
ily be implemented via CAI. Some of the modules would never have
been tried without media. No significant increase in computer resource
was required to accommodate the multi-media.

More people, vis-a-vis conventional CAI, are required to obtain
effective utilization of the audio and video functions. Assistance
from Audio/Visual, Graphic Services and the Language Laboratory were
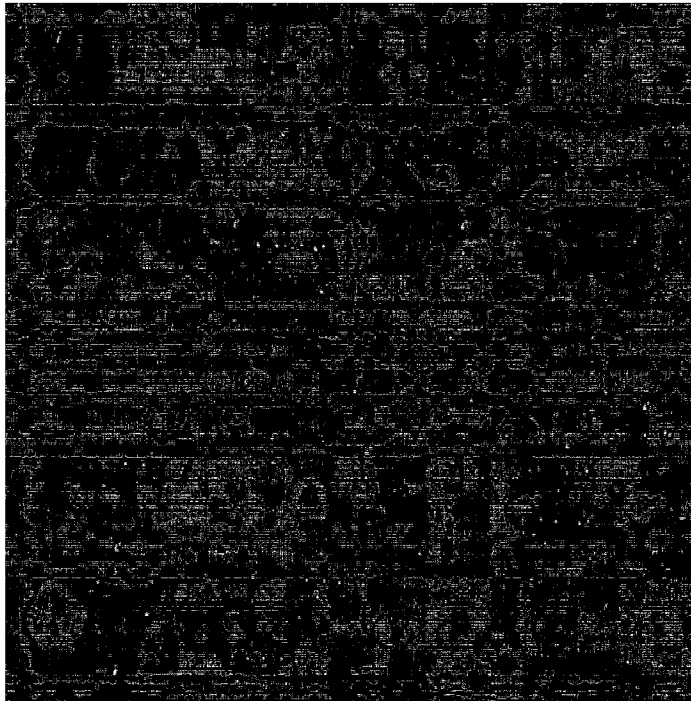required and greatly appreciated.

Authoring Approach

A team approach was used. As professors' time was voluntary, we
attempted to use them as subject matter experts only. Co-op students
were given training in authoring, coding, and making calls. Their
function was to interact with the professors in documenting the object-
ives and the flow of the presentation. From the professor's script or
lesson notes, they prepared a storyboard which showed the detailed con-
tent on the screen and on the audio tape. As well, it included pict-
ures and graphics. Once the level of documentation was satisfactory to
the team members, the student coded it. Only one professor did his own
coding. By using the team approach, we feel we best utilized the time
and talent of the subject matter expert. The co-op students were chall-
enged with new content and utilization of time. Their innovativeness
produced some beneficial by-products such as code and improved techniq-
ues.

The ability to use still images under computer control and the
digitizing aspect of the pen were great time savers for the team. Still
images saved a large amount of verbalizing, and digitizing allowed those
blackboard kinds of sketches and diagrams to be easily included.

Professors' Reactions

Quality of teaching was enhanced by allowing some of the course
material to be removed from the lecture load. Pre-requisite or supple-
mental material was put on the terminal system. Also, the COMIT module
could include more learning alternatives than could be used in a class.
An example is the Economics module. The computer module would greatly
assist in detecting the problems of students in a particular topic, so
that they could spend the tutorial on a discussion of a specific problem

12

9.

COMPUTER AIDED TEACHING IN ENVIRONMENTAL ENGINEERING

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is no significant statistical difference between the apparent learnt
experiences of the writt and the le cure mode participants

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Conclusions

ZONE 2

ZONE 5

TABLE 2: Results from Quota Sampling Experiment

| Student: | Sample Totals | | | | | | Sample Percentages | True Population Percentages |
	JY	PH	FY	MW	JD	All		
Occupation Class of Household Head								
Managerial	3	4	4	1	4	16	21.9	22.7
Professional	3	4	2	1	0	10	13.7	16.3
Clerical	1	1	0	3	2	7	9.6	10.9
Sales	0	2	1	1	2	6	8.2	8.2
Service	0	0	0	0	0	0	0	3.2
Craftsman	5	3	5	6	6	25	23.2	26.8
Labourer	0	0	0	0	0	0	0	4.0
Other	3	1	1	3	1	9	12.4	7.9
	15	15	13	15	15	73	100.0	100.0
Answer to Q1								
Yes	10	9	10	10	10	49	68.0	74.3
No	3	4	1	4	5	17	23.6	20.5
Don't Know	2	2	1	1	0	6	8.4	5.2
	15	15	12	15	15	72	100.0	100.0
Answer to Q2								
Yes, strongly	2	3	2	1	2	10	13.9	17.0
Yes	6	5	3	2	3	19	26.4	34.9
No opinion	2	0	2	5	3	12	16.7	11.2
No	4	6	4	5	6	25	34.7	26.0
No, strongly	1	1	1	2	1	6	8.3	10.9
	15	15	12	15	15	72	100.0	100.0
Location								
Zone 1	5	1	1	-	1	8	13.8	18.9
Zone 2	3	3	3	-	4	13	22.4	19.2
Zone 3	7	6	2	-	7	22	37.9	31.6
Zone 4	0	5	7	-	3	15	25.9	30.3
	15	15	13		15	58	100.0	100.0
Building Type								
Townhouse	0	0	0		0	0	0.0	8.2
Apartment	1	0	0	-	1	2	3.4	16.5
Other	14	15	13		14	56	96.6	75.3
	15	15	13		15	58	100.0	100.0

they ought to do something about all them dirty soap operas" (no, strongly).
They found the exercise itself reasonably enjoyable and not difficult
(according to one student, not difficult enough). They seemed to be quite
interested in the results of the combined sample.

The Probability Sampling Exercise:

The exercise called STRATA SAMPLING is more technical in nature. Here
the student is not to "interview" occupants of the households, but is
required to "design" a probability sample for gathering household character-
istics and to "test" the design.

The first thing that the student is asked to do is to "stratify" the
blocks of the town into non-overlapping "strata". He or she may designate
the town as one large stratum, or may stratify the town into the four zones,
or may assign blocks to strata in any other way. The sample of households
will then be the union of subsamples, one from each stratum. The student is
asked to specify the number of households to be selected in each of the
subsamples. He or she must then specify the sampling design to be used
for the subsamples, and has four options (see [1] for definitions of the
terminology):

A: simple random sampling of households

B: systematic sampling of households

C: two stage sampling, in which a simple random sample of blocks is
selected first, and the households to be sampled are selected from these
blocks

D: further stratification by building type, followed by simple random
sampling within strata.

If C or D is chosen, there are more detailed sample size specifications to
be made.

Once the design is completely specified, the program implements the
design once, and displays estimates of quantities like the proportion of
households with head having a specified occupation, or the average number of
children aged 0-4 per household; together with these are shown estimated
standard errors of estimation. It also prints out the true population value

for each quantity and the theoretical standard error of estimation under the design.

In the associated laboratory assignment in the Winter of 1978 the students were asked to try out the various options, with design parameters given to them, for a sample of total size 75. They were then asked to examine the results to see if they were in accordance with theory. For example, theoretically a dispersed sample (systematic or stratified by zone and allocated to the zones proportionally) should be relatively efficient, and tend to have lower theoretical standard errors than a clustered sample (two stage with several households chosen from each sampled block). The students were asked to compare the performance of these samples with that of the quota sample in estimating the distribution of occupation of household head. Finally, they were asked to design a sample which would be more "efficient" than any of the prescribed ones for estimating the average number of preschool children per household.

An unexpected feature of this exercise was the finding that as in real life, there were results for some of the prescribed designs which did not apparently agree with theory! Apart from some confusion, the effects of this were largely beneficial, since the author was forced to spend a good deal of time and effort trying to convince the students that the theory could be relied upon in general.

Conclusions:

Because of the small size of the class on which the module was tested, and because of difficulties encountered with the operation and scheduling of the second exercise, conclusions about the effectiveness of the module as a teaching tool must be tentative. Continued use of the module in future terms is planned, however, and more definite conclusions should be available at a later date.

Happily it appeared by the end of the second exercise that the notions (i), (iii) and (iv) mentioned in the Introduction had been conveyed to most of the students (more could have been done with (ii), in a classroom Monte Carlo study, if more time had been available). In addition, the impression gained was that this sort of simulation of survey situations could

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A COMIT MODULE ON A TOPIC

FROM ADVANCED CALCULUS

by

Bev Marshman

Department of Applied Mathematics

Abstract: This is a report on an experiment conducted with
three successive second year calculus classes, in which part
of each class was taught the concept of uniform convergence
of a sequence of functions by an interactive COMIT module,
while the remainder were given lectures in the traditional
manner. An outline of the teaching techniques used in the
module is followed by a comparison of the performances of
the two groups on a pre-test, post-test, mid-term, and final
exam. Finally, an attempt is made to evaluate the significance
of any differences in the above results, and to assess the
assets and liabilities of computer-aided teaching in general.

Introduction:

This project was very much a joint effort of myself and L. J. Makela,

then a graduate student in the Department of Computer Science.

Basically, I developed the course content, while he took charge of the

programming, although there was much interaction at all stages. Since

details of the software are included in his master's thesis [1], I

would refer anyone interested in the computing aspects of the module's

development to that source. In this report , I'll generally stick to

a discussion of the teaching techniques we utilized.

Our principal aims were threefold. First, we wanted to see if the

graphics capabilities and interactive nature of the COMIT facilities

could be used effectively to convey the concept of uniform convergence

of a sequence of functions to second year calculus students (irrespective

of the effort and cost involved). Secondly, we wanted to compare the

performance, both short-term and long-term, of the students who learned

the topic through the COMIT module (approximately one-third of each group)

with that of the remainder, to see if there were any detectable

differences. Finally, we wished to assess, as far as possible, the

advantages and disadvantages of this medium in general.

The Module:

The subject material of the module, uniform convergence of a
sequence of functions, was chosen for a variety of reasons: it is
most easily interpreted geometrically, and would thus utilize the graphics
capabilities of COMIT; it is a concept which frequently gives students
difficulty, and would, we hoped, truly test the system as a teaching
device; finally, it is about the right length. The first stage was
development of a set of behavioural objectives, which break the topic
down into distinct steps, each building on the previous ones until the
'terminal objectives' are reached. These steps were then further
dissected, examples selected, and a flow chart designed for each. Several
months of programming followed, and the module was ready for use early
in 1977. (For more details on all aspects of the structure of the
module, see [1].)

The main teaching technique used was a combination of allowing
the students to display for themselves the graphical behaviour of the
functions involved while at the same time continuously soliciting
answers to pertinent questions. In the following, one of the
principal ideas contained in the module is presented (although not
verbatim), along with explanations of what the student might have done
and seen in that portion of the module; hopefully, this will clarify
how the above-mentioned technique was utilized. (Anyone not interested
in the actual content of the module can ignore the balance of this
section, as it is not essential to the remainder of the report.)

A sequence of functions, denoted $f_n(x)$, is just a set of
functions of a variable x ; one for each value $n = 1,2,3,\ldots\ldots$.
For example, consider the sequence $f_n(x) = x^n$, several terms of which
are shown in Figure 1. Note that each term of the sequence is a
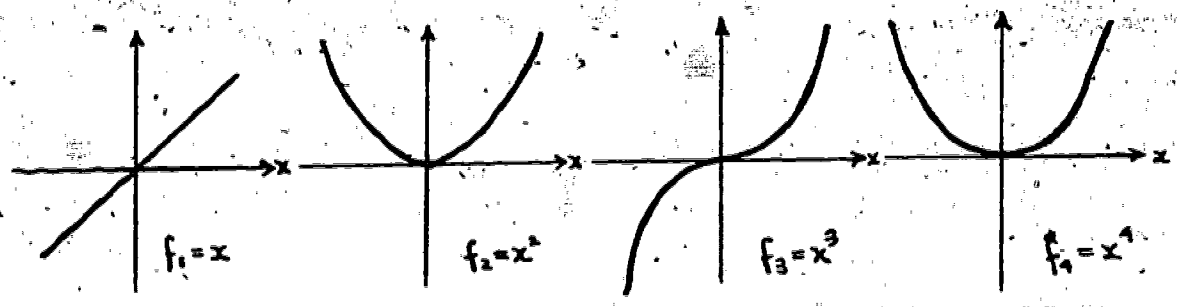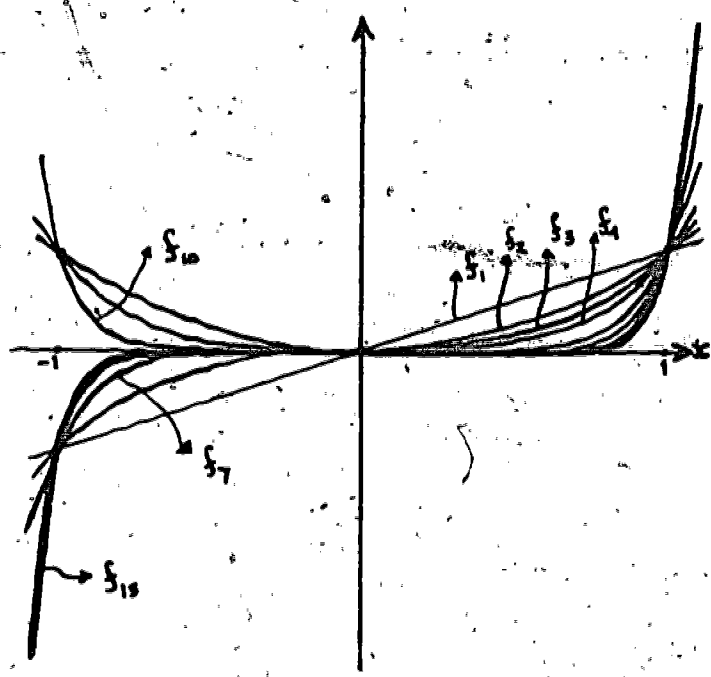single function of x .

32

Figure 1

Figure 2

In the COMIT module, the student could choose to see any terms desired, but each was superimposed on the previous graphs, with the latest displayed in bright white and the former choices dimmed to a pale green. Thus a student who had asked, in turn, for terms $n = 1,2,3,4,7,10$ and 13 on the interval $[-1.1,1.1]$ would, in the end, see Figure 2 displayed on the screen, with the graph of $f_{13}(x)$ displayed most brightly. (Note: To facilitate the fit, the vertical scale in this figure has been compressed.)

This example was then re-used to illustrate the notion of point-wise convergence: the sequence $f_n(x)$ converges pointwise at $x = x_0$ if the sequence of real numbers $f_1(x_0), f_2(x_0), f_3(x_0), \ldots\ldots$ approaches a certain value as n gets larger. For example, if $f_n(x) = x^n$, and $x_0 = \frac{1}{2}$, we get the sequence $\frac{1}{2}, (\frac{1}{2})^2, (\frac{1}{2})^3 \ldots$ or

$\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \ldots \frac{1}{2^n}$, which obviously approaches zero as n gets

large. (When this happens, we say the sequence has a limit and write,

for example, $\lim\limits_{n\to\infty} \dfrac{1}{2^n} = 0$.) On the other hand, if we choose $x_o = -1$,

we get $(-1),(-1)^2, (-1)^3, \ldots,$ or $-1,1,-1,1,-1, \ldots$ which does not

approach any particular value as n gets larger. A moment's thought

will convince you that the sequence x^n will only have a limit for

values of x such that $-1 < x \leq 1$; i.e. either x is a fraction,

so that x^n approaches 0 as n gets large, or $x = 1$, which gives

the sequence $1,1,1,\ldots\ldots$. We say, then, that the sequence $f_n(x) = x^n$

has limit function

$$f(x) = \begin{cases} 0 & \text{if } |x| < 1, \\ 1 & \text{if } x = 1. \end{cases}$$
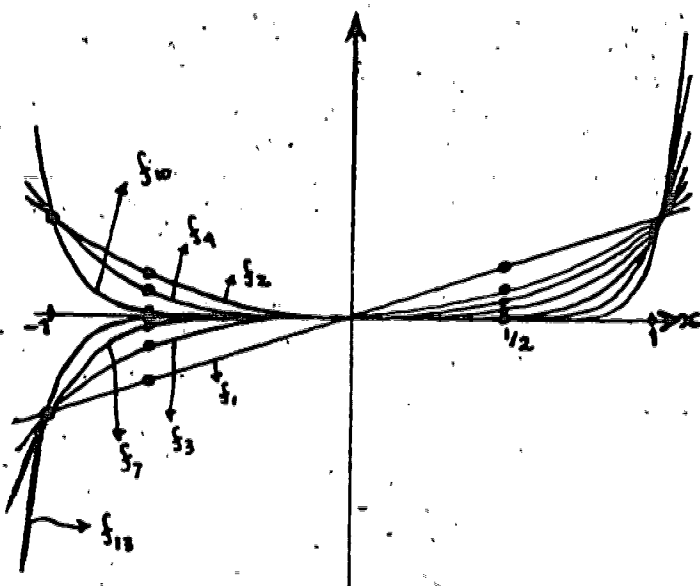
Figure 3

We again utilized graphics to illustrate this in the COMIT module; the convergent sequences for $x = \dfrac{1}{2}$, and $x = -\dfrac{2}{3}$, for example, are displayed as the vertical rows of dots in Figure 3. It is clear that they approach zero, while $x = -1$, say, oscillates between 1 and -1. (Here, 'approach zero' means the dots get arbitrarily close to the x-axis as $n \to \infty$.)

Once the concept of pointwise convergence had been presented, the student was allowed to 'play' with several other examples of sequences, using the graphics capabilities of the system to assist in finding for which values of x each sequence converged, and to what limit function $f(x)$. The student's grasp of the material was constantly monitored by a variety of types of questions (including some multiple choice), with immediate feedback giving the proper reasoning when errors

were made.

It should be pointed out that the above is a simplification of the
actual material presented (mathematical rigour not being the object here);
the aim was simply to demonstrate that the ideas could be handled
graphically, and to give a hint of how this was done. (Complete flow
charts of actual material are contained in [1].)

Structure of the Experiment:

From each of three different classes of students in Math 230B
(Advanced Calculus), we selected ten students to use the module by first
ranking them according to their Math 230A grades, then selecting every
third student; the remainder of each group attended the usual two
lectures on this topic, all being given basically the same two lectures
by the author. All the students were given, unannounced, a pre-test
just prior to the experiment (to measure their background in the
relevant area), and a post-test, immediately following, to measure their
grasp of the topic at that point. In addition, grades on the relevant
questions on mid-term (except for group 2, where no mid-term was given)
and final examination were recorded for each student, to serve as a
measure of long-term retention of the material, although it should be
noted that they are probably not very reliable indicators of any effect
of the module or lectures encountered initially, since by that time
many other factors will have come into play.

The students who used the module were given a set of notes which
roughly paralleled the material in the module, except the interactive
portions. These same notes were used as a basis for the lectures given
to the remainder of each group, in hopes that all students would be
exposed to more or less the same material.

Statistical Analysis:

I wish to thank G. W. Bennett of the Department of Statistics for the
summary which comprises the balance of this section; further detail

analysis may be obtained from him. Data used are the scores on the above-mentioned tests and exams, converted to percentages. Throughout the following, PRE and POST refer to pre-test and post-test grades, respectively, COMIT and NON-COMIT refer to the portions of each group using the module and attending lectures, respectively, and T1, T2, T3, and T4 refer to pre-test, post-test, mid-term, and final examination grades, respectively.

Table 1 illustrates the performances of COMIT and NON-COMIT on the pre-test and post-test for each of the three groups. The figures in brackets indicate the number expected in that cell under the hypothesis that there is no relationship between COMIT and POST > PRE. In all three groups, the figures are consistent with this hypothesis; that is, any differences are well within the allowable error.

An analysis of variance on $-\ln(\text{grade})$ was done as a nested factorial with main factors COMIT, NON-COMIT, T1, T2, T3, T4, and students as a factor nested within the COMIT factor. This analysis shows a significant time effect for Groups 1 and 3, but with no significant differences between COMIT and NON-COMIT insofar as their patterns go. In Group 2, there were no significant effects, although the error terms were large enough to make differences difficult to detect.

Table 2 gives the means of grades on the various tests for each group.

In summary: (i) there is no evidence that COMIT versus NON-COMIT is related to the fraction of students with POST > PRE; (ii) there is some evidence that over time, the students learn, in that T3 is greater than T1 and T2, although again, there is no evidence that COMIT students behave any differently from NON-COMIT students in this respect.

It is important to note that the various marks measure performance under different conditions in that T1 and T2 are local to the

TYPE OF STUDENT	GROUP 1			GROUP 2			GROUP 3		
	NO. WITH POST > PRE	NO. WITH POST ≤ PRE	TOTAL (30)	NO. WITH POST > PRE	NO. WITH POST ≤ PRE	TOTAL (32)	NO. WITH POST > PRE	NO. WITH POST ≤ PRE	TOTAL (27)
COMIT	7 (6.7)	3 (3.3)	10	6 (5)	4 (5)	10	7 (6.7)	3 (3.3)	10
NON-COMIT	7 (10.3)	13 (9.7)	20	10 (11)	12 (11)	22	11 (11.3)	6 (5.7)	17
TOTALS	14	16	20	16	16	32	18	9	27

Table 1: Comparison of COMIT and NON-COMIT Students Results on Pre-test and Post-test. Three separate groups of students were involved.

	GROUP 1				GROUP 2			GROUP 3			
	T1	T2	T3	T4	T1	T2	T4	T1	T2	T3	T4
COMIT	.729	.821	.821	.780	.494	.594	.630	.538	.713	.787	.480
NON-COMIT	.607	.655	.869	.663	.632	.639	.564	.479	.686	.719	.414
COMMENT	This difference is mostly T3 improvement over T1 and T2.				No significant time pattern.			The bulk is due to the steady rise T1 → T2 → T3 and the sudden fall T3 → T4, although a significant T2-T1 component does not exist.			

Table 2: Comparison of Mean Grades for COMIT and NON-COMIT Students on Pre-test (T1), Post-test (T2), Mid-term Test (T3) and Final Exam (T4).

material, whereas T3 is only as a component of about half the course, while T4 is as a component of the whole course. Study preferences may influence T3 and T4.

Conclusions:

Our primary aim, that of testing the capabilities of COMIT as a teaching device for mathematical material, was fully achieved, and with great success. Aside from some complaints about the response time of the computer, over which we had no control, student reaction to the module was very favourable. The following is a selection of more or less typical quotes from the written comments handed in on completion of the module:

"I feel that seeing the graphs and being able to experiment with various n's and x's greatly helped me understand the concept of uniform convergence...... Another advantage of this teaching method is that it requires active participation of the student, where in a class, full attention is not always given."

"... I was forced to respond to questions all the time and thus take part in what was going on...."

"The graphical aspect certainly added to the comprehension..."

"Being able to go at your own pace and having things repeated when you didn't catch a concept was helpful. The use of examples with immediate feedback and explanations of how to do the questions was good also."

"The advantage was that I had to be on the alert all the time and thus I learned more about the topic. In class I normally feel sleepy sometimes ..... The idea of asking questions after each section was a good one. It tested the student's ability to retain the work."

Some of the students thought even more examples should have been included; some would have preferred two one-hour sessions rather than one two-hour, as their attention flagged towards the end. It should also be pointed out that the novelty of the situation probably contributed somewhat to their enthusiasm. I feel quite strongly, however, that the immediacy of the feedback is a really valuable asset of computer-aided instruction; we don't ever learn much by listening to someone _talk_ about something; we learn by trying things out, making errors, correcting for them, and trying again. It is in this aspect that an interactive system excels.

Regarding our second aim, that of comparing the performances of COMIT versus NON-COMIT students, the statistical results speak for themselves: any differences are well within allowable error. The post-test grades, which are certainly the measures most closely related to the material presented in the module, were obtained on a ten-minute quiz, and it could be questioned whether such a quiz could test anything in depth. Nevertheless, it was designed to test whether their knowledge was at a level acceptable for that topic in that particular course, and as such represents as extensive a performance test as would ever be required. Keeping this in mind, we conclude that using COMIT did not produce perceptibly better performance (at least as we measure it) from the COMIT students over the NON-COMIT students. Whether that means they did or did not understand the concepts any better is quite another question!

Our third and final aim was to assess some of the advantages and disadvantages of the medium in general. The obvious ones have already been mentioned: the student sets the pace at which the material is covered; the constant stimulus provided by the interaction with the terminal keeps interest up, and accelerates assimilation of the concepts; the explanations given after each error provide a degree of 'personal' attention impossible in a lecture where there are more than half a dozen students. It is true that students using an interactive system like COMIT is not getting the benefit

CLASSROOM CIRCA 19 8

CLASSROOM CIRCA 19 8

... subjected to ... Analysis ... there were 2 ...
1. stylbene ... phenyl ... pentanone ... and ... Jones [1] ... given ...
the first ... (T_2,) ... predicted the most likely ...
... that (T_1) ...

knowledge ...

pe Synthe

...

The testing ground

I hope these few examples have convinced you of the great importance of visual aids to the teaching of mycology. COMIT promised to make this material available in an automated, interactive system.

After some initial planning sessions, during which the aims of my segment were enunciated, we began to build the framework. I found that many diagrams I usually draw on the blackboard had to be produced as colour transparencies for COMIT. This was a plus, because I was subsequently able to use some of these diagrams in a correspondence version of Biology 232. But I soon became horrified by the massive investment of time which the production of this segment was obviously going to entail. I did not keep a record of the hours I spent on it, but I know their number was excessive. The parallel investment of time on the part of the COMIT programmer was, I know, larger by an order of magnitude than my own. After a protracted period of development during which innumerable changes and corrections had to be made, the system became operational, at least in theory. Another problem surfaced at this point. The computer had to be programmed to cope with all possible incorrect answers, as well as with essentially correct answers which had been misspelled. This called for additional hours of programming and consultations. After a further extended period of fine-tuning, it became possible to sit at the console and run through the module.

I had originally requested that a sound-track be incorporated in the module. I didn't press the matter too hard, and in the event, the sound track did not materialize.

I regretted this omission, because I believe that the information I try to present is better accepted when received by more than one of the senses. The mycology module in its final form was entirely visual. The students have to stare at a T/V screen, at very close range, for an hour or more. This probably bothered them far less than it did me, since they have been exposed to T/V from birth.

Because of certain unavoidable delays in putting the final touches to the COMIT module, the topic had already been covered in the regular lecture format when the time came for 20 volunteers from among the one hundred second year students to do the modules. I announced that there would be a class test on the topic the following week. This gave non-COMIT students a chance to revise the topic from their regular text and other material

The test showed that although scores of the students taking the COMIT module were, on average, slightly higher than those of the rest of the class, the difference was not significant.

I asked for written comments from the COMIT students. Since the COMIT module was a new toy, I was not quite sure how these comments would reflect on my regular presentations. I need not have worried. Their general tenor was reassuring. Many students claimed to have enjoyed the module, and to have found it a good method of revising material, but most of them also insisted that it could not replace the normal lectures.

But perhaps I should let the students speak for themselves. Here are some representative comments:

"... an excellent attempt at using sophisticated technology as a teaching aid ..." "... it was very well organized ..." "I look forward to using teaching aids of this sort (and this quality) in the future ..." "... you were able to go at your own speed ..." "... served as an excellent review ..." "... I intend to use the computer as a way to review for the exam ..." "... it was very effective in reinforcing the basic characteristics of the Ascomycetes due to the immediacy of interacting with the computer, and the thoughtful manner in which the segment was organized and illustrated..." "As a supplement to lectures it was worthwhile. It helped to clarify and condense the lecture material.... It was a good idea to involve the students in answering questions: since I was receiving immediate feedback, I felt like I was getting personal attention .. but if there was something I didn't understand, I couldn't ask the computer to explain. The slides were good, although not as clear as when projected..." "... You were unable to return to a previous part of the module if you found you had not grasped the concept fully..." "Even with the questions the computer is much like reading a text-book..." "... Perhaps if a sound track had been provided, it would have helped..." "... the lack of an audio stimulus made it perhaps a little boring..." "...Though the computer method was interesting enough, I felt I preferred the lectures and slides..." "... The programme was very impersonal ... the colours on the screen were often very bright, and after reading it for two hours your eyes became very tired ... lectures are preferable..." "... A good professor brings a lot more to a course than this pro

gramme did. He brings interesting anecdotes, vitality, living proof that
somebody really studies all this stuff, as well as a lot of humanism that
the computer didn't have...."

My own feelings after the experiment can be expressed as follows:

(1) I now realize very clearly that it would be enormously expensive in
    hardware, software and labour, for computer instruction to replace
    even one professor for one course.

(2) Perhaps even more importantly, there is still no substitute for the
    human element in teaching. A good professor can communicate enthusi-
    asm in a way that any computer would find difficult to emulate. In
    addition, the professor can immediately handle all kinds of red herrings,
    offbeat but interesting questions and backtrackings, and he can respond
    to the mood of a class or individual in a more flexible way than is
    possible even for the most elaborately programmed machine. (This is not
    to say that he always does!)

My general conclusion is that computer assisted instruction can be a
useful additional resource, but that it is not yet time for the professor
to quit the classroom forever. Only internal motivation can make a student
learn and retain information and ideas. I believe he is still most likely
to contract that motivation from another human being.

THE POTENTIAL USE OF COMIT IN THE

STUDY OF HUMAN MOVEMENT

by

David A. Winter

Professor

Department of Kinesiology

Abstract: Two undergraduate student projects were undertaken on COMIT aimed at presenting many variables associated with human gait. The goals were to display the outline of the leg along with other diagnostic variables such as muscle activity (EMG), kinematic, kinetic and energy calculations. The projects were partially successful in demonstrating possible potential of the COMIT system as a teaching and diagnostic tool.

Introduction:

A complete analytical description of one stride of gait requires twenty or more time domain plots. These would include time histories of kinematics (trajectories of mass centres, angular velocities of limb segments, accelerations of joints, etc.), kinetics (reaction forces at the ground and between the joints, muscle moments, gravitational forces, etc.), energetics (potential and kinetic energies of segments, energy generation and absorption by muscles, etc.) and muscle activity (as indicated by its electromyogram). It is an extremely difficult problem to assess the interaction of a fraction of these variables in normal gait, and even more complex to integrate them to assess pathological locomotion. It therefore appeared that COMIT had the potential of presenting an integrated picture of many of these variables and of seeing their influence in time.

Student Projects

Two senior undergraduate research projects were directed to the development of user programs for the assessment of human gait. Data routinely obtained from the Gait Analysis Laboratory in the Department of Kinesiology were used. The aim of the two projects was the same: to present to the user a flexible display with which he could interact and see the "cause and effect" of the forces and muscle activity acting in gait.

The difference in the projects was in the mode of data entry. The first was given the coordinates of each limb segment from which a "stick" diagram of the leg could be generated to represent the body position every 33 ms. An algorithm was then used to generate the contour of the leg at each position. The second approach was to generate the leg and muscle outlines via a light pen tracing of the cine frame image as seen on the COMIT terminal. Once the leg outline was generated, by either technique, the outline of the major muscle groups was generated and their activity was presented two different ways: a 32 intensity level colour code was used to grade activity from 0 to 100%, or the % activity could be written alongside each muscle. The user could then call up the leg outline for any point in the gait cycle, insert the muscle activity and then examine the position of the limb at successive points in time to see the effect of the muscle activity. A second aim was to display quantitative measures such as reaction force vectors, energy levels, etc.

Success of Projects

The first goal, as described, was achieved successfully, but with some limitations to the user. The turn around time between instructions and display was sometimes delayed so it was difficult to assess rapidly changing events. The second aim was not attempted because of the time and effort required to achieve the first goal.

A logistic problem that severely limited the potential of COMIT was the use of cine film as a data base. There was no ready way to convert the cine data to TV so that it could be displayed on the COMIT terminals.

Conclusions

The project was successful to the extent that it demonstrated a potentially valuable area for the COMIT system. A considerable amount of additional programming was necessary to realize a properly interactive system that was useful for teaching and clinical diagnosis

COMIT ICE HOCKEY PRACTICE

by

Robert C. McKillop

Varsity Hockey Coach

Department of Athletics

Abstract: Computer Ice Hockey practice was developed at the University of Waterloo in order to present the coach's systems to the players in a much more controlled academic setting than is available during practice on the ice. The objectives of the computer practice were: to allow players time to think about the systems and discuss alternatives with the coach; to give the coach a documented evaluation of how well the players knew the material; and to enable new material to be thoroughly taught and understood before going on the ice.

The results of this project were very encouraging to the University of Waterloo Hockey team players and coach. The idea is definitely a valuable one which could be adopted in many other sports as well.

In recent years, coaching the game of ice hockey has taken a very noticeable change towards a much more structured game. This attitude has been given a great deal of credibility with the emergence of such people as Fred Shero, Bob Pulford and Roger Neilson in the ranks of NHL coaches. These men all believe very strongly in a disciplined "system" approach to hockey where all players have basic responsibilities in almost all situations that may arise.

When a coach attempts to implement these systems, he finds that he requires much more ice time than was used in the traditional approach. The availability of ice time is at a premium in almost all locations. This has forced coaches into many alternative methods of presenting their material to their teams and led to the development of the hockey coaching module using COMIT at the University of Waterloo.

This COMIT module was capable of reproducing the various ice hockey systems in a manner that allowed players of the University of Waterloo Varsity Hockey Team to view them and to respond to a series of questions based on specific assignments designated by the coach. The program was designed to allow each player maximum time to study the systems in question and also to provide the coach with a detailed print out of the player's responses to the questions he answered.

There are many advantages of having a program of this nature available to a hockey team. Valuable ice time was not wasted in a time-consuming teaching process of the system. Players were taught using a blackboard and then tested on the computer. The players had an unlimited time period in which to study and respond to questions. This allowed each player to study the problem thoroughly at his own speed before having to respond. The positions of all of the players of both teams were readily visible on the screen and he could see a complete system in one look, something he can not see or perhaps even comprehend while on the ice. The system allowed the player to make one incorrect response to each question before showing him the correct response. This feature meant that the player had to think out his replies based on the knowledge of the previous wrong answer.

The author was responsible for putting all the hockey technical data on the computer. Dr. Moore and his computer associates spent countless hours developing the computer program required, so that all the various systems could be included. The player sat down at the terminal and introduced himself by typing his name on a conventional typewriter keyboard. The player was then asked what position he wanted to study. Upon replying, the player was then asked what area he wanted to study. He had the following choices:

a) forechecking

b) backchecking

c) breakout patterns

d) power plays

e) penalty killing

f) miscellaneous - face-off
  - special plays

g) all of the above

When the player indicated what area or areas he wanted to study, he was then presented with a plan view of the rink on the screen as shown in the Figures. The set-up on the screen showed the player the formation with the offense in one colour and the defense in another. The position he was studying then began to blink (on and off) on the screen so the player knew exactly where he was on the ice surface. The question would then appear on the screen at the side of the rink outline. The player then had to point with a light pen to the place on the screen which he thought was the

move. If he was correct, an exit statement appeared along with all of the other players' correct movements so that the player could see his movements in relation to his team-mates' moves. If he was incorrect, he would be told so and asked to try again. If he then succeeded, the above (correct) display would follow. If he was again incorrect, the player would be told so and then the correct movements would appear. The player could study the screen for as long as he wanted; when he was ready to proceed, he simply pressed "enter" and the next step would confront him. This procedure was followed for all questions in all systems. When the player was finished, a record then appeared on the screen. This showed his responses to each question, whether right, wrong or skipped, and then a percentage right and wrong for all questions.

This record was also available to the coach in the form of a print-out. The print-out told the coach who had taken part in the program, and how well he had done in each area. This turned out to be a very valuable asset to the coach. After the player had completed the test on his own position, he was then encouraged to try the tests for all the other team positions as well.

The players could attend the program at any free period during the day and could make very constructive use of free time.

The results of this project were very encouraging. All the basic objectives were met and then some. It was found that the players could easily operate the program and did not feel out of place with it. The program initiated a great deal of discussion between the players and the coach. Usually this was precipitated by incorrect responses to various questions. This type of dialogue is often very difficult to initiate in a normal practice or game setting and turned out to be a major positive aspect of the entire program. The fact that players had to come up with specific answers to each question thoroughly tested their knowledge of the various systems and supplied the coach with these results. The result-ing discussion made the players much more aware of all the systems and thus made the hockey club a better team.

When the players were introduced to this system, the team's league record was 0 wins and 7 losses after competing against teams that were not the class of the league. In the next 13 games, the team won 7 games and tied 2 against much superior competition. These results, in the opinion of

the <u>coach and the players</u>, was due in a large part to the team being exposed to this computer hockey practice.

The only major negative comment that can be associated with this project was the tremendous amount of time required to get the system operational. This would be drastically reduced in any future project due to the groundwork laid in this endeavour.

The author wishes to express his sincere appreciation to Dr. J.B. Moore and his associates for their untiring work in developing the system so that the University of Waterloo Warrior Hockey team could take part in this project.

59.
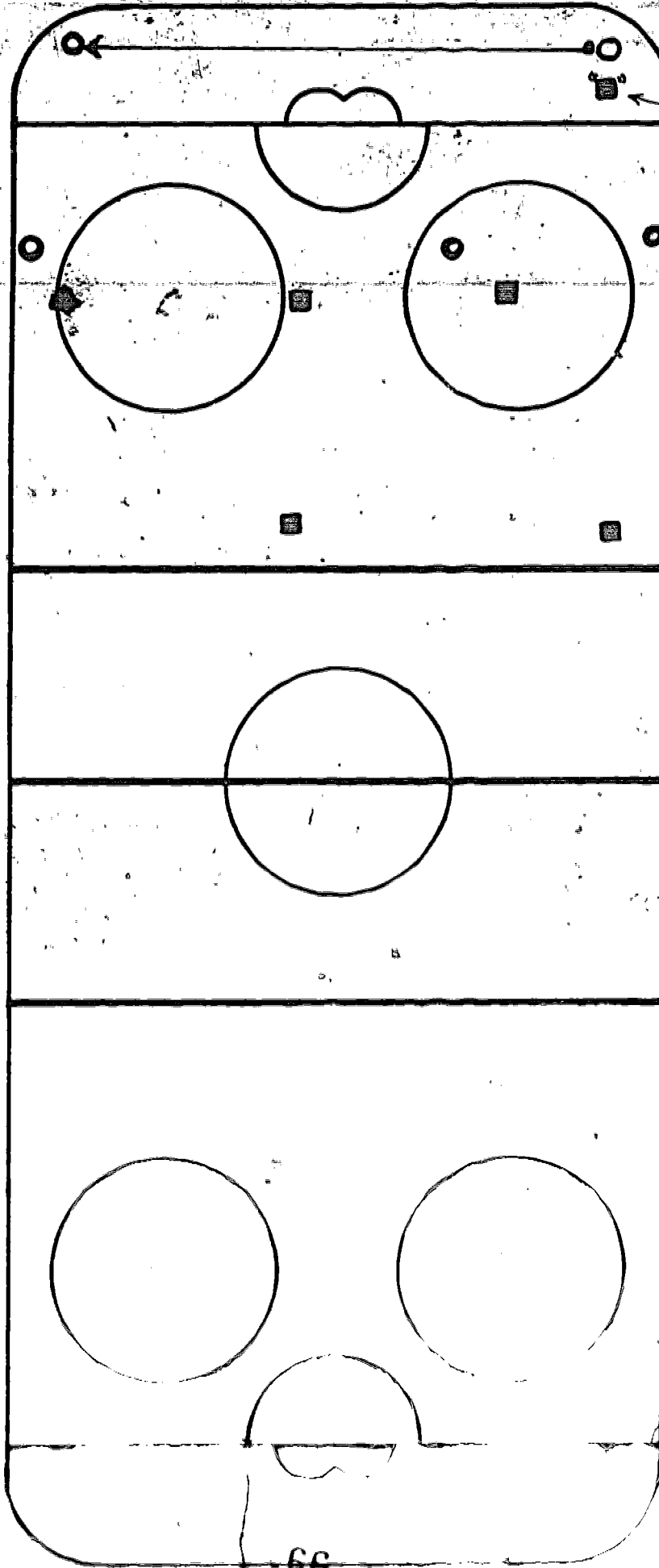
(RW Position
Blinking)

Question
QFC1

Playing RW

Where should you go?

Explanation:
Seeing the question with
the RW position blinking
on and off, the Player
would now take the light
pen and indicate where he
thinks he should go, now
that the puck has gone be-
hind the net to the other
defenceman.

If the player responded
incorrectly the following
would appear.

66

60.
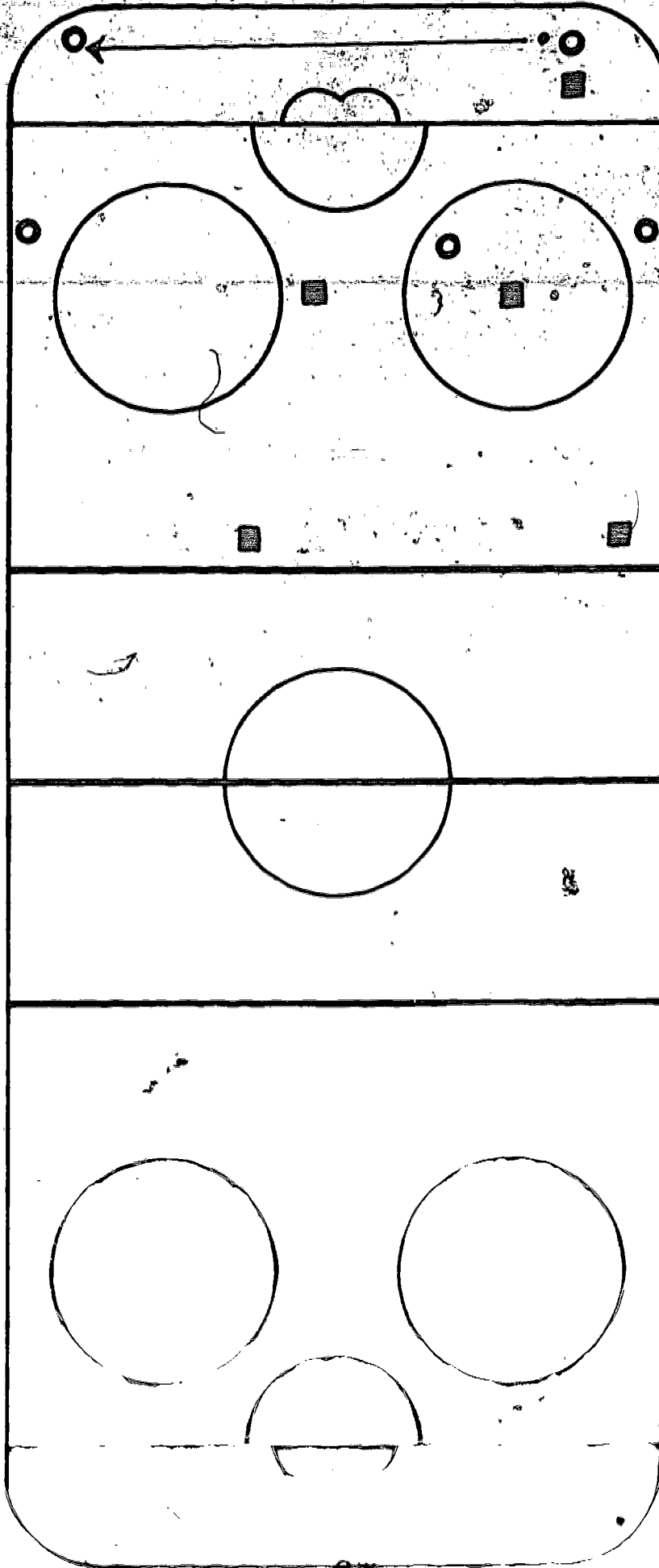
Question
QFC1

NO. Must always force
from the front.

Try again.

Explanation:
The player would now
repeat the original
process.

61.
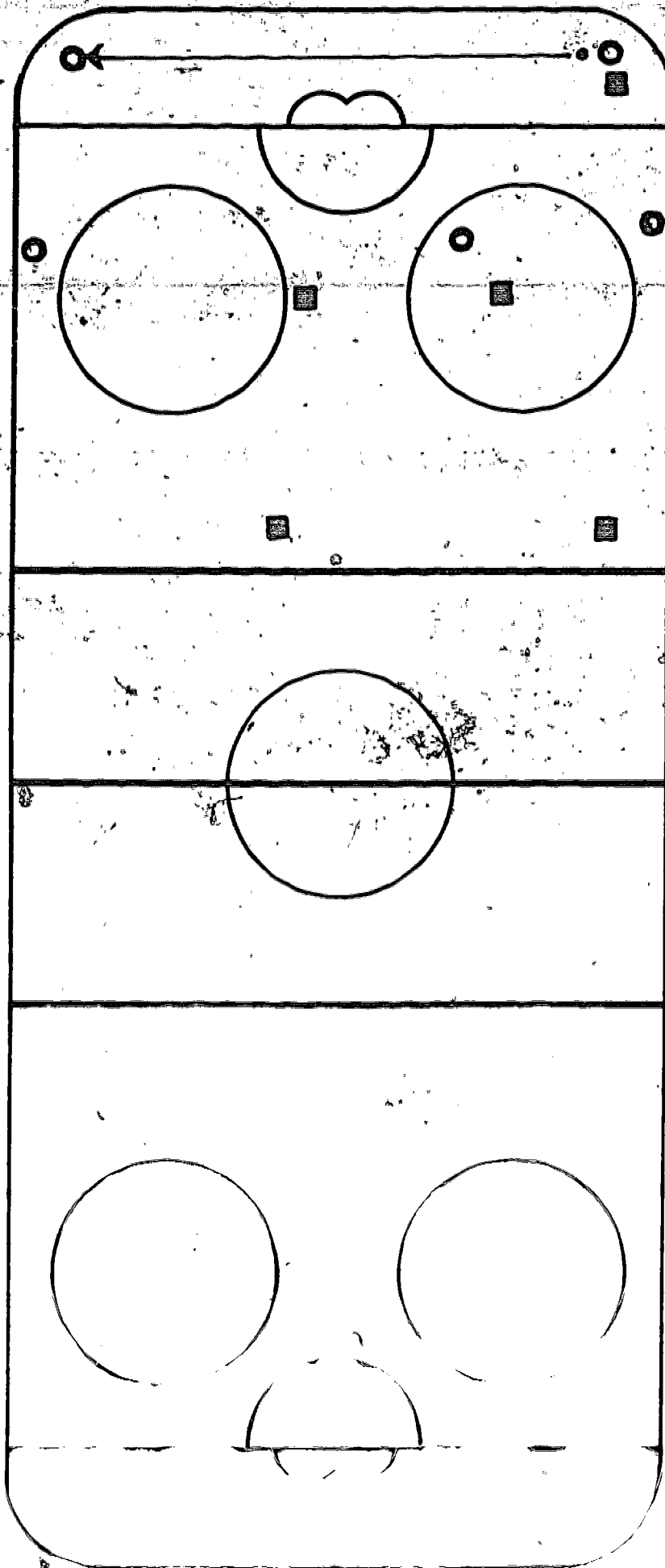
Question
QFCI

Very good.

In forechecking we
always want to force from
the front.

Explanation:

If the player answers the
question correctly he
would then be shown what
is indicated on this
diagram.

Fig. 2: Correct Movements of All Players are then Shown:

I. _____ l __g___ation ____l_____ __ ___ _____

Thi_ _ecti_n _ontained que_ti_ns pe_tai_ing to the __

_u__ _____ __number___ _____

_____

_____

1,

Consequently, at any

assignment for each play v

the study

project

identif

a ecific play ver us a varie

excellent indicator

ivid a

types of opp

indicates that the project itself may be a glimpse of leisure behavior in the not-too-distant future.

Three other results are immediately apparent from the experience. The department curriculum committee has decided to make use of components developed for the project in a correspondence course to be offered this fall. Dr. Avedon's course notes cum script are now in such organized condition, that he has a draft of a manuscript for a publishable textbook. Finally, he looks forward to teaching the course this fall with all of the enhancements developed for the COMIT project. The project stimulated a number of new thoughts on better ways to teach the material, and he is going to try to include some of these methods this fall. I only wish the University were going to retain some of the software from the project to provide all the students with tutorial and review capability if not through the computerized instructional television then via standard UW hardware.

ITEM	DID	WOULD DO
write script	4	1
tape video	6	2
tape audio	5	3
choose visuals	2	4
write tutorials	1	5
write reviews	3	6
add enhancements	7	

Figure: COMPARISON OF THE ORDER OF VARIOUS METHODS USED

COMIT AS A TEACHING TOOL FOR THE HISTORY OF ART

by

Eve Kliman

Assistant Professor

Department of Fine Arts

Abstract: This brief paper reviews our experience of COMIT for an introductory survey course on the History of Art and concludes that its useful application to the subject is relatively limited.

Fine Arts 111 is a course in the history of art which introduces students to the painting, sculpture and architecture of the Western world from ancient Greece to modern times. The course stresses the fact that works of art reflect the preoccupations of their epoch. Students are therefore expected to become familiar with the broad categories of style and meaning in Western art. They are required to recognize their works, to be able to place them historically, and to understand something of their particular meaning.

As an experiment we fed 200 slides into the computer terminals and arranged viewings for approximately 70 students. Some problems of reproduction immediately became evident. The terminals reproduce sculpture and architecture with an acceptable degree of accuracy; colour can remain close to monochrome and fine details are not essential. Reproductions of paintings fare much worse, however; the proper colour balance is often impossible to achieve and the quality of the line suffers.

In general the students found it interesting and novel to use the terminals. There were inevitable frustrations, of course, some of them minor. The chief drawback I became aware of was that though the terminals had been scheduled for use, in practice, there were a few occasions on which they were not available. Once the equipment had broken down, another time it was being overhauled. Even if such interruptions are rare, the fact that they can and do occur creates problems for the management of a course. The problem is insignificant so long as the slides are merely supplementary, but if the students are to be tested on material included in the television presentation, even a single breakdown ...

For our purposes books, slides and good quality photographs provide
us with simple, flexible tools for teaching. The terminals are unable to
do justice to the subtleties of art, particularly of painting and they
are somewhat rigid in the way they have to be used with large classes.
Our conclusion therefore is that the COMIT project does not provide a
workable addition to teaching methods in the Fine Arts department.

COMIT ENGLISH MODULE

by

Paul Beam

Associate Professor

Department of English

Abstract: Purpose of Module - The module is designed to teach
analytic method to second year English students in a required course
and it requires (depending on student's ability) between four and ten
hours of study. It permits a more thorough presentation and review
of the lesson than is presently available in any other form,

Structure of Module - The subject of the module is Analytic
Criticism and involves four contexts - Linear, Setting, Imagery,
Structure. Students may review within and across categories and seek
additional information at any point in the lesson. Both voice record-
ing and visual display combine to teach sequences of the lesson and
the student is required to respond to points throughout; records are
kept of all responses from keyboard and light pen.

Assessment - Throughout the lesson, student responses elicit
author comments on the correctness and completeness of each response.
Since all responses are recorded, the author can obtain a complete
record of each student's performance. This data can be made available
to the student for self-evaluation and provides a cummulative data base
for subsequent authors to predict student performance. In addition,
the COMIT module has some unique memory features which permit the
author to check, for example, the time taken to respond or the sequence
of answering questions.

Problems - technical, pedagogical and instructional - Response
time by the unit is critical - it must be instantaneous, as fast as the
student can write, draw or type. Failures here were my greatest frust-
rations. Next were difficulties in synchronizing audio and visual
signals to link the two responses to student requests. Both of these
are resolvable by changes in equipment. Results of student performance
have been high in comparisons with control groups in conventional
lecture/tutorial situations. Personal responses have varied between
acute frustration over technical delays to strong feelings of accomplish-
ment and an awareness of materials and methods more complete than any
previous learning experience in isolation. Students have not been
"isolated by the machine". The questions they now ask are academic res-
ponses to the work at a high level.

The COMIT English module uses most of the interrelated devices of sound,

sonic pen, keyboard, slide and terminal display in a lesson which, depending

on the student's interest and ability, may last from four to ten hours and

which forms an integral part of our second-year course in critical analysis.

From the outset I sought to present a combination of a lesson, a test
and a means of detailed assessment which would permit (or oblige) a student
to learn more by his or her involvement in the lesson that I could provide
in a similar period of classroom time. I hoped that the user would be able
to examine in detail those areas which seemed to best offer insights into
the methods of analysis and I planned to watch over the students' reactions
and choices of direction using the whole range of the machine's ability to
record, time and compare statistically the user's performance. Throughout
the project I have regarded the module - the student's use and development
of the material under the lesson's direction - as yet another extension
of my teaching method. Over the years I have become increasingly aware of
the advantages to students in selection of learning time, the ability to
reuse lecture material for greater comprehension and review and the per-
manence of records which are present in the simple expedient of recorded
lectures. The Correspondence Program further taught me the advantages of
several new kinds of organization of individual lessons and of the whole
pattern of a course. I was anxious to extend this into a more sophisticated
lesson and COMIT offered this possibility.

Finally, class size and the kinds of unwarranted assumptions an in-
structor must make about "average" levels of training and preparation, the
"average" number of illustrations one should use to walk between a class's
boredom and confusion, the degree of "participation" one can permit in a
contest with the clock and the reactions of the class as a whole - these
questions made me seek answers in kinds of teaching over which the individual
student had greater control and to which he or she was obliged to make many
contributions. The idea of the student constructing the lesson with em-
phases on areas of best understanding at an optimum rate of progress seemed
to be a good adjunct to my teaching in the course.

As in most disciplines, large areas of English lend themselves to
facts and concepts - "genres" are categories of similar structures, "periods"
presume similarities by chronological proximity. I tried to avoid these
completely and chose instead part of a course in which two thirds of the
students' year mark is derived from material which can be read orally in
_____ minutes. The point of the course is to have readers become aware

it is uncompromising in its insistence that each user meet each of its questions, puzzles or requests for knowledge and structure and it will not proceed on the happy assumption that the person sitting in front of it actually does understand and declines to answer because the question is not of sufficient interest.

At the outset my purposes in COMIT were twofold; I sought a teaching device which made no compromise with the best academic standards of my subject and which involved the student at each stage of the lesson more directly than the conventional lecture method can. It is not a question of belief but rather a matter of fact that modules of this kind meet both conditions. Questions of their role vis a vis an instructor, how much of this kind of instruction is optimal, the demands on academic resources in their implementation, matters of cost and the social and pedagogic research we derive are all, in the long run, peripheral. The project's value lies in its thoroughness and the ability to have students take charge of their own learning; Any module's flexibility, across and within disciplines, depends only on the imagination and skill of the authors and designers who create it. Not only in COMIT, but in other systems already functioning in higher education, the only functioning adverb is not "how" or "whether" but "when."

References:

[1] P. Beam, "Comparative Teaching Techniques: A Computer Module and
     Criticism", U.C.T. Studies in English, Cape Town, South Africa,
     Vol. 7, pp. 76-98, Sept., 1977.

[2] P. Beam, "The Design of a Computer-Directed Teaching Module in
     Analytic Criticism",Third International Conference on Computing
     in the Humanities, University of Waterloo, August 2-5, 1977.

[3] Eileen Elkeer, "The COMIT Project: An Executive Overview", a
     report prepared for The Educational Research Division, I.B.M.
     Canada Ltd., May, 1978.

Appendix: The passage used in the COMIT English module on
Analytic Criticism is shown below:

When the Present has latched its back-gate behind my trembling stay,
And the May month flaps its glad green leaves like wings,
Delicate-filmed as new-spun silk, will the neighbours say,
"He was a man who used to notice such things?"

If it be in the dusk when, like an eyelid's soundless blink,
The evening-hawk comes crossing the shades to alight
Upon the wind-warped upland thorn, a gazer may think,
"To him this must have been a familiar sight."

If I pass during some late night blackness, mothy and warm,
When the hedgehog travels cautiously over the lawn,
One may say, "He worked that such innocent creatures should come
But he could do little for them; and now he is gone."   to no harm,

If when hearing that I have been stilled at last, they stand at the door,
Watching the full-starred heavens that winter sees,
Will this thought rise on those who will meet my face no more,
"He was one who had an eye for such mysteries?"

And will any say when my bell of leaving is heard in the gloom,
And a crossing breeze cuts a pause in its outrollings,
Till they rise again, as they were a new bell's boom,
"He hears it not now, but used to notice such things?"

REFLECTIONS ON A COMPUTERIZED MULTI-MEDIA
INSTRUCTIONAL TELEVISION MODULE

by

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Abstract: The development of a COMIT module has involved a broad
spectrum of experiences. Initially the concepts presented sparked
visions of fascinating combinations of computer graphics, slides,
tapes, films, student-computer interaction and many other potential
"tools" to be utilized in geographical education. The selection of
a subject however, lead to a rapid revision of initial concepts. In
addition, the methodology of module development soon established the
necessity for a much more detailed knowledge of the chosen subject.
The steps which had appeared relatively simple and straightforward
became complex and time consuming. Finally, the emergence of a
reasonably complete module permitted testing to begin and the problem
of testing to come to the fore. Attempting to draw conclusions on
the basis of inadequate testing results yielded recommendations for
the future.

Initial Concept

As originally presented, the objective of Computerized Multi-Media
Instructional Television was to combine educational television with computer
assisted instruction and to evaluate the educational capability of this
marriage.

To a geographer with specializations in the fields of geomorphology and
remote sensing, the potential was fascinating. Imagine being able to incorpo-
rate in one unified module such diverse but interrelated teaching components
as colour movies (video tapes), colour slides, sequential images with appro-
priate annotation (letters, arrows, dashed lines, etc.), dynamic computer
graphics (in which lines could be made to move across the screen, letters
could be made to flash on and off to emphasize audio comments, and colours
could be used to distinguish the various segments being discussed), a sonic
pen (which could be used by the student to indicate his or her selection in
response to a visual or spoken query) and audio commentary overall (discussion,
explanation, or query). Visions of colour movies showing waves breaking on
a beach at normal speed and then in super slow motion, followed by graphics
illustrating the way in which water particles moved in a "normal" wave, then

in a wave breaking on a beach, the whole backed by the sounds of breaking waves and a discussion of wave dynamics, and followed by a series of questions to evaluate the students' comprehension of the factors and concepts involved, and of an almost infinite number of similar possibilities, were generated. Enthusiasm ran high.

Module Development

Then the crucial question was posed; given the need to test this apparently unlimited potential system, what small segment of a course currently being given should be developed into a COMIT module?

From the many possibilities, a segment which seemed ideally suited to the technique (as discussed above), or a segment which formed a small, important, but difficult to grasp, part of the course, could be selected. Based on numerous factors, but primarily the difficulty experienced, by students in understanding the concept and the consequent length of time spent on explaining it, the subject of parallax, as used in remote sensing, was chosen.

Parallax is defined as: "The apparent displacement of the position of a body with respect to a reference point or system, caused by a shift in the point of observation".

Initially, the approach taken in attempting to set up a module was, in essence, to translate the lecture format to the COMIT format. A considerable number of weeks later, weeks which involved pages and pages of writing, innumerable diagrams, and enlightening discussions with the COMIT advisors, a significant factor became evident; the "author" didn't know as much about parallax as he thought he did!

This somewhat less than earth-shaking discovery led to an intensive review of the literature on the subject. This in turn led to another discovery; many other authors of texts and reference works, were unable to explain the concept of parallax clearly and concisely, or in any event, had not bothered to do so in their works!

However, an acceptable explanation was eventually formulated and the problem of developing the module was again attacked.

The first approach involved a spot on the screen, a student, and his or her thumb. The student closed his left eye and held his thumb between his right eye and the screen such that it obscured the spot (Figure 1 a); then,

Spot S · T   Screen

T
Thumb

Left Eye ○   ○ Right Eye

b

a

S · T

P

c
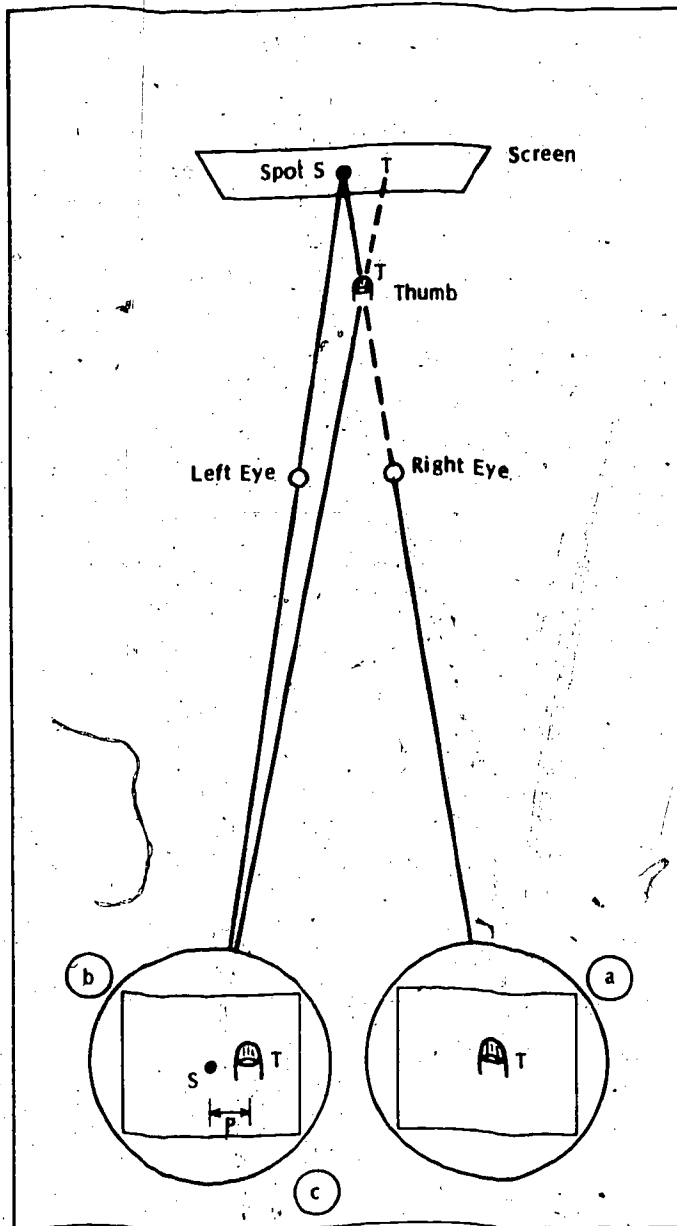
Figure 1 — a, b, & c

a. Right Eye View — Thumb, No Spot
b. Left Eye View — Spot, Thumb to the Right
c. S — T in l.b. is Parallax Displacement P

maintaining the same position (ie. not moving his head or his thumb), he
closed his right eye and opened his left. At this point he could see the
spot again and the thumb appeared to have shifted to the right of the spot
(Figure 1 b). This apparent shift in the position of the thumb with respect
to the reference point on the screen, when viewed from two different points
in space (the right eye view and the left eye view); is called parallax dis-
placement (Figure 1 c).

Problems of relating this simple example to the geometry of a sequential
pair of air photos led to a number of revisions, and eventually, after a con-
siderable length of time, to a somewhat different example involving a tree,
a pole, and a car moving along a highway. This produced a sequential set of
images which not only illustrated the apparent displacement of one body with
respect to another and, in turn, both with respect to a reference point, but
also permitted the utilization of a movie or video tape sequence which re-
lated the concept to a common every-day experience (Figures 2 a,b,c).

It was possible to display the geometry of this situation on the screen
using slides; and also, using the dynamic computer graphics capability, to
illustrate in a sequential format, the relationship between the angle of
parallax (Figure 2) and the linear displacement of the features on the image,
ie. linear parallax (P).

Throughout this developmental stage, it was necessary to keep in mind
the necessity for interaction between the student and the "message" being
presented on the terminal screen. A whole series of questions had to be de-
vised (and answers provided) to lead the student to an understanding of the
concept being presented. A number of incorrect answers had to be devised as
well, (for each question) and a system of feed-back included such that, if a
student selected the incorrect answer, he could request a review of the ma-
terial, or a "hint", in order for him to satisfy the requirements before he
proceeded to the next step.

Intermediate phases of the module involved measuring the apparent dis-
placement (parallax) on the screen using scales incorporated in the image
(Figure 3), and, in the final phases, the translation of this example to the
aerial photograph and the geometry of parallax measurement as a method of
determining heights of objects (Figure 4).

However, since this paper is not attempting to explain parallax, but
rather to evaluate the COMIT approach to explaining parallax, no further

Figure 2

H — Horizon Reference Point

P_H — Parallax Angle at H

P — Pole

P_P — Parallax Angle at Pole

T — Tree

P_T — Parallax Angle at Tree

Car

Highway

c) Point of View 3

b) Point of View 2

a) Point of View 1

104

Point of View 2　　　　　　　Point of View 1

Total Apparent Movement of Tree with Reference
to + - Linear Parallax of Tree = 8+4 = 12 mm
(Measured on Screen)

Figure 3

Image 1   Image 2

b₁   t₁   t₂   b₂

N₁   N₂

H

T

h₀

B
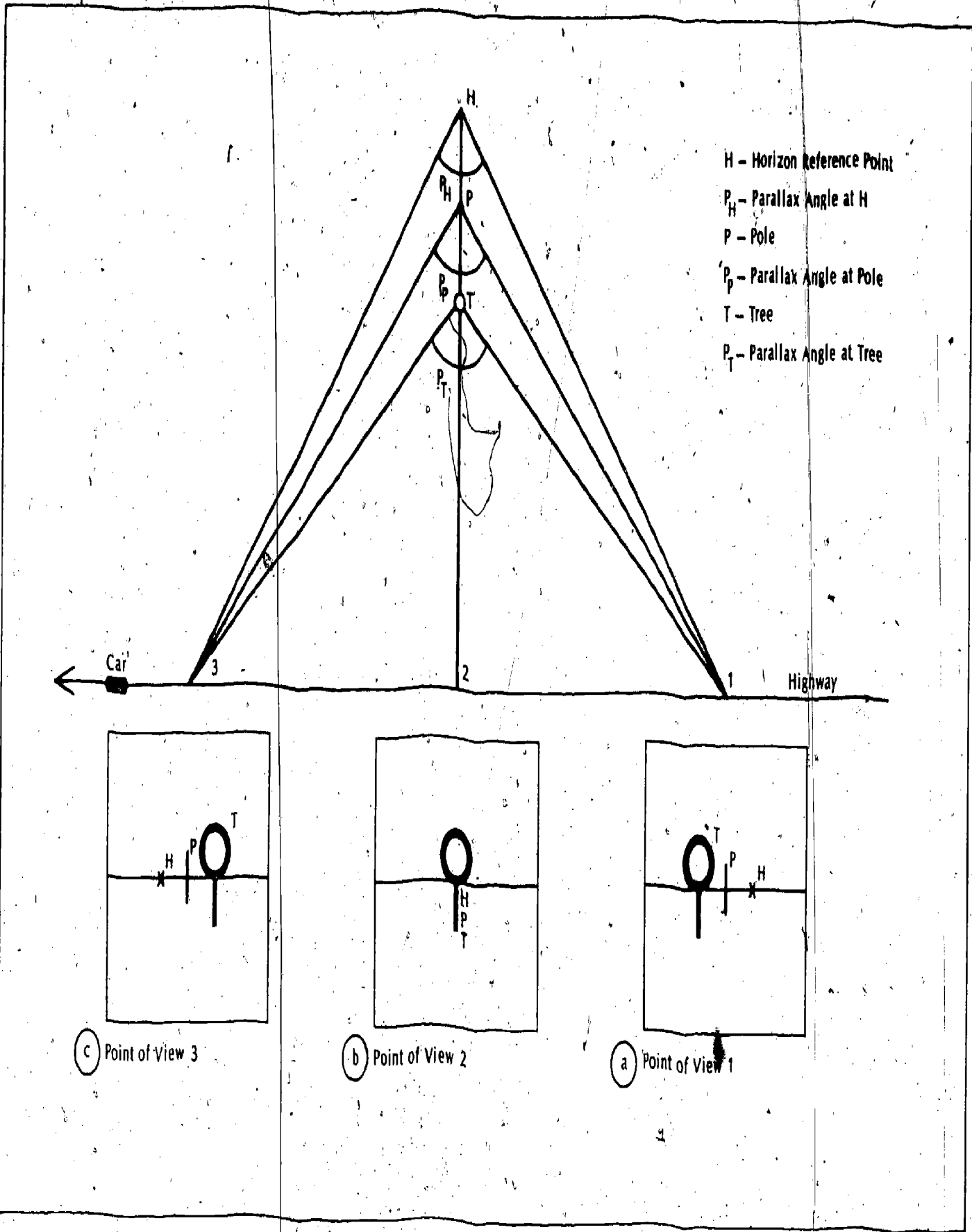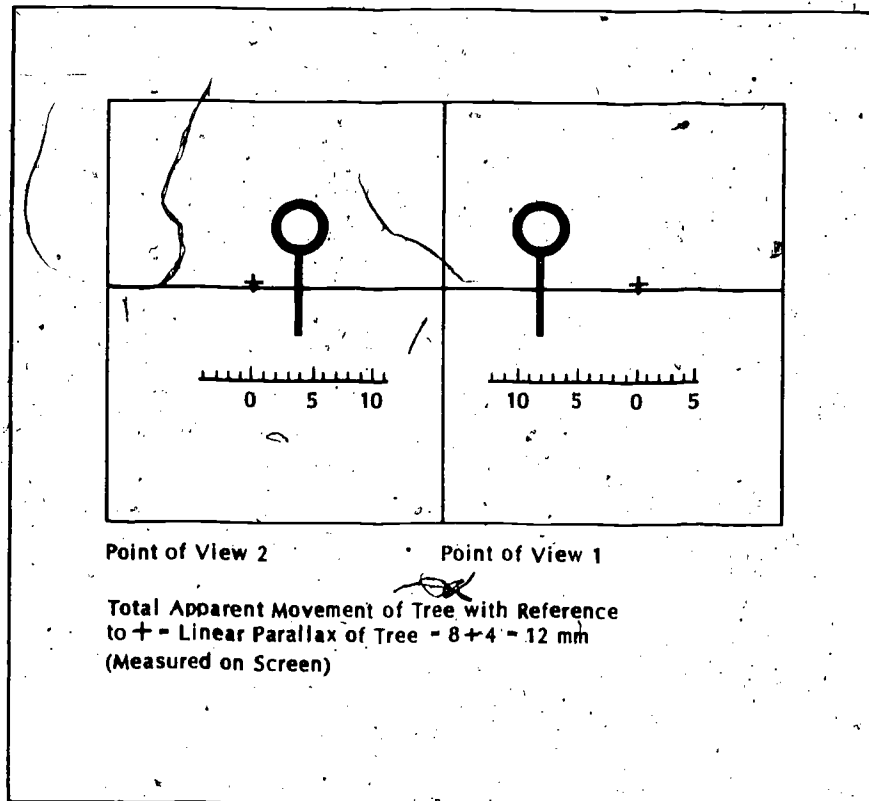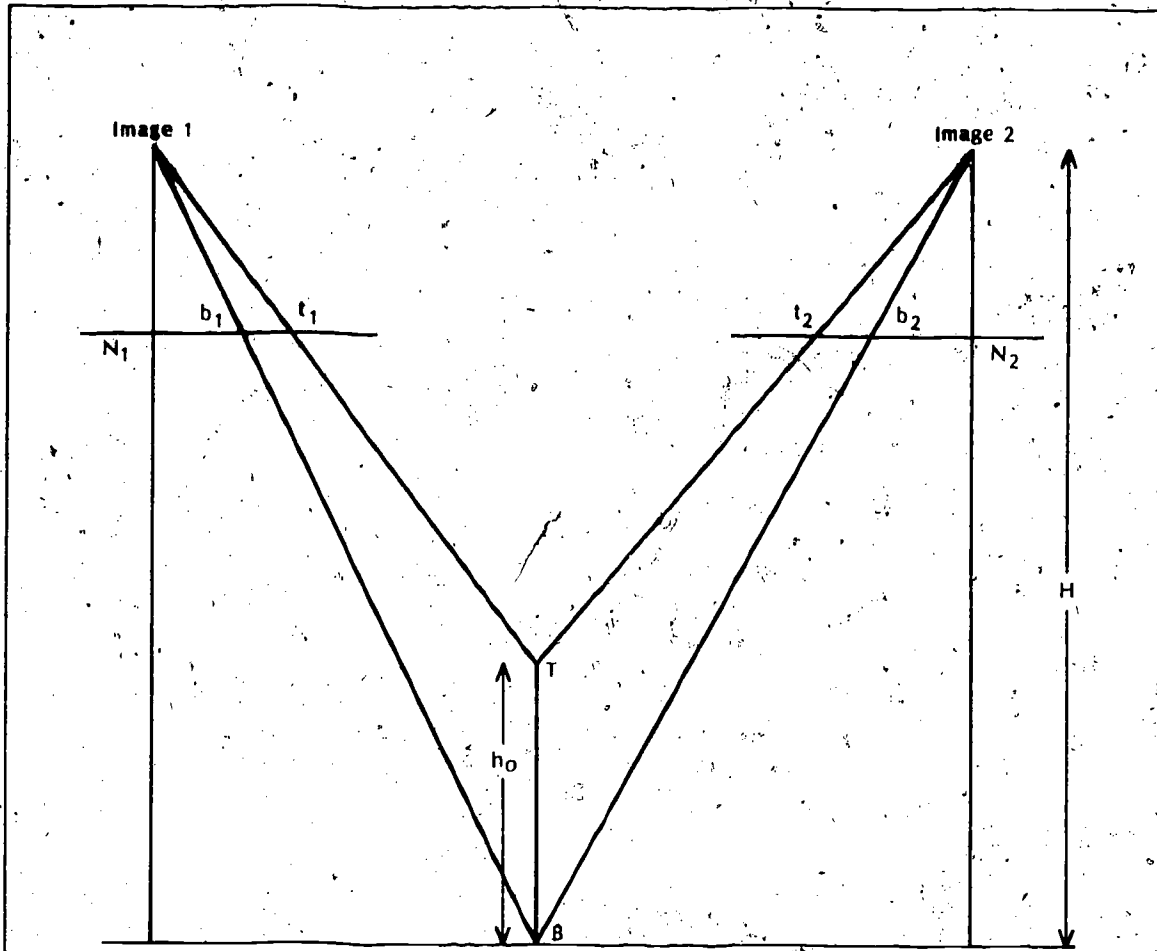
Parallax of Top of Pole = $N_1 t_1 + N_2 t_2$

Parallax of Bottom of Pole = $N_1 b_1 + N_2 b_2$ – Absolute Parallax P

Difference in Parallax Between Top and Bottom of Pole = dP

= $(N_1 t_1 + N_2 t_2) - (N_1 b_1 + N_2 b_2)$

= $b_1 t_1 + b_2 t_2$

$h_0 = \dfrac{H \times dP}{P + dP}$

h_0 = Height of Object

H = Flying Height

P = Absolute Parallax Base of Object

dP = Difference in Parallax

Figure   4

discussion of the actual module steps will be presented.

Having developed the module, the next step was to test it on the members of a class who were responsible for the concepts involved. At this point, one of the major disadvantages became apparent. The author, who at this point at least, should be assumed to know the answers, ran through the completed module on the terminal and determined that the time required was approximately 2½ hours. This was partly due to the fact that it was necessary to use a loose-leaf binder containing all the illustrations and diagrams instead of having them on the screen as previously proposed. This discrepancy or problem was in part the result of the author being on sabbatical during this phase of the programme.

The time required to complete the module when combined with a class of 120, obviously involved a major logistics problem; not only in terms of computer time itself, but also in terms of scheduling access to the limited number of terminals available. As a result, it was decided to use a small volunteer class sample and have them arrange their own scheduling. This proved to be another error. By the time the course had reached a stage involving the use of the concept, it was determined that only a few of the students had actually made appointments and worked through the module. The resulting comments were of minimal assistance in evaluating the system's capability.

This leads to some conclusions with respect to Computerized Multi-Media Instructional Television as a method of teaching a concept.

Conclusions

First, it does not appear to be a system which can be utilized to teach small components of a course, involving large numbers of students. Even assuming a relatively large number of terminals and access to these terminals over extensive periods of time during a normal day, the computer time required and the problems of scheduling the use of the terminals would be excessive.

Second, it is a system which demands a great many hours of input on the part of the author in order to develop a relatively simple module. This assumes an even greater number of hours of input on the part of an assistant, to programme the computer and handle the technical aspects, especially if video tapes, slides, audio tapes and many of the other elements which provide such a fascinating potential, are utilized.

Third, an author, or would-be author, should have or acquire a good working knowledge of computers and computer programming. It is difficult to foresee problems involving question format, answer format, graphic develop- ment, video, audio, and slide inclusion, etc., without any background know- ledge in the field.

Fourth, unless experienced in COMIT module development, it would be advisable for an author to produce one or two trial modules before attempting a final effort. Familiarization with the problems associated with module development obtained in this trial period would permit the author to save a great deal of time in selecting and planning segments of his course to be presented in module form.

Fifth, the author should be fully familiar with the course segment or concept to be developed as a module. If the author can combine this capa- bility with those discussed in three and four above, development of COMIT modules should not be too difficult.

Sixth, the nature of the subject matter has a great bearing on the use, development and effectiveness of the module format. Very difficult con- cepts requiring active faculty-student dialogue would not appear to be suitable in this context.

Seventh, in order to evaluate the effectiveness of a module, a statis- tically valid class sample should be selected, together with a control group subject to the standard method, and the two groups upon completion of the course segment involved should write an identical test. In addition, time expended by the students in the two methods should be taken into consideration. Finally, the opportunity for the one group to re-run the module if details of the concept were not clear, should be taken into account.

Eighth, if an author were to plan on using some, or all, of the various audio/visual capabilities of the system, knowledge of some of the basics of television programming such as story-board preparation, scenario writing, video "tricks", etc., would seem to be advisable.

Future

Most of the potential, which fascinated this author when the programme was first discussed, was not realized in the development of the module dis- cussed here. The capabilities are still there, but it will require a dif- ferent programme to make effective use of them. In this context, a multi-

unit module designed to present a complete segment of a course would seem
not only feasible, but also desirable. In its initial implementation, it
would not have the one-to-one, student/terminal interaction, but would be
designed to complement rather than supplement a faculty member, in a class-
room situation. However, individual units, making up the larger module,
could be utilized, with appropriate visual or audio programmes, to provide
the students with a very effective review facility (using a Comit-type
terminal).

The above format could be developed for a full course, thus removing the
repetitive aspect of a professor's programme and allowing him or her much
more time for preparation, discussion, and interaction with the class - re-
gardless of size. The length of each unit would be determined by the pro-
portion of the lecture period assigned for discussion.

Finally, this type of module format could easily be included in off-
campus (remote lecture theatre), in-home computer terminal, or conventional
television/telephone, educational programmes.

LEARNING FROM COMIT: THE EDUCATIONAL IMPLICATIONS

by

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Abstract: Experiences with the COMIT System of Computer-Assisted Learning are reviewed in relation to five evaluative criteria: effects on student learning, effects on student attitudes, effects on teachers, institutional effects, and extra-institutional effects. Conclusions are drawn concerning the possible future pedagogical role of computer assisted learning systems.

The impact of the computer on contemporary society has been so great during the past two decades that there are few individuals living in the industrial nations whose daily lives remain untouched by this aspect of modern technology. Education has of course been markedly affected by computers, especially with regard to administration and planning. Paradoxically, however, methods of teaching and learning within the educational system have been remarkably little influenced by the computer in any direct sense -- with the obvious exceptions of the use of computers as tools for numerical computation and as a means of teaching programming skills. This state of affairs is perhaps not as surprising as it may seem if we examine historically the impact on learning of instructional technology -- or indeed the impact of pedagogical innovations in general. On the whole, teaching techniques have been remarkably resistant to change, and it might plausibly be argued that no innovation has had any substantial impact on the way students learn -- at least in the formal education system -- since the invention of the printing press.

COMIT is one of the most sophisticated systems of computer-assisted instruction. As John Moore's introduction to this volume describes, it combines the facilities of a powerful computer with a rich and versatile presentation mode that is capable of supplying moving colour pictures, complex graphics and sound. The student's method of responding is also flexible, permitting communication by sonic pen or keyboard. This is an awesome facility, and it is consequently of immense interest to examine in some detail the attempts that have been made to use the COMIT system and, in particular, to assess the success of the system from an educational and

pedagogical standpoint. In this respect the preceding reports from COMIT
course developers have great relevance.

Assessment Criteria:

In attempting to evaluate COMIT, the question immediately arises of
what yardsticks are to be used to judge the effectiveness of such an
instructional system. I propose to use five criteria: Effects on student
learning, Effects on student attitudes, Effects on teachers, Institutional
effects, and Extra-institutional effects.

(a) Student Learning. There will be little disagreement among teachers
that a principal aim of instruction is to facilitate student learning.
Learning, however, is not a unitary concept, and those responsible for the
design of instruction must give careful consideration to the particular
type and level of learning it is hoped to achieve. Bloom (1956) in his
well-known Taxonomy of Educational Objectives [1] lists six types of
learning (see Table 1) and it is interesting to note that all six types are
represented in the COMIT modules described in the preceding papers.

Table 1. Types of Learning (from B. S. Bloom, Taxonomy of Educational
              Objectives, 1956)

Knowledge	— of specifics
	— of ways and means of dealing with specifics
	— of the universals and abstractions in a field
Comprehension	— translation
	— interpretation
	— extrapolation
Application	— use of rules, methods, concepts
Analysis	— of elements
	— of relationships
	— of organisational principles
Synthesis	— communication
	— planning
	— derivation of a set of abstract relations
Evaluation	— internal evidence
	— external criteria

Of considerable interest here are the ways used by the different modules
to achieve different learning ends. These range from drill-and-practice
techniques and remedial instruction, as described by Delahey to teach offen-
sive line play in football, to fairly elaborate simulations of real-life

situations where students are required to apply the knowledge they have attained, achieve some synthesis, and evaluate the efficacy of theoretical notions in relation to the simulated data. A good example of the latter approach is Thompson's programme to teach survey sampling, which exploits a capacity in which the computer excels (storing detailed information and arranging for its retrieval in a variety of different formats) and which would be virtually impossible to achieve by any other teaching technique that can be used in the classroom, as opposed to the "real world".

It is often, erroneously, assumed that the computer should be used to replicate as far as possible the function of the human teacher. (Indeed it is a common error in technological development to devise a machine that performs inefficiently exactly because it is made to ape human performance -- for example the common idea of a robot that looks, walks, and talks like a human would be an incredibly inefficient use of machinery for most purposes.). Computer-Assisted Instruction (as opposed to Computer-Managed Learning, for example) often tends to start from the basis that the learning material should be presented by the computer and confined to this mode of presentation. However, there is no reason why the computer need play such a direct teaching role. It may for instance be used as a learning aid, much like a dictionary or calculator, and indeed this is what Winter has done in using the machine to display various properties of human gait. The computer is also a convenient testing device (it was used for this purpose in nearly all of the COMIT modules) and a useful means of diagnosing each learner's knowledge and abilities so as to guide students to material uniquely suited to their individual needs.

This ability at efficient diagnosis, and the idea that the computer can cater to individual learning differences in a way that is not possible in the classroom, is a potential advantage of CAL that is frequently put forward by the system's advocates. Unfortunately in practice CAL, in common with previous instructional technologies such as programmed instruction, has a rather disappointing record of achievement. In reality, few modules employ very sophisticated diagnosis of student aptitudes (let alone student learning styles) and most of the branching techniques used for remedial purposes are fairly primitive, even in comparison with what was possible on the teaching machines of 15 years ago. There are good reasons why this potential strength of CAL has as yet gone largely unrealized: the deficiency

is probably due largely to the immense effort of time and commitment
involved to write and programme material for this purpose. Hence the modules
that in principle could cater to a wide variety of individual differences,
and which are capable of continual improvement on the basis of a detailed
examination of student responses, may remain in a crude and unmodified form
indefinitely. Naturally, it is too early to say whether this will be so for
the programmes developed in COMIT, although the fact that the system in its
present form has been dismantled makes the question somewhat unfair or
irrelevant.

If it is accepted that some demonstration of student learning is
important evidence of teaching success, then attention turns to the types
of evidence that might be useful for this purpose. Evaluation of any
teaching intervention may be carried out in terms of a change in knowledge
or (in the case of the teaching of a skill) behaviour compared to the
abilities demonstrated immediately prior to the start of the teaching. Such
"pretest – post-test" comparisons, if they are to be meaningful, should be
related to carefully stated learning objectives that can be operationalized
in terms of specific behaviour change. (Even then it is often difficult
to know whether the change was due to the teaching, to some extraneous
factor, or a combination of both.) Sometimes an attempt is made to supple-
ment evidence of such changes on the part of learners by comparative
measurements for a group of people to whom the material was presented in some
other way (or to whom it was not presented at all). A full discussion of
the design and shortcomings of such evaluative strategies is beyond the
scope of the present paper. Suffice it to say that several of the contri-
butions to the present collection describe attempts at evaluation that
incorporate pre-and post-tests as well as comparisons with other teaching
techniques. Some general comments about just what conclusions can be drawn
from such studies are made at the end of this paper.

(b) Student Attitudes. A measurement of learners' attitudes to a system of
instruction, while less important than evidence of student learning, is of
value, not least because favourable attitudes are likely to facilitate
learning (or, conversely, unfavourable attitudes are likely to be highly
disadvantageous for learning). Nearly all of the preceding papers report
on student reactions to their experience with the COMIT system, gathered
either by means of a structured questionnaire or from informal interaction

with the module author. As is often the case with teaching innovations
(indeed with any teaching technique) both positive and negative attitudes
are reported. Negative comments relate to the monotony and lack of flex-
ibility of the system: aspects that different authors attempted to deal with
by different means, such as humour or the provision of ancillary notes.
Another feature of the system frequently mentioned in a negative vein was
it's impersonality compared to a real, live teacher, and one attempt to
combat this feature and add a "human element" to the learning experience
is described by Avedon and Stewart.

This brings up the important question of the "man-machine interface"
and the related, more general question of motivation in learning. Unfor-
tunately our knowledge of the process by which humans relate to machines
in both positive and negative ways, as well as our understanding of why
machines are exciting for some individuals and frightening for others, is
disappointing to this point, notwithstanding increasing attention by
researchers to the question. It is interesting, for example, that most of
McBean's students could spend no more than two or three hours at the COMIT
terminal, while we know that students of similar age and intelligence will
spend much longer periods passively watching a somewhat similar machine
(television) or interacting with machines that seem on the face of it far
less challenging (pinball machines, slot machines, and so on).

In terms of positive attitudes to COMIT, many students expressed
pleasure at the idea of proceeding at their own pace and being able to
review the material presented -- attributes that are not confined to CAL,
but are greatly facilitated by such a system. In the case of favourable
comments to the general notion of learning via such a system (and there were
many such comments) it is important to recognize that there may be a con-
founding influence caused by the very novelty of the system and the fact
that learners were part of a special experiment (the "Hawthorne effect").
On the other hand, some of the negative comments may come from conservative
students who are resistant to any new type of learning. Furthermore the
greatest area of negative reaction -- which concerned the technical problems
with the system -- relates to features of COMIT that could almost certainly
be remedied in the future.

(c) <u>Effects on Teachers</u>. The attitudes of authors and instructors to the experience of working with COMIT reflect the same divergence of opinion as do those of the student learners, and range from considerable enthusiasm about the general potential of the system to a measure of disillusionment, with positive attitudes predominating (perhaps not surprisingly in view of the need to justify the great amounts of time and energy expended on preparing the modules). The negative comments were clearly influenced by frustrations with technical aspects of the system (frequent breakdowns and slow response time) and the immense amount of authoring time required.

Of even more interest, however, are the comments by authors about the teaching/learning process itself that have applicability far beyond the COMIT system or computer assisted learning. For example, three of the authors, as a result of working on the preparation of their modules, soon realized that their knowledge of the material and their understanding of the best way to organize the material for efficient learning was far less than they had assumed at the outset, in spite of several years of lecturing on basically the same topics. If this was primarily a self-insight, there were other insights into the learning process itself. For example, four of the authors came to the realization that learning is essentially an active process that requires students to respond constantly and frequently, rather than passively receiving transmitted material, as happens frequently in so much traditional teaching. Authors also commented on another learning principle that is well known to psychologists but frequently ignored in the classroom, the notion that effective learning requires frequent and immediate information to students about how well they are progressing with the learning task. At least one of the authors raised the important issue of social factors in learning, to what extent students benefit from working alone at their own pace as opposed to learning with and from other people. Hence McBean felt that many of his students were able to benefit from being able to work in pairs when reviewing the material in the module.

It is important to realize that these insights about the learning process are not restricted to learning by computer, but are generally applicable. At the same time, it is instructive to see how effectively they were brought home by the experience of working with a new instructional system, such as COMIT, that places new demands on the teacher, especially with regard to the way he or she analyzes, selects, and structures the

material to be learned. Even for experienced teachers it appears that
involvement with a new medium of instruction leads to a rethinking of
principles and techniques previously taken somewhat for granted. To this
extent experience with COMIT is of undoubted benefit to those involved in
designing and administering the different modules.

(d) Institutional Effects. Over the three year existence of the COMIT
project there was a considerable outlay of institutional funds and resources
and an even greater investment of time on the part of the project staff and
module authors, not to mention the effort and involvement of the many
hundreds of student learners. Yet the essential components of the system
have now been disbanded with little likelihood that the University of
Waterloo -- at least in the short term -- will change its basic methods of
teaching. Why is this the case, and why has this been the fate of so-
many experiments in educational technology in established educational
institutions?

Part of the answer lies in the inherent conservatism of academics --
and students -- when it comes to the implementation of new methods of
teaching and learning. Additional reasons relate to the basic complement
of skills that most faculty bring to the teaching process (few faculty are
trained in pedagogy and most learn through the examples of their own
teachers), to the considerable costs involved (to cite just one example,
the costs of providing and servicing an adequate number of terminals), and
to the general reorganization of the university system that would be
required in terms of timetabling, classroom arrangements, and so on.
Furthermore, at a time when universities are threatened with severe fin-
ancial stringencies and the very job security of university teachers is
challenged, the political climate is probably not conducive to the intro-
duction of a radical change in teaching methods, especially when the argu-
ments for effectiveness are equivocal. Hence in the immediate future
innovations like COMIT will probably remain in the domain of experiments to
be tried and tested in forward-looking institutions, by faculty who are
willing to devote their time and enthusiasm largely for the reward of their
own self-satisfaction and personal insights into the learning process.

(e) Extra-Institutional Effects. In his introduction to this collection
Moore states that one aim of the COMIT project was to see what implications
might result from the experiment for extramural education. He points out

that this system seems to have particular promise in that its basic compo-
nent is an ordinary colour television monitor (though supplemented with a
number of sophisticated additions, such as a light pen, keyboard, and so on).
It seems probable, however, that any hopes to introduce such a system on a
widespread basis are rather premature.

In the first place, there appear to be formidable technical obstacles
to the efficient operation of such a system, even when it is used "in-
house" on a fairly small scale, and with constant technical assistance
available to students using each terminal. Secondly, the authoring time
required to produce material is vast, especially when it is borne in mind
that the segments represented by the modules described here comprise only
a fraction of the material normally presented in the one-term courses of
which they form part. Thirdly, it is probable that the outside clientele
for such a system is probably considerably more conservative about pedagog-
ical matters than the student body in established institutions of higher
education. In this regard the British Open University is an interesting
case in point. Although this is a remarkable _social_ innovation, from a
technological and pedagogical point of view it is fairly orthodox, relying
on the traditional mainstays of further education -- correspondence
courses, personal tutors, textbooks (albeit extremely well organized ones)
and traditional lectures during the compulsory periods in residence.
The television component of the Open University is just that -- good tele-
vision programming, involving none of the interactive element that is a
principal feature of COMIT and CAL in general.

COMIT and the Future Role of Computers in Education:

A number of the experiments with COMIT described in previous papers
have attempted to compare the system with other teaching methods. In the
last analysis, however, such an approach is probably unproductive. Rather,
we should try to analyze which media of instruction, including the human
teacher, are most suited for particular pedagogical ends and for particular
individual learners. This is a research question of great importance,
about which very little is known as yet.

In the COMIT system the computer, it could be argued, is best seen
not as a teacher, but as a "super-coordinator" of instruction --
potentially better than the human teacher at this task, though whether
acceptable in this role by the human learner is something that has yet to

be determined. Certainly COMIT is far from cheap as a coordinating system, even though it is far less expensive in this role than when it is used as a direct teaching device. It must then be asked if it is worth this cost, or whether we shall continue to use our existing systems, largely human, or some alternative non-human, non-computerized system, such as written modules that are capable of guiding learners to a variety of existing resources.

If we accept the computer as a useful coordinator of instructional resources, then we must seriously question the notion that all the material involved has to be presented directly on the computer itself. The system will depend ultimately, I would suggest, not solely on its efficiency, but also on its flexibility. This is the future challenge of computers in education, and an issue for which the COMIT experiment has provided invaluable empirical data.

Reference:

[1] B. S. Bloom, Taxonomy of Educational Objectives: Handbook 1. Cognitive Domain, McKay, New York, 1956.

COMIT SYMPOSIUM

SCHEDULE FOR PARTICIPANTS

A SYMPOSIUM ON COMIT

Presented under the auspices of the

Computers in Education Committee and the

Teaching Resource Person

FINAL PROGRAMME

Place: MC 5158

Date: Thurs, 6 April, 78

Time: 1:00 p.m.

Call to Order   1:05 p.m.
    G.C. Andrews, *Chairman, Computers in Education Committee*

Introductory Remarks   1:10 p.m.
    T.A. Brzustowski, *Vice-President (Academic)*.

A Brief Summary of the COMIT Project   1:15 p.m.
    J.B. Moore, *COMIT Project Director*

Some COMIT Highlights   1:35 p.m.
    E. Elkeer, *IBM, Project Coordinator*

Representative Papers by COMIT Participants:

1. COMIT: The Leisure Experience   1:50 p.m.
    E.M. Avedon and T.O. Stewart, *Dep't of Recreation*

2. Armchair Survey Sampling: An Aid in Teaching Survey Design 2:10 p.m.
    M.E. Thompson, *Dep't of Statistics*

3. Student Response to Computer-Aided Teaching   2:25 p.m.
    E.A. McBean, *Dep't of Civil Engineering*

Coffee ———————————————————————— 2:40 – 3:00 p.m.

4. COMIT and Offensive Line Play in Football   3:00 p.m.
    W. Delahey, *Dep't of Athletics*

5. COMIT and Hockey Systems   3:15 p.m.
    R.C. McKillop, *Dep't of Athletics*

6. A COMIT English Module   3:30 p.m.
    P.D. Ream, *Dep't of English*

7. Computer-Assisted Instruction in Organic Synthesis   3:45 p.m.
    V.A. Snieckus, *Dep't of Chemistry*

General Discussion and Summary   4:00 p.m.– 4:30 p.m.
    Moderator: C.K. Knapper, *Teaching Resource Person*

RECEPTION: Following the Symposium, there will be a reception in the 4:45 – 6:30 pm
Faculty Club for all persons attending the Symposium. Wine and Cheese (approx.)
will be served.

Note: All persons wishing to attend the Symposium must contact
    Heather Baker (Ext. 3132) to reserve a place