Resource considerations often limit the degree to which educational institutions are able to duplicate technology-based successes that are commonplace in industry. For this reason, despite consistent reports of the success of interactive videodisc-based instruction in industry, many educational institutions have been slow to adopt the technology. In 1988, California State University, Fullerton initiated activities that resulted in establishing an interdisciplinary interactive videodisc learning center. Although the center was created on a minimal budget, the goals, standards, and procedures that were defined, indicate that even within budgetary limitations, industry successes can be replicated at public universities.

Personal computers have become a commonplace tool found on the desks of an increasingly large number of company employees. Even most underfunded educational institutions have established personal computer work centers for students and faculty. Software vendors have recognized the nature of these mass user environments and have established flexible pricing policies for their products. For example, site licenses are often available for companies that require multiple copies or networked versions of spreadsheets or wordprocessors. To address the needs of educational institutions, many software vendors have formed liaisons with textbook publishers to provide reduced function versions of software for student use (Reisman, 1987).

These kinds of arrangements work well for most personal computer tasks. However, for applications that require special hardware or unique software, they can be completely irrelevant. For example, applications that use CD ROM’s or optical videodiscs require relatively expensive disc drives. Although the cost of these devices continues to decline, their general unavailability still restricts their use to computer configurations more likely to be found in the office or in a PC work center.

Similarly, the kinds of software that must be used in these environments tend to be more expensive than conventional PC application software. For example, while the price of CD ROM-based software does compare to the price of soft-
ware sold on magnetic media (floppy disks), the price of laserdisc-based software is often much higher. It is not unusual for a single videodisc-based training course to cost more than $2,000. And unlike their magnetic media-based counterparts, the physical properties of laserdiscs and laserdisc players preclude their use by more than one person at a time (i.e. - they cannot be networked or timeshared).

These economic factors can inhibit the use of laserdisc products, even though it may be clear that the technology can provide significant benefits to its users. For example, many studies have shown conclusively that interactive videodisc can be a superior instructional medium (DeBloois, 1988). Unfortunately, the higher cost of videodisc workstations can be an obstacle for those who wish to use them.

Budgetary considerations are further exacerbated by the need to provide multiple copies of a single training course to meet the needs of groups of learners. While it is common practice for the companies that market these training materials to offer various payment alternatives and discounts for additional copies of a single course, the total price of materials can still be extremely high.

Businesses often perform cost-benefit analyses to justify these costs on the basis of factors that include higher employee productivity resulting from improved training (Gentry, 1989). Educational institutions however, usually cannot make equivalent analyses. In either case, the ability to determine the optimal (minimum) number of special workstations with associated application software can be a hit and miss proposition.

The Center at California State University, Fullerton

In 1988, faculty members at California State University, Fullerton (CSUF) began to plan for the operation of an Interactive Videodisc Learning Center (IVLC) to be located on the main floor of the University’s library (Reisman, 1989). The issues needing to be addressed were diverse and complex. The IVLC was conceived as a facility that would provide multi-disciplinary access to individualized learning materials within a very traditional university environment. The challenge was to determine policies and practices that would provide the benefits of interactive videodisc (IVD) within the day-to-day routines and practices of campus life, at the lowest expense. While the experiences and models developed by others provided a measure of advice (Parkhurst & Grauer, 1989), few have focused on how to accomplish similar goals on a shoestring budget.

In February, 1989, the Center undertook a study to assess a variety of issues that related to the operation of the IVLC. The following items were addressed through the course of this study:

- Selection of workstations.
- Selection of appropriate instructional programs.
- Selection of videodisc learning materials.
- Operation in an individualized learning environment.
- Minimizing courseware costs.
- Determining learning center operating schedules.
- Operation within the constraints of a semester-based program.
- Student testing.
- Student attendance.

In summary, however, the main purpose of the study was to determine how to offer as many courses as possible to as many students as possible, as effectively as possible, all at the lowest expense possible.

Selection Of Workstations

CSUF, like many other universities provides students with access to personal computer laboratories. Each of these PC centers contains 30 to 40 personal computers - enough machines to meet the demands of student computing on the basis of seven day, 24 hour access. These labs are staffed by graduate students who oversee the secu-
rity of the facility, provide their clientele with assistance if needed, and lend out various computing-related materials. These labs are established by departments that require personal computing to support the curricular needs of their courses.

The IVLC had been established as an interdisciplinary center with the goal of providing instruction to any department in the university. It was this mission that resulted in the Center’s having been established in the main library. Additionally, an interdisciplinary mission implied the availability and utility of a larger selection of already-produced videodiscs than might be available for a single discipline.

One of the major disadvantages of the interdisciplinary mission however, was that the IVLC had no particular academic department acting as its source of support and funds. The consequence of this was limited funding for staff and equipment. Despite this it was decided that the budget allocated to the purchase of workstations be used to acquire IBM InfoWindow System workstations. The main reason for this was that InfoWindow Systems have become the de facto standard for the delivery of IVD instruction. Although it was possible to acquire more, and less expensive workstations, the IBM products were chosen to avoid the expensive problems that might later arise due to hardware unreliability, poor maintenance, or a lack of vendor support. Available funding permitted the IVLC to begin operation with 10 of these workstations.

Instructional Programs

It was decided that for the period of the study, the IVLC would provide instruction to full time undergraduate students. In order to force both IVLC staff and learners to take the study seriously, instructional objectives were selected from a regular course curriculum - material on which students could be graded as part of their general academic program.

The course that was selected for the study was a three unit course entitled MS265: Introduction to Information Systems and Programming. This course is prerequisite to the undergraduate business program, and approximately 12 sections are offered each semester. Two sections (approximately 35 students per section) were randomly selected for the study.

The curriculum for MS265 is comprised of a) principles of information systems, b) introductory computer programming (BASIC), and c) basic principles of productivity software. The productivity software is a database manager (dBase III+), a spreadsheet (Lotus 1-2-3), and a wordprocessor (Wordperfect 5.0).

Selection Of Learning Materials

The purpose of this study was to establish and assess procedures for running an IVLC. Hence, to avoid confounding issues it was decided that new or experimental instructional course materials would not be used. Instead, instructional videodiscs that had already been developed and tested elsewhere were obtained.

One of the main reasons for selecting MS265 as the target course for this study was the existence of a large selection of commercially available videodiscs that relate to the productivity software aspects of the curriculum. It was decided that such discs could be used to replace the lecture approach normally used to teach those packages. Catalogues of suitable discs were surveyed and a number of vendors’ courses were reviewed to assure their operation on the IVLC’s workstations. Although many software vendors make claims about the compatibility of their products with different hardware configurations, not all those claims have been well tested. It was necessary to ensure that any instruction that was initiated during the study would not be interrupted because of technical problems with untested course material.

Individualized Learning Environment

Most classes at CSUF are taught in a traditional lecture format. The material selected
for this study is normally taught in regular lectures supplemented by hands-on work in a PC laboratory. This was the first time that the productivity software part of the course had been taught entirely in an individualized instructional setting.

There were implications of this both for faculty and for students. This study allowed instructors to reallocate their lecture time to the IVLC. Hence, during their regularly scheduled lecture time instructors could assist IVLC graduate assistants by being present in the IVLC to help.

For the students, the “come when you like” nature of individualized instruction provided them with an opportunity not generally available at the university - receiving instruction at times that were convenient to the student.

**Minimizing Courseware Costs**

Budgetary considerations precluded the acquisition of one copy of each set of materials for each workstation for all three software packages. While that strategy would have permitted each software product to be presented on all 10 workstations at any time, the approximate total cost of 30 sets of course materials would have been $60,000 (Lotus, dBase, and Wordperfect on 10 workstations, each costing approximately $2,000). Consequently, three copies of each set of materials were acquired (3 each of Lotus, dBase, and Wordperfect) for an approximate cost of $18,000.

The students in each of the classes were randomly assigned to one of three groups (Table 1). Each group received a different sequence of instruction in the three packages.

Table 1 indicates that during Period 1, Group A learned Lotus, while Group B learned Wordperfect, while Group C learned dBase. In this way, nine of the 10 workstations could be allocated to three each of Lotus, dBase, and Wordperfect instruction. The tenth workstation was set aside as a backup.

**Daily Operating Schedule**

A graduate assistant was required to oversee the Center, both to provide assistance when it was required and for purposes of security. Budgetary considerations limited the Center’s schedule to Monday through Thursday from 10:00 AM to 4:00 PM, and Friday from 10:00 AM to 1:00 PM. These hours (27 per week), together with the 10 workstations, limited the total amount of available student contact time to a maximum of 270 hours per week.

**Semester Constraints**

Time constraints implicit in offering this kind of material within a traditional university environment in one semester imposed restrictions on the preferred instructional strategy. Normally, individualized instructional materials are used in a self-paced learning environment in which stu-

<table>
<thead>
<tr>
<th>Period</th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lotus</td>
<td>Wordperfect</td>
<td>dBase</td>
</tr>
<tr>
<td>2</td>
<td>Wordperfect</td>
<td>dBase</td>
<td>Lotus</td>
</tr>
<tr>
<td>3</td>
<td>dBase</td>
<td>Lotus</td>
<td>Wordperfect</td>
</tr>
</tbody>
</table>

*Table 1: Instructional Sequencing*
dents proceed through the lesson materials, from objective to objective, at their own pace. When a student completes an objective, the student is tested and either proceeds to the next objective (if successful), or receives remediation (if unsuccessful).

Self-pacing results in some students’ completing instruction sooner than others. The university environment demands that all students complete a course by the end of the semester. This requirement imposed time limitations on the students in the study, forcing them to complete all the instruction within a prescribed timeframe. Because of this, the semester was divided into the three, three-week time periods shown in Table 1. Students were required to complete the instruction for each package within each assigned period.

This scheme provided a maximum of 810 workstation-hours for each period (3 weeks @ 270 hours/week). For each of the approximately 70 students in the study, this allowed for approximately 11.5 hours of workstation contact time for each package. The duration of instruction for each set of instructional IVD materials, as quoted by the vendor, was 7 hours. This implied a factor of safety of almost 70%.

To maintain a uniform rate of workstation usage, students were not permitted to use a workstation for longer than one hour at a time. This rule served two purposes. If all the workstations were being used, it prevented newly arriving students from being kept waiting for an excessive time. Secondly, workstation sessions longer than one hour serve no useful purpose. From a learning standpoint, multiple sessions, each of shorter duration, are more beneficial than fewer and lengthier sessions. Students were not permitted to reserve workstations.

**Student Testing**

The use of self-paced (criterion referenced) individualized instruction implies that all learners will reach criterion, the only variable being the time it takes for instruction to be administered. However, the norm referenced nature of final grade assignment in traditional (university) learning environments dictated that a post-test be administered to all students at the completion of their instruction.

For each set of IVD materials, multiple choice and true/false paper and pencil tests were created. The items were selected from a test bank that accompanies the SRA textbook, *Information Systems, A Problem-Solving Approach* (McLeod, 1989). Students were advised that they must complete the test for each package within one week after their completion of the instruction for that package. These test grades partially contributed to students’ mid-term grade. (Tests and assignments on other curricular material contributed to the balance of the final grade.)

Because students could take their tests at any time of their choosing during each period, it was possible that information regarding the tests could be passed along to other students. To eliminate this potential problem, three versions of each test were created and assigned randomly to students. Although it would have been preferable to have the computer administer post-tests in an online fashion, there were not enough workstations available to allow for this luxury.

**Student Attendance**

In keeping with the benefits of self-paced instruction, students were advised that they could attend and use the facility any time within each period. The only caveat was that all instruction and the “post-test” had to be completed within each assigned period. Classes that had been scheduled to provide traditional instruction in the packages were canceled and replaced by access to the videodisc facility. Because one of the objectives of the study was to determine workstation usage, an online log was developed and maintained in order to record each student’s use of the IVD materials.

At the onset of the study, approximately 70 students were assigned to one of the three groups (A,B, and C). By the end of the semester, normal
attrition reduced this number to approximately 54 students.

Results Of The Study

The study began in February, 1989 and was completed by the end of the semester in June, 1989. The results of this study can be examined in terms of three issues - a) student achievement and reaction, b) resource utilization related to individualized learning, and c) logistical issues regarding the management of the center.

Student Achievement And Reaction

In order to measure and compare the effectiveness of IVD instruction in this learning environment, the two class sections of course MS265 who had used the Center were administered the post-tests described above (IVD group). These same tests were administered to three other class sections of this course that had been taught by two instructors who used a traditional lecture-plus-assignment approach (TI group).

For each set of posttest scores for groups IVD and TI, one way ANOVA’s were performed. For all three subject matters, IVD students’ scores were higher than those of the TI students (Table 2). For the Lotus and Wordperfect modules, IVD scores were significantly better than TI scores. (Lotus: F(1,120)) = 6.9, p< .01; Wordperfect: F(1, 119) = 8.82, p <.004.) While the dBase posttest scores of the IVD students were also higher than those of the TI students, these results were not statistically significant.

On the basis of student performance alone, the study illustrated that in all three subject areas students in the two sections of MS265 who participated in the study outperformed students in other sections of the course by between 5% and almost 12%.

An anonymous, two part questionnaire was administered to the IVD students after they had completed all the testing. The questionnaire was designed to determine IVD subjects’ overall attitudes regarding a) their experience with the IVD materials used in this study, and b) IVD in general. In the first section, using a four point rating scale (4= Excellent, 3 = Good, 2 = Fair, 1 = Poor), subjects were asked to rate three factors specifically related to the IVD materials used in this study. Respondents’ overall opinions about all the modules was determined by calculating the mean rating for each factor, and the overall mean. As Table 3 indicates, with an overall mean rating of 3.42 respondents were overwhelmingly positive about the IVD materials used in this study.

Resource Utilization And Individualized Instruction

Individualized instruction can be a two
edged sword. On one hand, for students and instructors there are many benefits that can be realized from its use. On the other hand, because of the freedom that it allows learners, it can present major questions regarding the planning of resource utilization.

During the design of this study, one of the main concerns was the paucity of resources, particularly with regard to the number of available workstations. Every effort was made to ensure that the IVLC would be open enough hours to provide sufficient workstation hours for all students for all the learning materials. No amount of planning could solve the problems that might arise if student usage were not uniform throughout each time period. If a disproportionate number of students elected to receive their instruction during the last week of each period, there would not have been enough workstations available to satisfy the demand.

This situation did not materialize. It should be noted, however, that students were warned that this could happen and that failure to complete a post-test within the allocated period would result in a grade of F. (Even in individualized instructional settings, sometimes fear is the best motivator!)

Despite these warnings, student attendance was noticeably low in the first week of a period, picked up in the second week, and was very high in the last week. Though there were sometimes occasions in the third week when students had to wait for a workstation, the wait times were not excessive. It is probably for that reason that this weekly attendance trend was consistent in all three periods. If there had been fewer available workstation-contact hours, students who procrastinated until the last week would probably have learned from their first experience to use the facility sooner in subsequent periods.

### Logistical Issues

**Managing the facility.** Student attendance at the IVLC was recorded using online software specially designed for the study. The log was updated and maintained by the senior graduate student who was responsible for administering the post-tests. The senior graduate student was also assigned the responsibility of ensuring that students have a focal point for resolution of their problems.

Despite all the courseware having been thoroughly tested, shortly after the onset of the study it became obvious that the courseware was not designed for the laboratory environment in which it was being used. Each course consisted of two kinds of media, a) hard disk-resident computer programs that displayed lesson text and graphics on the screen, and b) videodiscs that were controlled by those computer programs. To initiate a particular lesson, the learner was expected to

<table>
<thead>
<tr>
<th>Factor</th>
<th>Section 1 (n=23)</th>
<th>Section 2 (n=22)</th>
<th>Overall (n=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of Instruction</td>
<td>3.09</td>
<td>3.55</td>
<td>3.31</td>
</tr>
<tr>
<td>Flexibility of Instruction</td>
<td>3.43</td>
<td>3.41</td>
<td>3.42</td>
</tr>
<tr>
<td>Ease of Use</td>
<td>3.35</td>
<td>3.68</td>
<td>3.51</td>
</tr>
<tr>
<td>Overall Section Mean</td>
<td>3.30</td>
<td>3.55</td>
<td>3.42</td>
</tr>
</tbody>
</table>

Rating scale: 4 = Excellent, 3 = Good, 2 = Fair, 1 = Poor

Table 3: Questionnaire Ratings About Courseware
insert a “startup” floppy diskette into the computer. The startup program loaded the hard disk-resident lesson program. Throughout each lesson, students created student exercise files that were stored on, and input from the startup floppy diskette.

It was not possible, desirable, or even legal to provide each student with a copy of a startup diskette for each lesson. Instead, a “shell” program was devised to allow students to select as menu items from the screen, a lesson on which to work. That shell program also redirected all student data files to and from a student-supplied work diskette.

Although one backup InfoWindow System was available in the IVLC, there was no need to use it during the study. All workstations operated perfectly, and no hardware or other software problems were encountered.

**Number of workstations versus available hours.** Because availability of workstations was one of the concerns of this study, it is important to consider the effect of this variable on the number of students that could be accommodated in the IVLC. Based on the observed pattern of usage, it seems that there is a linear relationship between the number of available workstations and the number of classes that can be offered instruction such as that provided in this study. If the IVLC had 30 IVD workstations, six sections of MS265 could use the IVLC. Thirty workstations is the same number of PC’s usually found in department computing laboratories.

Doubling the number of hours that the Center was open, however, would probably not have doubled the Center’s utility. Students cannot and should not be expected to receive instruction late at night or on weekends. Based on the experience of this study, it could probably be expected that extending the Center’s operating hours would have had diminishing returns, depending on when those extra hours of operation were scheduled. For example, opening two hours earlier and closing two hours later Monday through Thursday would probably significantly increase usage. Similar but not as much extra usage might be expected for Fridays, the last day of the week. Much less usage can be expected for weekends. However, rules of thumb such as these could probably be easily affected by a “strategically announced” testing/exam schedule.

**Recommendations**

Much has been learned from studies and activities such as the one conducted at CSUF. The following is a list of suggestions and recommendations that should be considered by anyone planning to initiate a facility similar to the IVLC.

a) Acquire industry standard hardware in order to have the broadest possible selection of generic courseware from which to choose if you decide to use commercially available materials.

Try to have at least one complete workstation available as a backup should a workstation become inoperable. Purchase the best hardware that you can afford. End users will be very unhappy if hardware keeps breaking down. If two workstations become inoperable and they cannot be repaired quickly, try to replace components of one system with components of the other. That way, at least one of the systems may be made operable.

b) If your facility will have as primary goal the delivery of instruction (as opposed to the development of instructional materials) use commercially available courseware. Although this courseware is costly, for the sake of the publicity, many vendors are willing to negotiate substantial discounts, especially for universities.

Be sure that the courses that you select have been tested for educational utility in other instructional environments. Test them thoroughly in your own environment to be sure there are no technical problems.

c) Although it is surely possible, with a limited budget, to undertake a project such as the one described in this paper, try to obtain a specific department’s ongoing support (i.e. funding) for the project and for subsequent projects. It is
inadvisable to undertake projects on the basis of “Let’s see how it all works out before we commit any of next year’s funding.” (Realities being what they are, you probably will have to accept such conditions, as undesirable as they are.)

d) Establish your learning center as a separate entity, not as part of an existing computer laboratory. Videodisc learning centers have different needs than conventional computer labs and should be perceived as library-like facilities. De Marco and Lister (1987) have shown that computer programmer productivity is significantly higher if the programming workspace is aesthetically pleasing, quiet, and private. Your center should provide similar conditions for its learners.

e) Ideally, a learning center should be managed by a full-time director. In the early stages of development this may not be (fiscally) possible. Planning and managing such a facility is very time consuming and will affect the time available for teaching, research, etc.

If it is not possible to employ a “professional” director, hire/select/obtain one senior graduate assistant who can be responsible for the day-to-day management of the facility. That person’s responsibilities should include managing other student assistants, enforcing guidelines and rules, ensuring that student testing policies are enforced, etc. That graduate student must report to a faculty or staff member who is ultimately responsible for all aspects of the center.

f) It is not necessary to begin your project with studies to determine the effectiveness of the technology. There have been countless studies that have already done this. Your first project should be the provision of a service to end users. Although testing of procedures and rehearsal of activities will definitely yield interesting, if not useful data, the real test is in delivering instruction to real students in a meaningful learning task.

g) Be sure to collect achievement and opinion data. Ultimately, a learning center provides a service for its “customers.” If it is not serving its customers satisfactorily, changes will be in order. Data that you collect will point to changes that may be required.

Collect comparative data as well. Your greatest accomplishment will be to show that your customers are more satisfied and performing better than your competition - in the case of CSUF, that was lecture format.

h) Start slowly. Select one subject area for the first project. Gain experience based on the simplest case. As your experience-set grows, incrementally add new courses and new disciplines.

Conclusions

The Interactive Videodisc Learning Center at Cal State Fullerton was created to support the interdisciplinary needs of students, staff, and faculty. A study was conducted to test the assumptions and operating procedures that had been devised in the planning of the Center. During this study the Center provided more than 2,000 hours of workstation-contact time to two classes of undergraduate business students. Student post-test achievement scores were superior to the test scores of traditionally taught students, and opinion surveys indicated an overwhelmingly positive reaction to all aspects of the IVLC.

As a result of the experience gained in this study, the Learning Center has continued its operation providing more and more service to an increasingly larger number of end users.

References


Sorel Reisman has been involved in computer-based interactive audio/visual research and development since the 1960’s. First as a graduate student and later at IBM, Dr. Reisman has participated in a number of state-of-the-art interactive videodisc projects that eventually evolved into some of the services and products now offered by key vendors in the videodisc marketplace. After leaving IBM DiscoVision in 1982, Dr. Reisman joined Toshiba America where he was senior manager of the company’s first microcomputer product line. In 1984 Dr. Reisman became Vice President of Product Development at THORN EMI Computer Software. Dr. Reisman joined the Management Science Department in the School of Business at Cal State Fullerton in 1986. Since that time he has been actively involved with multimedia computing, promoting the multi-disciplinary use of interactive videodisc at CSUF and within the California State University System. Dr. Reisman is a contributing editor to IEEE Software Magazine responsible for the regular column, End User.
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