ATHABASCA UNIVERSITY

INTERACTIVE INSTRUCTIONAL TELEVISION (IITV) CLASSROOM SYSTEM DESIGN: AN APPLICATION AND COST COMPARATIVE ANALYSIS

BY

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The undersigned certify that they have read and recommend to the Athabasca University Governing Council for acceptance a thesis INTERACTIVE INSTRUCTIONAL TELEVISION (IITV) CLASSROOM SYSTEM DESIGN: AN APPLICATION AND COST COMPARATIVE ANALYSIS by KIMBERLEY DAWN RYAN-NICHOLLS in partial fulfillment of the requirements for the degree of MASTER OF DISTANCE EDUCATION.

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Date: May 1998

DEDICATION

This thesis is dedicated to my family: Doug, Marshall, and Meghan.

To my son Marshall and my daughter Meghan, thankyou for your easiness in being pleased. Your being so made it possible for “mummy” to complete this endeavor. To my husband Doug, I would like to say thankyou for being my “rock”. For without your patience and unwavering support, none of this would have been possible.

Love Mom/Kim

ABSTRACT

This study identified conditions under which IITV might be an appropriate choice of technology for delivering instruction in the K-12 environment; presented an analysis of different IITV classroom system design applications and corresponding transmission systems; and provided estimates of the typical costs associated with the creation, as well as ongoing usage, of such systems. Three instruments, developed based on literature review and validated through expert review and external feedback, were used to collect data relevant to the research questions. Study participants consisted of the Superintendents and IITV Coordinators in three Manitoba school divisions which utilize IITV.

The findings indicate that, first, IITV is chosen as an instructional technology primarily as a mechanism for ensuring that rural students receive the same educational opportunities as do their urban counterparts. A by-product of this is the assurance that rural school districts survive. Second, each IITV system design has its own set of defining characteristics. However, underlying these unique attributes some common elements are found which are fundamental to the delivery of two-way audio and video interactive instructional television. Data analyzed in relation to a total of 81 design considerations revealed that of this total, 24 design considerations are common across all three designs, while 57 design considerations are uncommon. Third, costs to remodel a standard classroom into a basic IITV classroom system are minimal; and costs to remodel a standard classroom into intermediate and deluxe IITV classroom systems are approximately 3 1/2 times and 5 times, respectively, the cost required to remodel a standard classroom into a basic IITV classroom system. It costs 1 1/2 times as much to equip an intermediate IITV classroom system as it does to equip a basic IITV classroom system; and more than 2 times as much to

equip a deluxe IITV classroom system as it does to equip a basic IITV classroom system. It costs almost 3 times as much to establish a multi-point transmission system for an intermediate IITV classroom system as it does to establish one for a basic IITV classroom system; and that establishing a leased fiber optic system costs approximately 1/6th of the cost to establish a multi-point transmission system for an intermediate system. However, the ongoing lease cost of fiber is 20 times that of the costs associated with the ongoing usage of microwave.

Two limitations of this study were: it did not conduct a comparative analysis of the costs for specific services associated with microwave transmission system design, construction and installation and costing information was not obtained for a purchased fiber optic system.

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INTRODUCTION

Background to the Problem

Rural education is an area on the verge of a major transformation that can be attributed to numerous pressures. According to Jordahl (1991), "declining rural populations, along with flagging economies and mounting teacher shortages, have forced many smaller, more isolated school districts to exclude from their curricula all but the most basic subjects" (p. 72). Consequently, "many rural high schools have had to graduate students without the background in foreign languages, higher-level math, and advanced science that today's colleges and careers require" (Jordahl, 1991, p. 72).

In rural schools, declining enrollments often put these schools at risk. School boards and administrators have difficulty attracting specialized teachers and staff to offer non-core, advanced and specialized school programs. In many rural and remote schools low numbers of students make it difficult to provide many programs. A related problem is the fact that providing for professional development opportunities for teachers, staff and administrators is more difficult in rural and remote schools. "For many rural schools remaining viable seems to be a constant battle" (Doncaster & Walker, 1996, p. 3). For rural communities, closure of schools has disastrous consequences: a valuable resource is lost; employment opportunities are lost; children must endure longer bus rides to and from school; there are subsequent increases in transportation costs; and schools encounter extra timetabling and scheduling pressures (Doncaster & Walker, 1996).

“Viewed within the larger context of continued funding restraint in education, the increasing technical nature of society, the need to do better with less, and demands to respond to the needs of lifelong learners, education in general and rural schools in particular are faced with greater and greater challenges” (Doncaster & Walker, 1996, p. 3). In addition to educating youth, rural and remote schools are being asked to serve a broader range of community needs. According to Doncaster & Walker “rural schools often act as a focal point for information dissemination in health care, and support services within the community” (p. 3).

According to Hobbs (1985), “the rural education problem has always been closely linked with space and economics” (p. 4). Hobbs elaborates that the traditional view of the school is very much space bound and that this has been and continues to be an important feature of the notion of the community school. The view has prevailed that all the educational resources (i.e. teachers, administrators, counselors, texts, library books, etc.) needed to be located at the school site and under direct management of each school system (Hobbs, 1985).

“As the educational enterprise expanded and public expectations of schools increased, the economics became an important consideration in what the school had to offer” (Hobbs, 1985 p. 4). Consequently, in situations where the student and resource base of the school were small, economics dictated that the educational offerings of that school would also be small.

The initial response to the rural education problem was consolidation, which Hobbs (1985), explains is the “combining of several schools to increase the resource and student base in order to economically expand educational offerings” (p. 4). However, according to

Hobbs the benefits achieved by consolidation were not without costs. Hobbs identifies these as “social and economic costs to communities that lost schools, and costs to both the school and students associated with greater travel” (p. 4).

In addition to consolidation, other remedies to “the economic-space-program problem” have included correspondence study courses, traveling teachers, or pairing agreements. Some of these solutions still have value; however, according to Barker (1990), “new - and in some cases better - approaches are available through technology” (p. 4).

Within the last two decades there has been a rapid expansion in the range and types of technologies available for use in education. In response to the increasing challenges facing rural schools, educational planners are turning to cooperative approaches involving distance education and technology, for solutions. One form of technology-based distance education is "telecommunicated distance education" in which the learner is physically separated from the teacher in terms of location, but is linked by some form of telecommunicated medium that permits live, interactive audio and/or video exchanges between teacher and students (Barker, Frisbie & Patrick, 1989). Doncaster & Walker (1996), assert that telecommunicated distance education can offer unique opportunities to reshape educational environments as well as impact the social, economic and political realities of rural communities by providing cost effective linkages to other communities and information sources beyond community boundaries.

Today’s rural schools are facing increased demands for better performance and access to a broader, more rigorous curriculum which will ensure that rural youth receive the same educational opportunities as their counterparts, who attend school in larger metropolitan areas. “As a result, many rural schools find themselves in the awkward situation of having to offer elective subjects for which neither funds nor teachers are available” (Jordahl, 1991, p. 72).

Rural school districts require a more efficient and effective distribution of resources which does not necessitate a relocation of staff. This is exactly the promise that telecommunicated distance education holds. Its essence is the inclusion of crucial two-way communication links between students and teachers. “These links allow rural schools to simulate traditional classroom interaction, even though the teacher may be many miles away from the students” (Jordahl, 1991, p. 72). Rural schools can use telecommunicated distance education to provide courses and opportunities they would otherwise be unable to offer, without having to rely on either of the previously identified remedies to “the economic-space-program problem” (Hobbs, 1985, p. 4).

In January, 1994, a telecommunicated distance education initiative began in the province of Manitoba, in response to the following growing challenges: "the need to provide a wider range of specialized courses to prepare students for an increasingly complex and competitive workplace; and the need to find cost-effective ways to deliver courses to smaller groups of students, as training becomes more specialized and population shrinks in some rural communities" (Manitoba Government, 1995, p. 7).

The telecommunication technology selected for this initiative is Interactive Instructional Television, otherwise referred to as IITV. This type of technology is a two-way interactive television system which provides the opportunity for an instructor at one geographic site, called the “home site,” to teach students located at other sites, called “remote sites” (Kitchen, 1988). IITV accomplishes this through the placement of video cameras and microphones in specially designed classrooms and transmitting video signals to each participating site (Doncaster & Walker, 1996). The signal from the home site to the remote site and back again can be relayed via microwave, fiber optics or coaxial cable systems (Kitchen, 1988). Manitoba's proposed IITV initiative will utilize microwave and fiber optic connections (Doncaster & Walker, 1996).

Statement of the Problem

"One of the most thorny issues by far in distance education is the cost. The design and implementation as well as the maintenance of a two-way interactive system may be expensive" (Kitchen, 1988, p. 74). Jones (1992), concurs by stating that while IITV does offer solutions to enable school districts to improve their curricula and learning experiences, it also creates new problems because this type of technology is "expensive and complicated" (p. 7). If this is so, then it is vital that distance education planners understand why IITV would be the technology of choice in light of considerable expense and challenges.

According to Price (1991), an often overlooked aspect of teaching with telecommunications is the physical nature of spaces in which students are located. Effective classroom system design depends on attention to detail, a clear understanding of overall objectives and an understanding of the design factors that affect auditory and visual performance (Brase, 1989).

"To make effective use of a two-way interactive distance education system, classroom design should be a primary consideration" (Gregg & Persichitte,1992, p. 2). A properly designed classroom system will enhance content objectives and increase acceptance of this type of instructional delivery within student and faculty user groups (Price, 1991; Gregg & Persichitte, 1992).

A variety of literature exists concerning IITV systems. However, only a limited amount of this material focuses on the physical design of an IITV classroom system. Furthermore, none of this literature provides an analytical comparison among different design applications.

“One major question asked by administrators, school boards, and policymakers is, How much does distance education cost?” (Jones, 1992, p. 8). For individuals contemplating the establishment of an IITV classroom system, information that identifies the costs associated with the installation and ongoing system operation is limited. Moreover, literature that provides a comparison between the costing of different IITV classroom system applications is sparse and difficult to locate.

Substantiation for this claim is provided by Morgan (1994), who maintains that even though evidence exists to suggest that distance learning through IITV will become a significant addition to the educator’s toolbox, cost data and cost effectiveness studies are lacking. According to Jones (1992), there are few studies that specify detailed costs for different transmission systems. Jones further asserts that “it is difficult to find in one location, complete, non-technical information listing the major cost variables affecting each transmission system and classroom equipment” (p. 8).

Individuals considering the use of IITV require information that justifies its use. If the decision is made to establish an IITV system, then these same individuals need access to current and reliable information that presents several classroom system design options, as well as the related costs of each. As part of IITV system design, there are also transmission system costs to consider. A study which analyzes the specific variables which contribute to the total costs of an IITV classroom system would be beneficial to distance education planners.

Purpose of the Study

The purpose of this study was to:

1) Identify conditions under which IITV is an appropriate choice of technology for delivering instruction in the K-12 environment;

2) Present an analysis of different IITV classroom system design applications and corresponding transmission systems;

3) Provide estimates of the typical costs associated with the creation, as well as ongoing usage, of such systems.

Research Questions

This study was designed to provide information relevant to the following key research questions:

1) Why choose IITV as an instructional technology?

2) What should the design of varying IITV classroom systems include?

3) How much do the varying IITV classroom systems cost?

This study consisted of an analysis of three IITV classroom system design applications designated as basic, intermediate and deluxe. A basic design was defined as an IITV classroom system where the equipment required for two-way audio and video interactive instructional television has been installed into a standard classroom with minimal provision made for remodeling. An intermediate design was defined as an IITV classroom system where the equipment required for two-way audio and video interactive instructional television has been installed into a standard classroom with provision made for remodeling into a flat-floored IITV classroom system design. A deluxe design was defined as an IITV classroom system where the equipment required for two-way audio and video interactive instructional television has been installed into a standard classroom which has been remodeled into a tiered IITV classroom system design. The three design applications used in the study are based upon literature review and previous work conducted in this area. They represent only one of several possibilities for range of design and cost.

Using the designation of basic, intermediate and deluxe IITV classroom system design applications as a framework, this study addressed key research questions 1, 2 and 3 through an investigation and analysis of 14 specific research questions (specified below). Key research question # 1 was addressed through an investigation and analysis of specific research question I. Key research question # 2 was addressed through an investigation and analysis of specific research questions II - V. Key research question # 3 was addressed through an investigation and analysis of specific research questions VI through XIV.

Specific Research Questions

I Why choose IITV as an instructional technology?

II What are the design characteristics of:

i) a basic IITV classroom system?

ii) an intermediate IITV classroom system?

iii) a deluxe IITV classroom system?

III Which elements are common to all three designs?

IV Which elements are not common to all three designs?

V What are the advantages and disadvantages associated with each design?

VI How much does it cost to remodel a standard classroom into:

i) a basic IITV classroom system?

ii) an intermediate IITV classroom system?

iii) a deluxe IITV classroom system?

VII How much does it cost to equip:

i) a basic IITV classroom system?

ii) an intermediate IITV classroom system?

iii) a deluxe IITV classroom system?

VIII What are typical recurring and maintenance costs for the classroom equipment in:

i) a basic IITV classroom system?

ii) an intermediate IITV classroom system?

iii) a deluxe IITV classroom system?

IX a) As opposed to other transmission systems, why would an organization choose to use a:

i) fiber optic transmission system?

ii) microwave transmission system?

b) What are the characteristics, advantages and disadvantages of a:

i) fiber optic transmission system?

ii) microwave transmission system?

X What steps are involved in setting up a:

i) fiber optic transmission system?

ii) microwave transmission system?

XI What does it cost to establish a multi-point transmission system using:

i) fiber optics?

ii) microwave?

XII What are the major cost considerations of a:

i) fiber optic transmission system?

ii) microwave transmission system?

XIII What are typical recurring and maintenance equipment costs of a:

i) fiber optic transmission system?

ii) microwave transmission system?

XIV What are the costs associated with the ongoing usage of a:

i) fiber optic transmission system?

ii) microwave transmission system?

Significance of the Study

As indicated previously, individuals considering the development and implementation of an IITV system may not have ready access to the information essential for sound decision-making processes. This study provided an analytical comparison between three IITV classroom design applications and their respective supporting transmission systems, as well as the total costs associated with the creation and ongoing usage of such systems. The data obtained from doing this study should provide distance education planners with sufficient information to answer the three previously stated key research questions.

Glossary and Definition of Terms

Analog communication: A communication format in which information is transmitted by modulating a continuous signal, i.e. a radio wave. Physical quantities such as temperature are described as analog while computer data are discrete pulses or bits and referred to as digital.

Bandwidth: The range of frequencies an electronic communications channel can support without excessive deterioration. The more information a signal contains, the more bandwidth required. In analog communications systems bandwidth is often specified by frequency and is expressed in multiples of Hertz (Hz), as in kilohertz or gigahertz (ghz). While in digital communications systems bandwidth is often specified in multiples of bits per second, such as Kilobits (kbps), megabits (mbps), or gigabits (gbps).

Coaxial Cable: Shielded wire cable that connects communications components together. Because of its ability to carry multiple video (or other broadband) signals, coaxial cable is commonly used in cable television systems.

Bit: Stands for 'Binary Digit' - the smallest unit of information a computer uses. Bits are used to measure the speed of digital transmission systems.

Codec: Abbreviation of "coder-decoder". An electronic device that converts and compresses analog video signals into digital form for transmission, and reconverts the signal back into analog signals, upon reaching target destination.

Demodulate: The retrieval of an information signal from its associated carrier signal. Found in many analog transmission systems and equipment. Is the reverse process to modulation.

Digital: Discrete bits of information in numerical steps. A form of information represented by signals consisting of discrete steps, numbers or intervals in contrast to continuous analog information. Digital signals are often referred to as a stream of 1's and 0's (ones and zeros). Digital signals can be transmitted over the air or through metal fiber optic cable.

Digital communication: A communication format used with both electronic and light-based systems that transmit audio, video, and data as bits of information. Codecs are used to convert the analog signals to digital format and then reconvert the signal back to analog format. Digital technology permits communications signals to be compressed for more efficient transmission.

Duplex Microwave System: A microwave system capable of transmitting audio, video and/or data signals in two directions (two-way - in one direction and then back again).

FCC: Federal Communications Commission.

Fiber optics: Hair thin, flexible glass rods that use light signals to transmit audio, video, and data signals. These signals can be sent in either analog or digital format. Fiber optic cable has a much higher capacity than copper or coaxial cable, and is not subject to noise and/or interference. Transmission speeds of 90 to 150 megabits per second or approximately 1,000 voice channels per cable are possible.

Frequency: The number of times an electromagnetic wave cycle occurs in a given length of time, or the rate at which a current alternates. Measured in Hertz (Hz).

GHz: Gigahertz - One billion hertz (cycles per second).

Hz: Hertz - Basic measure of frequency of electromagnetic energy waves. A single hertz (Hz) is equal to one cycle per second. Conventional multiples include: kHz - kilohertz = 1,000 hertz; Mhz - megahertz = one million hertz; Ghz - gigahertz = one billion hertz

Initiating site: Also referred to as transmit site. *See* IITV.

IITV: Acronym for Interactive Instructional Television. A distance education delivery system that utilizes telecommunication technology to allow students and teachers who are separated by large distance to interact in real time via audio and video signal transmission provided by a two-way interactive television system. Video cameras, audio microphones, and video monitors installed in specially designed classrooms permit participants to see, hear and interact with each other. Sometimes referred to as Interactive Television (ITV), Interactive Video (ITV), videoconferencing or video teleconferencing.

ITFS (Instructional Television Fixed Service): A band of microwave frequencies reserved by FCC for the exclusive transmission of educational programming. This service permits broadcast of audio, video and data to receive sites situated within 20 miles of the initiating site. A converter that changes signals to those compatible with the standard television set, is required at each receive site.

MHz: Megahertz - million cycles per second.

Microwave: High-frequency radio waves used for point-to-point and omnidirectional communication of audio, video and data signals. Microwave frequencies require direct line-of-sight to operate; obstructions such as buildings or trees distort the signal.

Modulation: The process of encoding audio, video and data signals onto a radio wave (carrier frequency) for transmission.

Modulator: An electronic device which combines an information signal with a carrier signal just prior to transmission. Recovery of the information signal requires a demodulator which extracts the information signal from the carrier signal.

Multiplexor: A device that combines multiple signals for simultaneous transmission over a single channel.

Multi-point: Transmission of signals from one location to several other locations.

Point-to-point: Transmission of signals from one location to another location.

Real time communication: Two-way simultaneous communication, as opposed to asynchronous communication.

Receiver: A device used to receive transmission signals.

Remote sites: also referred to as receive sites. *See* IITV.

Simplex Microwave System: A microwave system capable of transmitting audio, video and/or data signals in one direction only (one-way).

Telecommunicated Distance Education: A form of technology-based distance education in which the learner is physically separated from the teacher in terms of location, but is linked by some form of telecommunicated medium that permits live, interactive audio and/or video exchanges between teacher and students.

Telecommunications: Communicating over a distance. Use of wire, radio, optical, or other electromagnetic channels to transmit or receive signals for voice, video and data.

Tiered: a series of rows placed one above another, or rising each above the preceding one; layered or bleacher style seating with either straight of fan shaped style or arrangement resembling an amphitheater.

Transmitter: A device used to transmit signals.

Video: A term relating the bandwidth and frequency spectrum required to electronically reproduce a picture

Summary

Rural educational systems are experiencing increased demands to ensure that students receive the same educational opportunities as their urban counterparts. In response to the increasing challenges, educational planners are turning to cooperative approaches involving distance education and technology, for solutions. One such approach is Interactive Instructional Television, otherwise referred to as IITV.

This study identified conditions under which IITV is an appropriate choice of technology for delivering instruction in the K-12 environment; presented an analysis of different IITV classroom system design applications and corresponding transmission systems; and provided estimates of the typical costs associated with the creation, as well as ongoing usage of such systems. This study provided answers to the following key research questions:

1) Why choose IITV as an instructional technology?

2) What should the design of varying IITV classroom systems include?

3) How much do the varying IITV classroom systems cost?

CHAPTER II

REVIEW OF RELATED LITERATURE

The purpose of this chapter is to review the literature relevant to the concepts that are central to this study. The information in this chapter is organized in the following sections:

(I) IITV Application

(II) IITV Classroom System Design Considerations

(III) IITV Classroom System Costs

Section (1) IITV Application

Two decades ago the technological options for delivering education over a distance were limited. Since then, a rapid expansion in the range and types of technologies available for use in education has occurred. Educational planners are now capitalizing on this increased availability by using cooperative arrangements between distance education and technology, to solve the challenges facing rural schools. Telecommunications technologies such as fiber optics, microwave, satellites, slow scan television, cable television, and microcomputer networking allow rural school districts to coordinate schedules and share resources, thereby providing an expansion of curricular offerings and educational opportunities for students (Barker, 1987; Kitchen & Russell, 1987).

Rural education planners opting to use telecommunications technology to provide alternative instructional delivery system for students have a variety of technologies from which to choose. With so many available, how does one know which one to choose ? According to Kitchen (1988), “there are several factors that must be considered when developing an alternative delivery system" (p. 73). These factors include: educational effectiveness, efficiency, and long-range goals and objectives (Kitchen, 1988).

The issue of IITV application can be examined by considering each of these factors, as it relates to an IITV system. The educational effectiveness and efficiency of an IITV system can be ascertained by asking the questions: Do students learn via an IITV system as well as in a traditional classroom? and Does the benefit of the system justify its costs? Whether an IITV system assists the educational institution achieve its long-range goals and objectives can be ascertained by asking the question: Does the system provide flexibility and efficacy in meeting the educational institutions goals and objectives? (Kitchen, 1988). Kitchen's questions can be rephrased to ensure that answers will include more than a simple "yes" or "no" response.

The rephrased questions include: How does learning via an IITV classroom system compare with learning in a traditional classroom? How do benefits and costs of an IITV classroom system compare? and To what extent does your IITV classroom system provide flexibility and efficacy in meeting the educational goals and objectives?

<u>How does learning via an IITV classroom system compare with learning in a traditional classroom</u>? In a survey of three high schools that used an IITV system, Nelson (1985) reported that students perceived little difference between the interactive instructional television class and the traditionally taught class. Additionally, teachers reported no significant differences in the students' test scores, grades, and participation when comparing sections of IITV classes with classes taught in the traditional classroom (Nelson, 1985).

Whittington's (1987), review of the general distance education literature led to the conclusion that students taking courses via interactive television achieve, in most cases, as well as students taking courses via traditional methods. According to Whittington "live, interactive televised instruction is that which is offered via satellite or microwave delivery systems in real time to students who have immediate talk-back capability with the instructor" (p. 47).

Other studies (Beare, 1989; and McCleary & Egan, 1989) focusing specifically on interactive instructional television revealed that there are no significant differences between the learning outcomes of students in face-to-face instruction and those of students in instruction mediated by IITV. This finding of no significant difference among technologies has resulted in some researchers claiming that medium does not really matter. Clark (1983), conducted a meta-analysis of research reviews considering the impact of medium on learning and concluded that "there are no learning benefits to be gained from employing any specific medium to deliver instruction" (p. 445). Clark argues "that media do not influence learning under any conditions" (p. 445). In situations where a noticeable change has occurred after the introduction of a specific medium, Clark attributes this change to "a curricular reform that accompanied the change," as opposed to the medium. Nadel (1988), concluded that students learn from any medium, regardless of whether they are in or out of school, whether they intend to or not, providing that the content of the medium leads them to pay attention.

In a review of research on learning with books, television, computers, and multimedia environments Kozma (1991), attempts to refute Clark's and Nadel's assertions. According to Kozma the "capabilities of a particular medium, in conjunction with methods that take advantage of these capabilities, interact with and influence the ways learners represent and process information and may result in more or different learning when one medium is compared to another for certain learners and tasks" (p. 179).

How do benefits and costs of an IITV classroom system compare? One way of examining the issue of cost versus benefit is to review the alternatives. For many small rural school districts survival in the face of high transportation costs, declining enrollment, increased state graduation requirements, and decreased state funding relies on the sharing of teaching expertise among districts (Kitchen & Russell, 1987). Hobbs (1993), concurs that "for many schools, the ability to technologically share teachers may mean the difference between closing the school-and therefore the community-and remaining a viable educational entity" (p. 3).

Another way to determine whether the benefits of an IITV system justify its costs is to examine its advantages and disadvantages, in light of costs. Barker, Frisbie & Patrick (1989) assert that although pricing is definitely important, the potential for interactive teaching/learning and the fact that geographically dispersed student bodies can be served simultaneously are appealing advantages of IITV. IITV establishes a visual connection among participants which enables students to hear, see, and to communicate directly with the teacher (Pirrong & Lathen, 1990; Reed & Woodruff, 1995). Since the teacher can see and hear remote learners in real time, conversation and body language can be used to enhance communication. Frequent interaction increases understanding and encourages more personalized instruction. IITV allows for interactive teaching strategies such as questioning and discussion which can also help engage and motivate students by encouraging them to become active participants (Reed & Woodruff, 1995).

There is considerable disagreement and debate concerning whether or not this visual connection is an advantage, considering the costs. According to Garrison (1990), the audio interaction which serves as the basis for much of distance education delivery today is "the true interaction" (p. 16). Walcott (1994), agrees that "while some distance education systems use interactive television and satellite transmissions to provide greater options for visual interaction, audio communication is the mainstay of these telecommunications systems" (p. 135). According to Garrison (1990), "interactive television is really audio teleconferencing enhanced with a live television image of the instructor" (p. 16). In Garrison's opinion the video in interactive television systems is too often seen as the primary means of communication and the audio (i.e. the true interaction) is viewed only as an adjunct.

Disadvantages of IITV include "enormous cost associated with the technical set up, production, and transmission; the technical coordination, production, and delivery of a video conference for educational purposes is beyond the capabilities of most educators; and the triability, or degree to which video conferencing can be experimented with, is clearly much more limited than audio teleconferencing" (Garrison, 1989, p. 74).

According to Barker (1991), IITV increases the potential for student-to-student interaction. In contrast to instructional delivery systems that focus on an individualized instructional model, IITV focuses on small groups or clusters of students at different locations networked together for real-time, two-way audio and video interaction. Use of audio and/or video bridge to link several distant sites simultaneously with each other and with the host instructional site allows students an opportunity to interact not only with their teacher, but also with other students at different sites (Barker, Frisbie & Patrick, 1989; Barker & Taylor, 1993). The opportunity for student-to-student interpersonal communication and social interaction is significant because "the prospect of student-to-student exchanges not only increases the likelihood of socialization between students but also fosters the potential for peer tutoring and small group study" (Barker, Frisbie & Patrick, 1989, p. 24).

The need for interactivity in distance education is another area of considerable disagreement and debate. Based on a review of the research literature Threlkeld & Brzoska (1994) conclude that “the research literature doesn’t confirm the need for live or synchronous interactivity in distance education. It’s impact on learner outcome is elusive, at best” (p. 49). In noting this, however, Threlkeld & Brzoska do acknowledge that “live distance education with synchronous interaction, even if not used, is desired by some students and administrators” (p. 49). This is attributed to synchronous interaction making “us feel more connected, as part of a “class.” Live, interactive learning is what we are familiar with, it’s “school” (Threlkeld & Brzoska, p. 48).

While comparing training effectiveness and user acceptance of live instruction and six different alternative Instructional TV (ITV) technologies, Simpson, Pugh and Parchman (1993) found that the most successful ITV technologies were those allowing continuous 2-way audio communication between classrooms with either 2-way or 1-way video. “Student test performance was poorer with ITV systems that restricted remote students’ ability to converse with or see the instructor and the performance decrement was evident in both local and remote classrooms” (Simpson, Pugh and Parchman, 1993, p. 147). The findings of Moore & McLaughlin (1992), and Chavkin, Kennedy & Carter (1994), support this: “ the interaction among participants is the key to the success of distance learning because nonverbal communication cues are important for the instructor as well as the other students” (p. 1) and “one-way video and audio with a talking head does not allow for student interaction” (p. 30).

Oliver (1994), asserts that “interaction doesn’t just happen” (p. 184). Interaction “must be a clearly articulated component of the televised session’s overall design. The instructor must employ purposeful strategies to initiate interaction” (Oliver, 1994, p. 184).

According to Kitchen & Russell (1987), interactive instructional television is a tool for providing students choices of classes that, ordinarily, one district would not feasibly be able to offer, such as low incidence, or advanced classes. One teacher can, over a two-way interactive system, reach the students in several districts by instructing from a home site to two other remote sites. Through the technology, the teacher can see and hear all students as clearly as they can see and hear him or her. Instead of just a handful of students at one site, the combination of students from several sites makes the course offerings possible (Kitchen & Russell, 1987, p. 55). Hobbs (1993), concurs that “an interactive television class consisting of 2,1,5, and 3 students, for instance, at four different high schools can combine for much greater student interaction, joint problem solving, and better educational dynamics than a single class of 1-3 students” (p. 3).

Libby (1993), and Droegemueller (1993), identify other advantages of IITV to be reduced cost, productivity gain, increased communication and the ability to set higher goals in education. Libby explains that reduced cost is evident through the travel money saved and productivity is increased because the time saved in not traveling can be used to work. Through the use of IITV, small rural school districts are able to cooperate and share low-incidence courses without busing students or moving teachers from one school to another (Lundgren, 1985). Costs associated with busing students can be quite high. Not only are the actual transportation costs a consideration, but the costs of purchasing buses and ongoing maintenance, as well. Additionally, students cannot be on a bus and in the classroom at the same time. “Time spent on buses is educationally nonproductive” (Lundgren, 1985, p. 17). Hobbs (1993), concurs that through the use of IITV “schools can share in the services of a single teacher in advanced or hard-to-fill positions without the prohibitive time loss and inefficiencies involved in transporting either students or teachers” (p. 3).

Doncaster and Walker (1996), claim that IITV can help to bridge the equality gap between rural and urban schools. Rural schools no longer have to be remote. Smaller schools can begin to access many of the learning/teaching resources and programs currently available in larger urban schools. IITV removes the distance between communities and educational resources and permits students to continue their education in the home community (Doncaster & Walker, 1996). Some examples are as follows: An IITV network was established in Bergen County, New Jersey, because school officials, concerned about maintaining their high academic standings, wanted to add new programs and preserve special curriculum even though declining enrollments were making such courses unjustifiable from a cost standpoint. “County educators wished to maximize student access to master teachers; at the same time, they sought to reduce the costs and administrative burdens involved in transporting students from school to school for special programs” (Daley, 1991, p. 15).

The major challenge for rural Minnesota public schools was to cut the budget without sacrificing the quality and quantity of academic course offerings (Kitchen & Fredericksen, 1987). Gaylord Community School with a population of 600 K-12 students met the challenge by utilizing IITV. In planning the project, technologies considered besides IITV included computer links, satellite dishes, video-disc instruction, and expansion of current computer-assisted instruction. IITV emerged as the best option (Kitchen & Fredericksen, 1987). An IITV system linking four school districts offers students a quality option to bussing and traditional rural educational course opportunities. The IITV network has proven to be a cost-effective delivery system that has not only enhanced educational opportunities but public relations opportunities, as well. “It has increased flexibility in teaching assignments and reduced the number of study halls all without raising taxes or consolidating” (Kitchen & Fredericksen, 1987, p. 25).

Bradshaw & Brown (1989), report that “in a thorough 1987 evaluation, K. Kitchen found that despite two-way television’s expense in Minnesota, it is cost-effective” (p. 3). Bradshaw & Brown explain that “through cooperation, sharing expertise and resources, Minnesota districts have been able to offer an enlarged curriculum and have expanded community and adult education. In some instances this resource sharing has allowed small rural districts to survive” (p. 3). Descy (1991), concurs that IITV has helped Minnesota expand course offerings in places where a critical mass of students do not justify the money to pay a teacher to teach a course. According to Descy, “interactive television technology also enables small, isolated school districts to meet minimum state curriculum requirements as well as offer enrichment courses that would otherwise not be available” (p. 45).

To what extent does your IITV classroom system provide flexibility and efficacy in meeting the educational goals and objectives? Small networks in Minnesota, Illinois, and Oklahoma (Barker, 1989; Kitchen, 1987; and Robinson, 1985) were among the first rural schools to report success in working with IITV systems. “Interest and participation by rural schools in two-way interactive TV systems has grown rapidly in recent years making it difficult to accurately document all those that are currently in the planning stages or actually in operation” (Barker & Taylor, 1993, p. 5). With this in mind, the following is an overview of the IITV projects reported in the literature.

Since 1981, the member schools of Project Circuit (Curriculum Improvement Resulting from Creative Utilization of Instructional Two-way Television) have been offering classes over two-way television in an effort to link a group of isolated, underserved school systems in rural Wisconsin. Through the use of IITV, Project CIRCUIT has attained several of its goals: “the enrichment of the curriculum through pooling of resources to offer limited-demand classes to students who otherwise would be unable to take advantage of them” (Hagon, 1986, p. 20). The project has also saved several programs and extended opportunities in others (Hagon, 1986).

Nelson (1985), reports that in rural Iowa, IITV is used to meet the following goals: to provide students with an opportunity for a quality education and to offer districts a viable alternative to consolidation. The network was established “because transporting students and/or exchanging teachers to meet these goals was not feasible” (p. 38).

Another Iowa IITV project which began in 1987 is The Star Schools Program. This program was developed “to encourage improved instruction in mathematics, science, foreign languages, literacy skills, and vocational education for underserved populations through the use of telecommunications networks” (Simonson, Sweeney & Kemis, 1993, p. 25).

Throughout the western region of the United States and other parts of the country educators are discovering that when designed and implemented well, live two-way instruction across long distances can expand curriculum, stretch budgets, and broaden student horizons, improving both teaching quality and student performances (Bradshaw & Brown, 1989).

In Kansas, education leaders from four southwest school districts used IITV to achieve the following goals: “to create new learning opportunities for students; to build a win/win partnership with business and industry; to bring communities closer together while reducing the travel between towns" (Droegemueller, 1993, p. 2). IITV is viewed as a means of keeping the community alive and together. This means that schools remain intact and consolidation is avoided (Droegemueller, 1993).

Section Summary

This section presented a review of the literature concerning IITV application. The literature tends to suggest that IITV is chosen as an instructional technology because: studies reveal that students taking courses via IITV achieve, in most cases, as well as students taking courses via traditional methods; and the benefits of IITV to rural school divisions outweigh its costs (i.e. the provision of equal educational opportunities for students and the assurance of rural school district survival, as well as the simultaneous delivery of interactive teaching/learning strategies to geographically dispersed student bodies).

Section (II) IITV Classroom System Design Considerations

The following is a synthesis of characteristics identified by various authors as important considerations/issues for planning the design of a IITV classroom. These characteristics have been grouped into five main categories: physical, environmental, furniture, equipment and classroom management considerations.

Physical Considerations

Classroom size. According to Gunther (1989) "the standard classroom is about 32 feet by 24 feet" (p. 20). Since the interactive instructional television classroom could be a sending or remote location housing anywhere from one to twenty-five students, Gunther recommends that the standard classroom size be used.

"Overall class size will have a direct impact on opportunities for student interaction" (Barker, 1989 p. 401). Consequently, Barker recommends that two-way TV system classes not exceed 20 students total. By keeping classes small, students will interact more readily and use the system more fully (Lanier, 1986).

Gregg & Persichitte (1992), propose that "classroom length should be one and one-half times the width. Rectangular shapes are more conducive to viewing angles and acoustics than are square shapes" (p. 5). Hughes (1988), concurs that the ideal IITV classroom is longer than it is wide. Recommended ceiling height is 12 feet (Allen, 1991).

Location of the Room. Plans to develop a network of interactive instructional television involve the decision of whether to make the IITV classroom dedicated or non-dedicated. A dedicated IITV classroom is one which is used solely for the purpose of IITV course delivery. During the off-hours, the dedicated IITV classroom is 'dark' as opposed to having non-IITV classes scheduled (Gunther, 1989). "In many schools, principals are hard pressed to give up a space to be devoted solely for its use" (Gunther, 1989, p. 20). However, Gunther asserts that the following concerns justify the decision to avoid using the room for other purposes: "thousands of dollars of equipment are at risk as uninitiated students and teachers traffic through the room; umbilical cords from these babies snake across the floor ready to trip the unaware; and furniture arrangements must be 'just so' to provide access paths for the floor camera, and to provide well-staged television pictures of teachers and students" (p. 20).

Hughes (1988), recommends that the IITV classroom "be located in an area where there is indirect supervision potential, such as near a library, media center or principal's office" (p. 10).

To improve acoustic weaknesses choose locations in a quiet area of the building (Carl & Densmore, 1988). "Best efforts should be made to stay away from restrooms, vending machines, lobbies, plaza areas and elevators" (Gregg & Persichitte, 1992, p. 4). Gunther (1989), suggests that "one sound idea is to have the room near the media center" (p. 22). The reason for this as suggested by Gunther is "the interactive teacher needs many audio and visual resources, and that's where they are" (p. 20).

Electric Service. Electrical service for the IITV classroom can be a complicated problem that requires careful forethought and competent installation (Gregg & Persichitte, 1992). Since the hardware system cable structures are sensitive to electromagnetic fields, heat, vibrations, surges and spikes, Cogliano (as cited in Gregg & Persichitte, 1992) recommends that "the classroom wiring system should not be located near compressor motors, blower motors, elevator motors, heating, ventilating or air conditioning systems/wiring structures" (p. 3).

Situations where a standard classrooms is being remodeled for IITV purposes necessitate minimal alterations to the existing wiring because, according to Jones (1992), most classrooms will have adequate wiring for IITV classroom equipment. It is necessary, however, to determine the power requirements for all equipment so that the technician can verify that there are sufficient outlets and amperage levels. General rules to follow, as outlined by Jones, are as follows: “(a) unless it is a special circuit, do not put more than five items to a line, and (b) always isolate a computer on a separate line from other equipment” (p. 83).

To increase effectiveness and minimize system failure, inner liners or separate conduit for each connection, as well as the installation of surge/spike protectors are useful alternatives. The best option, according to Gregg & Persichitte (1992), is to service IITV classrooms through a set of dedicated circuits with the breaker panel installed in the classroom and clearly labeled to indicate the control function of each breaker. Provision for future increases in the need for electrical service can be made by including additional capacity in the breaker panel (Allen, 1991).

“When complete, these classrooms will have complex networks of wiring that may or may not be connected to permanently fixed structures” (Gregg & Persichitte, 1992, p. 3). A maze of cords attached to various electronic equipment “will snake across the floor ready to trip the unaware” (Gunther, 1989, p. 20) unless precautionary measures such as the installation of a wooden sub-floor have been instituted. According to Gregg & Persichitte, sub-floor installation also permits access to floor wiring structures for upgrading and/or repair. Gregg & Persichitte further recommend that “access to ceiling wiring should be through suspended ceilings" (p. 3).

Classroom Arrangement. Classroom arrangement is influenced by the course content to be delivered, the instructional style, the number of learners and the technology to be used (Price, 1991). Anderson (1996), suggests that IITV classrooms should be designed to be as flexible as possible and cautions those designing these types of classrooms to “avoid the tendency to ‘nail things down’ such as the use of fixed seating, where tables are attached to the floor” (p. 18).

According to Jones, Simonson, Kemis & Sorenson (1992), IITV classrooms have few possible arrangements because “participants must be seated in relation to cameras and microphones, thus limiting the configuration of the room and the size of the groups” (p. 10). Additionally, “students should be seated so they can see each other and not have to turn to face the camera” (p. 10).

Other issues to consider when arranging an IITV classroom include:

-The number of viewers to be served by a single monitor. The rule of thumb is one viewer per diagonal inch of picture width. Thus a twenty-inch monitor can serve about twenty participants (Price, 1991).

- The maximum viewing distance is usually given to be twelve times the width of the monitor screen, and the minimal viewing distance is given to be somewhere between four feet and seven feet (Price, 1991).

- The vertical angle of view is also important. A viewer should not have to look up at an angle greater than 30 degrees. Looking upwards at a sharp angle for long periods of time can be tiring and uncomfortable. Avoid placing the monitor in a corner. This diminishes the importance of the material being presented and can create awkward viewing angles for the participants (Price, 1991).

According to Gunther (1989), "only one door should be used. It should be in the back of the room so that visitors do not become a distracting part of the telecast" (p. 20). Gregg & Persichitte (1992), concur by stating that "doors should be situated to be outside of the camera view range; usually at the back of the classroom" (p. 4). However, Hughes (1988), in opposition with these authors, recommends that the student camera in each IITV classroom be placed "so that the camera can not only monitor all students, but the IITV classroom door as well. This will provide teachers with a method for determining who enters or exits the classroom during each class" (p. 15).

Decor. The aesthetic considerations of the distance education classroom are fairly subjective (Jones et al., 1992). Nonetheless, these authors go on to assert that the following details do affect quality: "background colour is particularly important for two-way video-systems; there should be no complex patterns. All surface finishes should be none glare. Materials such as chrome, glass, and shiny plastics create distracting glare that can be reflected onto monitor screens" (p. 9).

Windows/Walls. If windows are present, they should be covered with drapes equipped with cord tighteners. Drapes will provide some control over light and acoustic problems (Gregg & Persichitte, 1992). Window coverings and walls should be mid-spectrum colours, i.e. tans, light blues or grays. Wood trims should be light to medium tones (Price, 1991). Gregg & Persichitte recommend that "the colour white and obvious patterns should be avoided" (p. 7).

Floors/Ceilings. According to Gregg & Persichitte (1992), "maximum audio application is facilitated by carpeting floors" (p. 7). Gregg & Persichitte further suggest that: "floors should be smooth and free of wiring and cords; floor colour should be light to medium and should contain some type of subdued pattern or fleck; and ceilings should be light coloured and made of non-reflective materials" (p. 7).

Private Conference Area. IITV classrooms are not particularly conducive to individualized learner/instructor contact (Gregg & Persichitte, 1992). As a result, Gregg & Persichitte recommend that a corner of the classroom be partitioned off to create a small, private conference area, equipped with a camera, small monitor, and headset, so that it will allow the instructor the ability to have a private conference with a remote site student.

Storage. "Each classroom should provide an adequate and secure storage area for peripheral instructional equipment, as well as, materials needed on a repeated basis" (Gregg & Persichitte, 1992, p. 8).

Security Considerations. While items in educational facilities occasionally disappear, electronic equipment, because of its expense and easy portability, is much more likely to disappear than other types of equipment. IITV classrooms contain an extensive inventory of electronic equipment that can quite literally "walk" if additional security provisions have not been instituted. Gunther (1989), offers the following security measures: "rooms with limited access ease the problem; fewer doors and windows are wise; providing locks with dead-bolts on all doors is a good practice; and metal flanges covering the door cracks from the outside can prevent break-ins" (p. 10). Allen (1991), recommends that "all equipment be clearly marked in such a way as to make the identification difficult to remove" (p. 27).

Environmental Considerations

Ventilation/Temperature Control. IITV classroom instruction relies heavily on the use of various electronic equipment. All of which generates heat and can be damaged by a high temperature environment (Gunther, 1989). While it is necessary to have an HVAC (High

Volume Air Circulation) system in support of this equipment, the circulation of air should not be achieved at the expense of controlling the background noise of the HVAC system or the effective usage of the delivery system. Diffusers and acoustically lined duct-work are options to consider (Gregg & Persichitte, 1992).

Student comfort is promoted by controlling the heat and cooling of the room. “Thermostats in the classrooms should keep temperatures at 65-68 degrees Fahrenheit in winter and at 72-74 degrees Fahrenheit in summer. Humidity levels should, if possible, be maintained at close to 50 percent” (Owu, 1992, p. 17).

Audio Considerations. According to Garrison (1989) and Price (1991) the most often-reported physical complaint of participants in video instruction and teleconferences is the quality of the audio. With this in mind, Price suggests that every audio system component should be of the highest quality possible. However, a high quality audio system is doomed to failure if the classroom possesses poor acoustical properties. According to Price “the goals of good acoustic design are to keep out exterior noise, limit extraneous noise and control echoes between walls, floors and ceilings” (p. 15). Some issues pertaining to these goals are covered in previous sections, however there are several additional factors to consider.

Exterior noise can enter anywhere air can. To eliminate exterior noise influences, Price (1991) recommends that “all holes and gaps in or between walls, floors and overhead structure should be filled and sealed” (p. 15). Price claims that walls must extend above suspended ceilings to the roof or floor structure above, while Jones et al. (1992) recommends that walls (floor and ceiling included) should also be sound resistant, constructed of such dense materials as concrete, solid masonry or double layers of gypsum board. Price cautions that windows should be avoided if possible. But if they are present Jones et al. recommend that windows should be double pane. According to Price doors should be of solid construction and equipped with floor sweeps and weather stripping.

Interior Noise is generated by television monitors, furniture, ventilation systems, fluorescent lights, and other equipment (Price, 1991). The primary source of interior noise, according to Price, is the ventilation system, which is essential for satisfactory health and comfort. To reduce the distraction of the ventilation system, Price recommends the selection of grilles and registers which do not constrict the flow of air into the space, and duct work that is lined with acoustical materials. Since systems that cycle on and off during viewing sessions can be very distracting and may require participants to make adjustments to the audio, Price suggests that "ventilation systems should run constantly at a low pressure, if possible" (p. 16).

Video monitors can be problematic because of the buzzing noise, sometimes emitted. Price (1991), recommends that professional monitors designed for extended use and high performance should be furnished in heavily used facilities.

"***Echoes*** or sound reflections within a space are a major concern for speech intelligibility. In fact, Doug Wilkens of the Pierce-Phelps Company, a major provider of video system and facilities, considers echo control the most important design aspect" (Price, 1991 p. 16). According to Price the installation of floor carpeting, acoustical ceiling tile and acoustical wall coverings over non-parallel walls are effective methods for echo reduction.

Echo-suppressing electronic systems, developed to reduce the need for special room treatments, are currently being marketed. However, Price (1991) claims that "these systems are not totally effective" (p. 16).

Lighting considerations. According to Gregg & Persichitte (1992), control of lighting is an important consideration within IITV classrooms. Gregg & Persichitte elaborate by stating that “good lighting designs permit fixtures to be selectively switched off or dimmed and include provisions for a highly concentrated light source at the instructor lectern” (p. 10). "For most purposes, common fluorescent light fixtures provide adequate and economical lighting" (Jones et al., 1992, p. 10). Cool white lights promote visual comfort; recommended levels are 30 to 100 foot-candles. “Light levels at the remote sites need only be high enough to provide a good out-going camera image” (Gregg & Persichitte, 1992, p. 10).

While television viewing is best in normal light or a slightly dimmed room, natural light originating from windows and skylights is usually too bright for television monitors and can create glare on screens (Jones et al., 1992). One way to control this, is to drape or face the monitors away from windows. Nevertheless, for television cameras to capture images they require light; normal room lighting is usually sufficient (Jones et al., 1992).

Furniture Considerations

Seating/Desks. “Individual comfort and appropriate style should be the highest priority” (Jones et al., 1992, p. 10). Learners and teachers should have comfortable seating. Individual, cushioned, moveable chairs provide a major, positive, critical attribute of optimal IITV classrooms. Upholstery should meet previous colour guidelines, be non-reflective, and hopefully, be aesthetically pleasing” (Gregg & Persichitte, 1992, p. 7). For extensive note taking or working with materials, learners should be provided with 20-24 inch wide tables (Jones et al., 1992, p. 10).

Instructor Area/Teacher Station. According to Jones et al. (1992), the teacher station in classrooms for IITV can be of various forms: table, desk, lectern, console, or special built podium, all of which should be designed to face the students. "The instructor area should be designed to accommodate the hardware controls which the instructor will need to access within the lectern" (Gregg & Persichitte, 1992, p. 8). Putting the area on a riser increases visibility (Minnesota State Department of Education, 1990). Having the instructor control all equipment negates the need for extra technical personnel. This promotes an instructional format similar to the traditional classroom, and as a consequence teachers do not need to completely alter teaching strategies (Currer, 1991).

Operational success of the IITV classroom is dependent upon the instructor having full control of lights, cameras, monitors and the different types of auxiliary equipment. “If the instructor controls the equipment, there is no need for extra technical personnel” (Jones et al., 1992, p. 10) Therefore, easy access to remote control devices, switching mechanisms and the presentation stand is essential.

Gregg & Persichitte (1992), make the following recommendations, in relation to the IITV classroom instructor area: “an adjustable, cushioned stool should be available; the instructor should be able to view off-site monitors on the same line of sight that the instructor camera is set on; and finally, blackboards and whiteboards do not emit quality video transfer, and should not be included in 2-way telecommunications classrooms” (p. 8).

Equipment Considerations

The Minnesota State Department of Education (1988) suggests that when implementing IITV the classroom equipment and installation at all site should be standardized and offers the following rationale:

- it allows the teacher to teach from any classroom without making adjustments;

- it allows the educational facility involved with project to maintain a minimum inventory of backup equipment when breakdowns occur. If the equipment is the same from facility to facility, the defective component can quickly and easily be exchanged with the spare unit; and

- it allows the teacher to verbally instruct students to correct or adjust equipment via the telephone or interactive system, since he or she is familiar with the equipment at all sites (p. 31).

Microphones. As cited previously, Price (1991), reports that “the most often-reported physical complaint of participants in video instruction and teleconferences is the quality of the audio” (p. 15). To counteract this, Price recommends that each component of the audio system should be of the highest quality. Jones et al. (1992), advise that "directional or cardioid microphones are best" (p. 10).

Besides the previously discussed problem of echoes, another common problem associated with audio systems is feedback. "Feedback is caused when microphones pick up sound from the speakers, producing overamplification and a piercing squeal from the speaker" (Jones et al., 1992, p. 10). A potential for this problem exists “any time open microphones and open speakers are in the same room” (p. 10). To alleviate this, Jones et al. advise “separating the microphones and speakers” (p. 10).

Karpiak (1995), recommends that each IITV student station be equipped with a low-profile microphone which is controlled from a panel at the instructor's podium. These microphones, which are left open if the instructor selects the 'discussion mode' or 'conference mode', permit immediate and continuous interaction among all learners and instructors at all classroom locations by means speaker systems mounted on the wall. In the 'class mode' only the instructor's microphone is on, while the learner microphones are off to prevent sound interference created by paper shuffling and page turning at the desks. The microphones can be turned on individually by the instructor on a 'first come, first served' basis when the instructor is alerted by a sound signal and a red light on the learner's monitor as soon as the question button has been pushed.

Besides proposing that a fixed microphone be situated at the instructor's podium, Karpiak (1995), also suggests that the instructor should have the option of wearing a small radio microphone, referred by Ivanovic (1995), and (Fink and Tsujimura, 1991), as a lavaliere microphone. This type of microphone permits more physical freedom.

Alternatively, one IITV network, The Panhandle Share-Ed Video Network in Beaver County, Oklahoma, uses a “live” microphone that is mounted overhead, above the student area. “Students talk in a normal voice which is picked up by the overhead microphone and transmitted over the entire system” (Barker, 1989, p. 121).

Other IITV networks (i.e. the Iowa Communications Network [ICN] use push-to-talk microphones for students at all sites, to interact (Ivanovic, 1995). While still others (i.e. Bloomington/Indianapolis) use “directional” also referred to as “voice-activated microphones” for interactive instruction (Fink and Tsujimura, 1991). These microphones remain closed until someone speaks near them. According to Fink and Tsujimura (1991), voice activated microphones offer one problem in that they turn on whenever they sense *any* type of sound nearby. Fink and Tsujimura elaborate by stating “at times, it is not a student’s voice that triggers a microphone, but some paper rustling, or some books sliding, or some other distraction” (p. 50). Consequently, students must be reminded to minimize excessive noise near the microphones.

Cameras. The majority of IITV classrooms are equipped with three cameras: one to show the instructor/presenter, one to show the students in the classroom, and a third focused on the presentation area on the front desk (Ivanovic, 1995). Some classroom systems include a fourth camera directed at the students. The end result is two student cameras; "one shoots the students on one side of the room"; while the other "shoots the students on the other side of the room" (Fink & Tsujimura, 1991, p. 49).

Both Hughes (1988), and Minnesota State Department of Education (1988), recommend remote zoom and auto focus controls for cameras. "Remote tilting and planning can also be added as extra features" (Jones et al., 1992, p. 11).

An alternative to the previously identified options for camera placement is the strategic location of two automatic colour cameras focused on the front of the room which permits the instructor to move freely from the podium to the whiteboard, yet remain in continuous view of the remote students (Karpiak, 1995). "Switching from one camera to the other takes place automatically by means of passive infrared sensors. A third camera with a wide-angle lens, positioned on the front wall, projects a full view of the class to the opposite classroom" (Karpiak, 1995, p. 385).

Monitors. Most IITV classrooms have 21-25 inch monitors (Barker, 1989; Minnesota State Department of Education, 1988). Some systems use large screen projectors (Fink & Tsujimura, 1991), while others use a split screen to present the view from two cameras, whereby the instructor is shown on one side of the screen and the visuals on the other side of the screen (Fink & Tsujimura, 1991).

Hughes (1988), asserts that the split screen makes remote sites even smaller and seemingly more remote. Hughes recommends that an additional 25 inch monitor be used as opposed to splitting the screen.

Visual Presenter. With a function similar to that of an overhead projector, the visual presenter is situated in the instructor's area/station, usually to the right of where the instructor stands. “A colour camera in the device projects photographs, charts, maps, and three dimensional objects. The camera has the ability to zoom in on the platform where the materials are placed and functions similarly to the overhead camera” (Jones et al., 1992, p. 11).

Telephone. Telephone wiring should be included with thought given to the possibility of future requirements for increased voice, data and video transmissions. “Multiple phone jacks should be accessible in various classroom locations” (Gregg & Persichitte, 1992, p. 4).

The Minnesota State Department of Education (1988), suggests that provision be made for classroom telephones, preferably with a direct line out of the building and offers the following rationale:

- it allows the teacher to maintain student contact during system failure;
- it allows the teacher the ability to communicate between classroom sites to correct system problems;
- it allows the teacher and student an opportunity to carry on a semi-private conversation without losing visual and audio contact with remote or host site students; and
- it allows the teacher a direct link to a remote site to alert the educational facility to a discipline problem in the remote classroom.

Facsimile Machine. Since it allows the teacher or student to transmit hard paper copy of material between remote locations in 30 seconds and permits immediate feedback for tests and/or corrected assignments, a facsimile machine is a strongly recommended addition to the IITV classroom (Minnesota State Department of Education, 1988). Gregg & Persichitte (1992), suggest that “a facsimile may not be necessary if there is a dependable delivery service or a traveling teacher or administrator” (p. 11).

Videocassette Recorder (VCR). The Minnesota State Department of Education (1988), advises that a VCR can be used to record class sessions for any/all of the following purposes:

- to be used by a student who has absent;
- as a backup in case of technical difficulty;
- to provide a record of student behaviour;
- to be reviewed by the instructor for self-critique; and
- to record special class sessions for future use.

Lochte (1993), recommends having at least two VCRs, one to play back and one to record. A further suggestion is to ensure that both are the same make and model so that the remote controls will start and stop either machine. “The least expensive VHS models that are the easiest to operate are the best choices” (Lochte, 1993, p. 88).

Auxiliary Equipment. Classroom presentations could require the use of a videodisk player, a videocassette player, a tape recorder, or a record player. According to Jones et al. (1992), “this equipment can be located in the room on a cart and plugged into the system as an auxiliary input” (p. 11). Jones et al. further state that “films and slides may also be shown as an in-class presentation by projecting the film or slides onto a projection screen and focusing the teacher, student, or visual presenter camera on the screen" (p. 11-12). Jones et al. recommend that "if there are many slide and film presentations planned, slide/film to video converters should be purchased" (p. 12).

Computers. Computer monitors differ from television monitors in both resolution capabilities and scan rates. Consequently, use of computer monitors as an auxiliary input warrants specific types of equipment. "Special equipment is needed to interface the two types of video. Output from high resolution computers must be converted down to the NTSC video standard, or multiscan monitors must be used" (Jones et al., 1992, p. 12).

Classroom Management Considerations

The very nature of IITV classrooms, wherein the remote sites lack the *physical* presence of a teacher, can result in the management of students becoming an important issue. To avoid disruption in the effective management of remote site classrooms, Kitchen & Fredericksen (1987), make the following suggestions: placing a set of monitors in each principal's office and in the superintendent's office; equipping each IITV classroom with a telephone that requires the push of only one button to call the remote site school district of the student who is causing a disturbance; and equipping the IITV classroom with a VCR to record offensive behavior for corroboration at a later time.

Section Summary

This section presented a review of the literature written concerning IITV classroom system design considerations. Literature tends to suggest that IITV classroom system design is an important issue in that a properly designed classroom will enhance content objectives and increase acceptance by teachers and students.

Section (III) IITV Classroom System Costs

The information presented in this section is organized in the following categories: an overview of technology system costs; initial and ongoing costs of the IITV classroom; an overview of supporting transmission systems with particular focus on microwave and fiber optic systems; an overview of supporting transmission costs; initial and ongoing costs of a microwave system; and initial, as well as ongoing costs of purchased and leased fiber optic systems. To simplify matters and for comparative purposes, all dollar figures presented in the remainder of this document, have been converted to Canadian dollar figures.

Costs of Technology Systems - An Overview. "There are no simple formulas to help estimate the cost of a technology system" (National School Boards Association, 1989, p. 10). Support for this assertion is provided by the U.S. Congress, Office of Technology Assessment [OTA] (1989), which states "the costs of distance learning technologies are difficult to analyze because technological options are so varied and are changing so rapidly" (p. 79). While more powerful today than in the past, the technologies used in distance education offer improved performance and advanced capabilities. This coupled with the fact that costs for component electronics of these technology systems are declining, has resulted in technology systems which are increasingly less costly for the capabilities they offer teachers and students (U.S. Congress, [OTA], 1989).

According to the U.S. Congress, [OTA] (1989), schools implementing distance learning systems have two types of costs: initial and ongoing costs. Initial costs include capital equipment costs and development costs. Capital costs are the infrastructure and hardware costs, such as fiber optic or coaxial cable, satellite dishes, Instructional Television Fixed Service and microwave towers, computers, monitors, and cameras, etc. (U.S.

Congress, [OTA], 1989). While development costs are those incurred while actually putting the system into operation. These costs cover initial program development, materials acquisition, staff support, management, professional training, and miscellaneous equipment. “Such costs are valued not only by actual dollars spent, but also in the time invested” (U.S. Congress, [OTA], 1989, p. 81).

Ongoing Costs include programming, transmission, operation and maintenance, and system expansion costs. Programming costs are those incurred to acquire, produce, or use educational programming or instruction. These include costs for individual courses or materials, subscription costs, and any other costs associated with producing a course or program (U.S. Congress, [OTA], 1989). Operation and maintenance costs are those associated with the continued operation of the system. Some of these costs include: maintenance and repair; expendable materials; and salaries for teachers, aides, and technicians. Transmission costs include such expenses as long distance telephone charges or costs of satellite transponder time (U.S. Congress, [OTA], 1989). “Also included in this category are recurring costs associated with training technical staff, teachers, and aides” (U.S. Congress, [OTA], 1989, p. 81). While, expansion costs are those which result from expanding an existing program. “These include: new equipment, personnel, and management costs” (U.S. Congress, [OTA] 1989, p. 81).

There is considerable disagreement and debate concerning, first of all, the need for training and education in corporations, and second, whether or not to include training when conducting a cost-benefit analysis. According to Gordon (1997), “considerable doubt prevails across the American business community that employee education is in any way a driver of business profit that can be measured by ROI” (return on investment) (p. 41). Few studies have been done which examine the impact of human-capital investments, such as education and employer-provided training, on productivity (Black & Lynch, 1996). “Senior management and finance managers see training and education as an ‘ivory tower’ the soft side of business” (Gordon, 1997, p. 41). Bookkeepers and accountants dispute that it is not realistic to measure the long-term effects of training for a business (Gordon, 1997).

In opposition to this, a growing number of experts suggest that human capital investment should be based on the reality that employees, business and society receive a direct economic benefit from investing in people. According to Gordon (1997), “the amount any organization invests or does not invest in training will have a positive or negative impact on both short-term and long-term profit” (p. 42).

Even though ROI analysis have almost exclusively been conducted in the business realm, Super (1993), asserts that this type of analysis can be applied to technology-based projects that need a substantial investment for hardware and software. Super explains that ROIs “are factual business presentations that say, with these dollars invested, our program will reduce public assistance by this much, increase local, state and federal taxes paid by this much, and expand our local economy’s purchasing power by this much. In short, the ROI presents the program in terms of paying back many more dollars to the community than are spent on funding the program” (p. 12).

The findings of Black & Lynch (1996), suggest that it is important to move beyond simple measures of the incidence of workplace practices such as training or TQM (total quality management) to understand how these types of workplace strategies/investments actually pay off for employers. If in establishing technology-based projects distance educators are not looking for an ROI, the following proxies (values) could be “used to obtain evidence that money was well spent: decreased number of dropouts, increased motivation, increased number of students continuing on to university, increased number of students served" (Pat Fahy, personal communication, October 2, 1997).

According to U.S. Congress, [OTA] (1989), the ongoing expenses associated with operating a distance learning system, in the long run, may be much more substantial that the initial costs. To reduce some expenses, schools can capitalize on opportunities to share infrastructure resources and programming costs with other districts or education agencies, private business, higher education and government. Cost can also be minimized by expanding the uses of the distance learning system to include other user groups who will pay in exchange for use of the system (U.S. Congress, [OTA], 1989).

IITV Classroom System - Initial Costs. Jones et al. (1992), suggest that the standard classroom can be adapted for IITV without significant remodeling costs. Jones et al. explain "the room is sufficient if there is adequate lighting for the cameras, no extensive glare problems, adequate wiring, and adequate space" (p. 83). Maintenance personnel can easily install camera and monitor mounts into "false ceilings by putting plywood over ceiling strips or by buying additional hardware" (Jones, 1992, p. 83).

Most rooms will have adequate wiring for IITV classroom equipment (Jones, 1992). It is necessary, however, to determine the power requirements for all equipment so that the technician can verify that there are sufficient outlets and amperage levels. General rules to follow, as outlined by Jones are as follows: "(a) unless it is a special circuit, do not put more than five items to a line, and (b) always isolate a computer on a separate line from other equipment" (p. 83).

According to Jones et al. (1992), the initial cost considerations for setting up an IITV classroom system include: consultation services, media specialist services, acoustical treatment, and equipment. Consultation services, media specialist services and acoustical treatment are considered development costs by U.S. congress (1989). Development cost estimates are presented in Table 1.

The last cost consideration, the one that Jones et al. (1992), suggest is the key to IITV classroom design, is the equipment list. A review of the literature pertaining to the initial costs of establishing an IITV classroom reveals wide variation among the reported costs (See Table 2).

Jones et al. (1992), propose two IITV classroom designs (called distance education classrooms), one a state-of-the art classroom and the other a basic classroom and projected the costs to equip each. Jones et al. found that the cost to equip a state-of-the-art IITV classroom would be $39,539, while a basic IITV classroom would cost $21,988 and in doing so noted that even though equipment costs usually reflect current catalogue prices, school systems can expect a 30 percent discount from vendors (See Table 3).

Table 1

Initial Development Costs for Establishing an IITV Classroom System According to Jones et al.

Cost Element	Description	$ Cdn 1997
Consultation services	Private design consultant -- preparation of complete plan (varies by customer need)	Average $6900 (i.e., $104 per hour)
	Installation charges:	
	high end equipment	$6900
	low end equipment	$3400
	average	$5500 (i.e., $41 per hour)
Media specialist services	Site visits and planning Design of the classroom Determination of hardware requirements Monitoring installation	Average $1725 (based on 5 days; $345 initial visits and $345 per day plus expenses for subsequent visits)
Acoustical treatment	Carpets, drapes, fiber ceiling tiles and/or material covered panels	$4100 to $5500
Total (development costs)		$16,125 to $21,045

Note. Based on US Congress (OTA) categorization of costs. All costs converted to current Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

Table 2

Comparison of Initial Capital Equipment Cost Estimates for an IITV Classroom System

Author	Capital Equipment Cost Estimate ($ Cdn 1997)
Kitchen (1988)	9660 to 11,040
Schiller and Noll (1991)	28,000
Fournier and MacKinnon (1994)	65,000 to 80,000
Descy (1991)	12,420 to 24,150
Bradshaw and Brown (1989)	19,320 per site
	start at 48,300 for central broadcast site
Hobbs (1993)	18,255 to 20,800
Gregg and Persichitte (1992)	average 20,000
	additional $5712 for furnishings

Note. Source: Jones et al. (1992). All costs converted to current Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed inconsequential between publication years and 1997.

- Kitchen: p. 75
- Schiller and Noll: p. 26
- Fournier and MacKinnon: p. 72; dedicated systems installed in classrooms; depends upon equipment and options.
- Descy: p. 16; based on KIDS network in Minnesota.
- Bradshaw and Brown: p. 2; ballpark figure of $14,000 for minimal two-way TV system; $35,000 for central broadcast site includes construction and equipment.
- Hobbs: p. 29; based on three IITV classrooms.
- Gregg and Persichitte: p. 11; furnishings include student chairs and table; instructor work table and stool.

Table 3

Capital Equipment Cost Estimates for Basic and State-of-the-Art IITV Classroom Systems

Basic Classroom $ Cdn 1997		State-of-the-Art Classroom $ Cdn 1997	
One student camera	2374	Two student cameras	11,854
One teacher camera	4043	One teacher camera	5927
Two camera mounting brackets	144	Three camera mounting brackets	215
Teacher camera control	552		
One visual presenter	4278	One visual presenter	4278
One light bar	414	One light bar	414
Two 25-inch monitors	4388	Four 25-inch monitors	8777
Two 25-inch teacher monitors	4388	Two 25-inch teacher monitors	4388
		Twelve individual 12-inch student monitors	8694
Three seven-inch teacher monitors	2484	Three seven-inch teacher monitors	2484
Four ceiling mounting monitor brackets	1220	Six ceiling mounting monitor brackets	1830
Four speakers	900	Four speakers	900
One teacher speaker	447	One teacher speaker	447
Four brackets	237	Four brackets	217
Twelve student microphones	3478	Twelve student microphones	3478
One teacher/lavaliere microphone	324	One teacher wireless microphone	828
One audio/video control unit	2063	Audio/video control unit	8280
One teacher control unit:		One teacher control unit:	
Rack mount shelving	690	Rack mounting shelving	690
One audio mixer	3864	One audio mixer	3864
One video distribution unit	400	Two video distribution units	800
One power strip	95	One power strip	95
		One light/dimmer control	932

Basic Classroom $ Cdn 1997		State-of-the-Art Classroom $ Cdn 1997	
Two VCR play/record	966	Two VCR play/record	966
One facsimile	1657	One facsimile	1657
Sub-total	39,405	Sub-total	72,035
Less vendor discount (30%)	(11,822)	Less vendor discount (30%)	(21,610)
Plus supplies, cabling, wiring and connectors	2760	Plus supplies, cabling, wiring and connectors	4140
Final total	30,343	Final total	54,565

Note. Source: Jones et al. (1992). All costs converted to current Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

A similar comparison was made by Southgate (1997), as shown in Table 4.

Table 4

Basic and Fully-Automated (Deluxe) Multi-point IITV Systems

Cost Element	Basic IITV System	Deluxe IITV System
Hardware:		
Eight 27-inch colour monitors	X	X
One video processing system	X	X
One instructor camera system	Remote	Automated
One student camera system	Manual	Automated
One document remote camera system	X	X
One audio teleconferencing system	X	X
One desktop presenter microphone	X	X
One instructor wireless lapel system	X	X
Eight student microphones with gooseneck mount	X	X
Sub-total	43,000	55,000
Sub-total (upgrading monitors)	47,000	59,000
Labour/installation	14,000	14,000
Total hardware and installation costs	$57,000 to $61,000	$69,000 to $73,000

Note. Southgate notes that additional classroom renovation costs include:

Chroma 50 fluorescent fixture system	$1500
Room acoustics	$3500
Computer anti-static carpets	$3000
Custom instructor desk	$5000
Total	$13,000

IITV Classroom System - Ongoing Costs. The majority of IITV classroom equipment is reliable, requiring little maintenance. Jones et al. (1992), report the operating costs for Des Moines schools to be less than $3,000 for one year. This included $700 to repair microphones and a camera. Other costs reported by Jones et al. to be significant were wireless microphone batteries and numerous repairs to push-to-talk microphones.

Supporting Transmission Systems - An Overview. As previously mentioned, IITV permits full audio and visual communication between the teacher and student. The information carrying capacity of a transmission system is directly proportional to its bandwidth: the wider the bandwidth, the greater its information carrying capacity (Tomasi & Alisouskas, 1988). “For comparison purposes, it is common to express the bandwidth of a system as a percentage of its carrier frequency” (Tomasi & Alisouskas, 1988, p. 304). Some examples are as follows: a VHF radio system operating at 100 MHz has a bandwidth equal to 10 MHz -10 percent of the carrier frequency; a microwave radio system operating at 6 GHz (6000 MHz) with a bandwidth equal to 10 percent of its carrier frequency would have a bandwidth equal to 600 MHz; fiber optic systems consisting of light frequencies which operate at between 100,000 to 1,000,000 GHz with a bandwidth equal 10 percent of their carrier capacity would have a bandwidth equal to 10,000 GHz and 100,000 GHz respectively (Tomasi & Alisouskas, 1988).

To provide two-way audio/two-way video, transmission systems require a large amount of bandwidth. Transmission systems able to support two-way audio/two-way video include: fiber optics, coaxial cable and microwave links. These systems generally operate as closed circuit systems, are usually local, and involve only a limited number of sites (U.S. Congress, [OTA], 1989).

For the purpose of this paper, only microwave and fiber optics systems will be investigated. This paper will present information obtained from the literature concerning characteristics, regulation, advantages and disadvantages of each transmission system, as well as, the initial and ongoing costs associated with each.

Microwave System. Microwave technologies are available for use today in two types: point-to-point microwave and Instructional Television Fixed Service (ITFS). The latter type uses microwave transmission in a broadcast mode and offers an audio return channel but limited capacity for a return video signal (Council of Chief State School Officers, 1995). Due to the focus of this paper, ITFS will not be presented for further investigation; point-to-point microwave, however, will.

"Point-to-point microwave transmission is a transport system that uses part of the radio spectrum to send either digital or audio signals between antennas mounted on towers or buildings that are usually located from 5 to 40 miles apart and within line of site" (Council of Chief State School Officers, 1995, p. 30). These systems can transmit audio, video or data in either a one-way (simplex) or two-way (duplex) format (U.S. Congress, [OTA], 1989). Point-to-point microwave is primarily used as part of a transport system to carry a signal without hanging or burying wire, or in small (2- or 3-site) networks for video, audio and data transfer (U.S. Congress, [OTA], 1989).

According to U.S. Congress, [OTA], (1989), "there are two types of point-to-point microwave systems: short haul and long haul" (p. 72). Short-haul systems typically have a range of 5 to 15 miles whereas, long haul systems usually have a range of up to 30 miles between towers (U.S. Congress, [OTA], 1989). Short-haul systems are commonly used for local communication between two schools. Whereas, until recently, multiple links of long-haul microwave were used extensively for the United States long distance services. “At this point, fiber optic chunks have largely replaced these microwave facilities” (U.S. Congress, [OTA], 1989, p. 72).

Long-haul microwave is made possible through the use of repeater towers. “The distance between repeaters depends upon (a) topography (b) antenna size (c) transmitter power, and (d) receiver sensitivity” (Jones et al., 1992, p. 7). Jones et al. further suggest that “a good rule of thumb is to consider microwave if two sites are more than one-half mile but less than 20 miles apart” (p. 7).

Point-to-point microwave systems require towers, antennas, antenna feed lines, transmitters/receivers, modulators/multiplexors and power units at each transmit/receive site (Jones et al., 1992; U.S. Congress, [OTA], 1989). “Each tower in a microwave relay system picks up the signal sent to it, amplifies the signal, and retransmits it to the next line-of-sight tower on the way to the destination point” (Jones et al., 1992, p. 6).

<u>Microwave System Regulation</u>. According to U.S. Congress, [OTA], (1989), “microwave frequencies are regulated by FCC, and licensing is required for all transmitter sites because of interference concerns, and is necessary for receive sites desiring protection from possible new source of interference” (p. 72). Placement of microwave towers may be affected by local zoning ordinances. For example: in some instances, towers cannot be situated near the school, but located instead some distance away and connected to the school by coaxial or fiber optic cable (U.S. Congress, [OTA], 1989).

<u>Microwave System - Advantages</u>. A microwave system is easy to install and cost-effective, for short distances. Microwave allows the transmission of full motion video resulting in excellent quality video and audio signals. It permits the transmission of many

data and audio signals, as well as video channels. Microwave has low maintenance costs and rights-of-way are not needed (Jones, 1992; Jones et al., 1992).

Microwave System - Disadvantages. A microwave system requires high start-up costs. The maximum distance between towers is 30 miles. Systems are influenced by environmental changes: fog, rain and lightning can influence transmissions and atmospheric changes may cause fading of signals. Power outages can occur and equipment can fail. Since many of the lower microwave frequencies are very crowded in high traffic, only a limited number of frequencies are available. The addition of channels to a system is not an easy process. An FCC license is necessary and special building permits may be required. Extremes in terrain can make towers and equipment more costly and areas of rough terrain prohibit the use of microwave. Typical lifetime of equipment is 7 to 10 years (Jones, 1992; Jones et al., 1992; Kitchen & Kitchen, 1988; & U.S. Congress, [OTA], 1989).

Fiber Optics System. "Fiber optics is one of the newest two-way interactive technologies" (Jones et al., 1992 p. 5). This type of system consists of hair thin, flexible glass or plastic rod fibers that use light signals instead of electric signals to transmit audio, video, and data signals. "An optical fiber consists of an inner cylinder called the core, surrounded by a cylindrical shell of glass or plastic called the cladding" (Jones et al., 1992 p. 5). Cladding prevents light from escaping while an exterior coating assures protection against the elements. "Light travels in straight lines, but optical fibers guide light around corners" (Jones et al., 1992, p. 5).

"To use fiber optic cable, an electrical signal must be converted into a light signal, and then injected into the fiber" (Kovacs, 1993, p. 15). At the terminal end of the fiber, the light signal is converted back into an electrical signal. Through the use of fiber optic systems analog electronic signals of voice and video as well as the digital signals of data can be converted into light signals and transmitted over the glass or plastic rod fibers.

According to U.S. Congress [OTA], (1989), these systems usually send information digitally, although some video applications do use analog format. “For digital transmission, analog signals are converted to digital bits, and then are transmitted by lasers or light emitting diodes (LEDS) as pulses of light along the fiber strand” (U.S. Congress, [OTA],1989, p. 75). These light pulses are sensed by receiving equipment which converts them back to electronic digital signals and then back to analog form for output.

Fiber optic systems require the following equipment: multiplexor, codec, optical transmitter, optical receiver or photodetector, fiber cable and repeaters. An explanation of how each piece of equipment works as provided by Jones (1992), is as follows:

> The multiplexor converts the signal to/from an electrical signal. The codec changes the signal to digital. The optical transmitter converts the signal to an optical signal, and the receiver reconverts the optical signal. Transmitters are of two types, lasers (ILD) or light emitting diodes (LED). The receivers are either positive-intrinsic-negative (PIN) or avalanche photodiode (ADP). Generally speaking, the ADP is used for systems greater than 100 km (62 miles) and PINs are preferred for shorter distances. The repeater is a signal amplification device often used along cables to extend transmission distances. The fiber cable carries the optical signal. Single mode and graded index fiber is best suited for long distances. Since a codec is needed only for digital transmission, an analog system would eliminate need for the codec. A modulator/demodulator would replace the multiplexor unit; additional amplifiers would be necessary. Life expectancy of this equipment is 20-25 years (p. 5).

Fiber Optics System Regulation. The huge capacity and high cost of broadband development present the telephone companies and regulators with the classic problem of telephone companies not being able to offer any services that justify putting in fiber optic lines directly to the public (U.S. Congress, [OTA], 1989).

According to U.S. Congress (1989), in many instances Bell Operating Companies (BOCs) cannot offer the complete service schools want, especially when video is desired. "In other instances, BOCs find it uneconomical because of restrictions or requirements of the MFJ or State public utility commissions" (U.S. Congress, [OTA], 1989, p. 77). Telephone companies can transport video signals but they are currently prohibited by the Cable Act of 1984 from providing video content (U.S. Congress, [OTA], 1989).

Fiber Optics System - Advantages. Fiber optic cables are small and lightweight, making them easy to handle and install. These cables are made of glass, which does not conduct electricity. Therefore, "fiber optic cables cannot carry pulses from lightning strikes or power line surges" (Kovacs, 1993, p. 15). Fiber is impervious to climatic changes, resulting in a durability that necessitates little maintenance/costs.

McCain & Ekelund (1993), suggest that "the great benefit of fiber cable is its extremely high capacity for carrying electrical signals" (p. 69). McCain & Ekelund further claim that of all cable types, fiber optic cable gives the greatest expandability for the future. Fiber's large bandwidth permits video, audio and data to be combined on one line, resulting in lower cost per channel. Fiber optic cable allows full motion video transmissions and its large capacity for channels results in a system that can easily be expanded. A low attenuation rate permits transmissions over long distances free from distortion (Jones, 1992; Jones et al., 1992).

Fiber Optics System - Disadvantages. High start-up costs are associated with fiber optic systems and right-of-way costs for placement of cable in the ground can be expensive. Barker (1991), states that “fiber optics, although more available, is still not accessible for telecommunications in many rural communities” (p. 6). If fiber does not exist in a particular area, expansion is costly. System installation is very complex, requiring the use of special tools and tests. The lifetime of light sources is limited. The expected lifetime of fiber optic system equipment is 20-25 years (Jones, 1992; Jones et al., 1992).

Supporting Transmission Systems - Costs. According to the U.S. Congress, [OTA] (1989), “costs for distance learning transmission systems vary widely depending on system design and complexity, range and scope, capacity, large volume purchase agreements, and lease vs. buy options” (p. 172). “In general, the declining costs of electronic components have made telecommunications equipment more affordable” and “continued declines in prices are expected” (U.S. Congress, [OTA], 1989, p. 172).

As mentioned previously, schools implementing distance learning systems have two types of costs: 1) initial costs that include capital equipment costs and development; and 2) ongoing costs that include programming, transmission, operation and maintenance, and system expansion (U.S. Congress, [OTA], 1989). Schools having to build a completely new transmission system, will face all these costs. While others who are able to take advantage of existing telecommunications resources, will be able to cut costs.

Microwave System - Initial Costs. “Since each site in a point-to-point microwave system is both a transmit and a receive site, the cost of installing and operating a microwave system can be relatively high” (U.S. Congress, [OTA], 1989, p. 172). Duplex microwave systems cost between $55,200 and $89,700 per channel, including transmitters, receivers, and all electronics (U.S. Congress, [OTA] 1989; Kitchen & Kitchen, 1988). Adding additional channels can cost almost as much (Kitchen & Kitchen, 1988).

A wide variation exists in the costs of microwave towers. Table 5 presents estimates by four authors.

The New York State Legislative Commission (1988), suggests that tower costs could be reduced or eliminated by using existing towers or placing multiple antennas on a single tower (p. 11). Jones et al. (1992), concur and report that “the use of repeater towers adds expenses for additional electronics, path studies, installation costs, and tower costs” (p. 14). “Each repeater tower adds approximately $124,200 in equipment costs and $27,600-$48,300 in tower construction costs” (Jones et al., 1992, p. 14). “Insurance, maintenance, and repairs can average between three and five percent of the system cost per year” (The New York State Legislative Commission, 1988, p. 11).

Table 5

Estimated Initial Costs of Microwave Towers

Author	Cost Element	Cost $ Cdn 1997
New York State Legislative Committee (1988)	Microwave system	138,000 to 207,000
Kitchen and Kitchen (1988)	Short haul towers	6900 to 69,000
	Longer-span towers	34,500 to 103,500
Jones et al. (1992)	Short haul distance	55,200
	Long-haul, one-hop systems over 8 to 15 miles	207,000 to 345,000
Southgate (1997)	Microwave system	180,000 to 250,000

Note. All costs converted to current Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between publication years and 1997.

The initial cost of a microwave transmission system is directly affected by distance. "The longer the distance, the higher the tower, and the larger the antenna dish required" (Jones et al., 1992, p. 16). Compared to a six foot dish which costs approximately $1,500, a 12-foot dish estimates at $6,000. According to Bradshaw & Brown (1989), "long-distance transmission costs range from $25,000 per 20-mile microwave hop to $85,000 per 50-mile hop" (p. 2).

Jones et al. (1992), investigated the purchase costs of microwave for two sites, for varying distances. "Purchase costs refer to all construction, material, and equipment (not end point) costs involved in building the system" (Jones et al., 1992, Table I). The purchase costs of microwave for two sites, based on varying distance, are shown in Table 6.

Table 6

Initial Costs of Microwave System ($ Cdn. 1997)

Distance	Purchase Cost for Two Sites
3 miles	48,300
10 miles	56,580
20 miles	229,080
30 miles	293,940
50 miles	492,660
75 miles	680,340

Note. Source: Jones et al. (1992) - Table 1. All costs converted to constant Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

Jones et al. (1992), investigated first year total costs and five year costs of microwave for two sites, as well as, the average cost per year for a five year period. All of these costs were done for varying distances (See Table 7).

Table 7

First Year Costs and Five Year Costs of Microwave Systems for Two Sites ($ Cdn 1997)

Distance	First-Year Costs	Five -Year Costs	Average Costs
3 miles	48,300	48,300	9660
10 miles	56,580	56,580	11,316
20 miles	229,080	229,080	45,816
30 miles	293,940	293,940	58,788
50 miles	492,660	492,660	98,532
75 miles	680,340	680,340	135,240

Note. Source: Jones et al. (1992) - Table 1. Costs do not include maintenance or operating costs. All costs converted to constant Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

According to Jones et al. (1992), the major cost considerations for installing a microwave system include: consultation services, tower construction, land, equipment, building, connections to the school, installation and testing, FCC application, and long and short haul systems. Table 8 summarizes cost considerations. Key factors are discussed following the table.

Table 8

Summary of Major Cost Considerations for Installing a Microwave System According to Jones et al. (1992)

Cost Element	Description	$ Cdn 1997
Consultation services	Path profile/coordination	2760 to 5520 (one-hop -- 2070)
	Tower specifications	2760
Tower construction	100-foot tower	27,600
	200-foot tower	41,400
	300-foot tower	48,300
	200-foot self-supporting tower (no guy wires needed)	276,000
	Short, light-weight tower for short distances	2760 to 4140
	100-foot tower that attaches to side of building	6900
Land	Land lease -- rural area	690 to 1104 per year
	Land lease -- urban area	6900 to 8280 per year
Equipment	Transmitters, receivers, antennas, hardware connections (each end of system):	
	Short-haul distances	15,180 per end
	Long-haul distances	62,100 per end
Building	Building to house electronic equipment	2070
Connections to school	If tower more than one mile from school, requires:	
	Coaxial cable	6900 to 8280 per mile

Cost Element	Description	$ Cdn 1997
	Amplifier every 2000 feet	690 each
Installation and testing	Installation and testing of equipment and systems	up to 20,700 to 41,400
FCC application	In US, Federal Communications Commission application required	214

Note. All costs converted to constant Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

Cost is directly proportional to the tower height, the higher the tower the more costly the construction. Therefore, microwave tower construction is another major cost concern. Tower height is dependent upon distance, obstructions, elevation above sea level, and earth curvature. To transmit 20 miles, the antenna must be at least 150-200 feet on both ends. “Towers over farm land can be fairly short, but any trees, buildings, or grain elevators in the path will increase the height requirement” (Jones et al., 1992, p. 14). Although a 20-foot tower is the minimum height for a transmitter, a 50-60- foot height is normally required to clear trees. If a dish located on a building is desired, the building must be high enough to clear trees and obstructions. In a situation such as this, antenna extensions which attach to a wall, extend above the building roof. “An antenna on top of a two-story school building can send signals only a short distance” (Jones et al., 1992, p. 14).

Since it is necessary to procure land for the tower site, land is an important cost consideration when installing a microwave system. According to Jones et al. (1992), “a 200-foot tower requires two acres of land” (p. 15). Jones et al. further report that it is sometimes preferable to lease land.

Whether or not a microwave system is a long or short haul system has direct bearing on the cost of system installation. According to Jones et al. (1992), the maximum distance between towers is about 30 miles and any distance over 30 miles would require repeater towers to boost and retransmit signals. Every addition of a new repeater tower requires a tower with two sets of electronics which can add $124,200-$165,600 for equipment, $27,600-$48,300 for tower construction, $1,380-$2,070 for path studies and approximately $34,500 for installation and testing (Jones et al., 1992). Distances nearer to the 30 mile limit require higher towers, larger antennas and more powerful transmitters. “Short haul systems can be purchased for as little as $20,700 to $27,600” (Jones et al., 1992, p. 15).

Microwave System - Ongoing Costs. Transmission equipment, in a general sense, is quite reliable and repairs are minimal (Jones, 1992). “However, service and maintenance are important considerations for these costly systems” (Jones, 1992 p. 77). Electrical storms, ice load, wind damage, and electronic equipment failure are all situations that can result in the need for maintenance on microwave systems (Jones, 1992). Maintenance contracts for not just microwave systems, but all transmission systems should state clearly how readily the vendor is expected to provide service. According to Jones et al. (1992), “maintenance contracts vary, and range between one to ten percent of the system’s purchase price” (p. 17).

Purchased Fiber Optics System - Initial Costs. “The cost of constructing a fiber optic system is relatively high, but is expected to decrease rapidly as electronics and cable costs decline” (U.S. Congress, [OTA], 1989, p. 174). Costs for fiber optic hardware are reported by the U.S. Congress, [OTA] (1989) as follows: analog transmitters and receivers - $16,560, repeaters (spacing varies) - $33,120, laser modulators $2760-$4140, coders/decoders (codecs) $11,040-82,800 (p. 174). An example of a fiber optic contract agreement provided by the U.S. Congress, [OTA] (1989) is Big Fork, Minnesota, characterized by direct ownership with four local telephone companies and one long distance carrier, with the schools owning the terminal equipment. In this example, it would cost “$12,358 per mile including some maintenance for a 134 mile network” (p. 174).

According to Jones et al. (1992), “the total cost of a fiber system depends on the fiber type, total system design, and location” (p. 13). Jones et al. found the following variations in cost: $16,560 per mile based on 10 miles, $13,800-$20,700 per mile, $20,700-27,600 per mile, $16,560-$30,360 per mile, $24,840-$30,360 per mile, and $30,360 per mile. All of these estimates were for labor and fiber only; equipment and right-of -way expenses were not included (Jones et al., 1992). In metropolitan areas, where there are right-of-way expenses and higher costs for labor, installation costs may be as high as $96,600 per mile (Jones et al., 1992).

Jones et al. (1992), investigated the purchase and end point costs of fiber optics, for two sites, for varying distances. “Purchase costs refer to all construction, material, and equipment (not end point) costs involved in building the system” (Jones et al., 1992, Table I). While “end point costs include transmission equipment, hardware, cables, and power supply, plus codices which change analog signals to digital signals and compress the signal” (Jones et al., 1992, Table I). The purchase and end costs of fiber optics for two sites based on varying distance are outlined in Table 9.

Table 9

Initial Costs for Purchased Fiber Optic System ($ Cdn 1997)

Distance	Purchased Costs for Two Sites	End Point Costs for Two Sites
3 miles	91,080	99,360
10 miles	292,560	99,360
20 miles	572,700	99,360
30 miles	848,700	99,360
50 miles	1,370,340	99,360
75 miles	1,974,780	99,360

Note. Source: Jones et al. (1992) - Table 1. All costs converted to constant Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

As is microwave, transmission using fiber is also affected by distance. However, Jones et al. (1992), report that compared to microwave, fiber is affected most dramatically with the costs of fiber per mile being very high and each additional mile contributing an additional $16,560-$27,600 to the cost of a system. Bradshaw & Brown (1989), report long-distance transmission costs as “$8,280 per mile for fiber optic” (p. 2).

Jones et al. (1992), investigated first year total costs and five year costs of purchased fiber optics for two sites, as well as, the average cost per year, for a five year period. All of these costs were done for varying distances (See Table 10).

Table 10

First Year Costs and Five Year Costs of Purchased Fiber Optic Systems for Two Sites

($ Cdn 1997)

Distance	First-Year Costs	Five -Year Costs	Average Costs
3 miles	190,400	190,400	38,088
10 miles	391,920	391,920	78,384
20 miles	672,060	672,060	134,412
30 miles	948,060	948,060	189,060
50 miles	1,469,700	1,469,700	293,940
75 miles	2,074,140	2,074,140	414,828

Note. Source: Jones et al. (1992) - Table 1. Costs do not include maintenance or operating costs. All costs converted to constant Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

According to Jones et al. (1992), the major cost considerations for installing a fiber optic system include: consultation, construction/materials, easements, and terminal equipment. Consultation is a major cost consideration with fees consultants charge varying greatly and being dependent upon detail, distance, and location (See Table 11).

Table 11

Major Cost Considerations for Installing a Fiber Optic System According to Jones et al. (1992)

Cost Element	Description	$ Cdn. 1997
Consultation	Feasibility studies, coordination of specifications, route surveys, right-of-way checks, route designs with drawing	Average 6900 to 20,700 Range: 4140 to 4830 in rural area
	In some cases, staking the route, crew scheduling and construction supervision	10,350 in urban area (engineering rate of $69/hour)
Construction/ materials	Fiber, manholes, warning signs and splicing -- rural areas	13,347 per mile
	Above plus additional splicing and manhole costs and added duct costs -- urban areas	21,682 per mile
Easements	Public easements re: rights-of-way	1.38 per foot per year
	Other entities: percent of revenues	
	Private land: payment also required	
Terminal equipment	Digital end point equipment, including installation for one site	34,500 to 78,660
	Digital terminal equipment, connectors and installation for two sites	96,600
	Analog end point equipment	8280

Note. All costs converted to constant Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

Besides consultation, construction/materials costs are important areas to consider when installing a fiber optic system. Labor construction costs are estimated to range from $1.34 per foot to $2.14 per foot depending upon distance, with costs of construction reported to be different for rural vs. urban locations. The reason for this, as reported by Jones et al. (1992), is that “urban areas require more field work, engineer work, concrete work, and easement attainment. A downtown urban area requires additional concrete work costing $13.80 per foot or more” (p. 13).

Another cost consideration of fiber optic system installation are easements. If construction crosses roadways or railroads, an application usually must be filed to obtain an easement right-of-way (Jones et al., 1992 p. 13). The majority of easements can be obtained as public right-of-ways by formal application to the city, county, or state. A public easement requires a license to place the cable in this right-of-way. The standard fee for city easements is about $1.38 per foot, annually. Other entities usually charge a percent of the revenues for easements and if private land is involved, the private individual could be entitled to payment for easement rights (Jones et al., 1992).

When installing a fiber optics system terminal equipment is yet another important cost consideration. Digital end point equipment, usually one unit that functions as the codec, laser transmitter, optical receiver, and multiplexor/demultiplexor (MUX/DEMUX can vary in price according to speed of transmission and capacity.

<u>Purchased Fiber Optics System - Ongoing Costs</u>. According to Jones et al. (1992), “fiber equipment is reliable and needs few repairs” (p. 16). Although uncommon, laser failure can result in laser replacement costing $2,760-$5,520. End point equipment

maintenance contracts are approximately one to two percent of the purchase price. Which is on average $4554-$10,488 per year (Jones et al., 1992).

Leasing a Fiber Optics System. Jones et al. (1992), claim that “for short term uses, leasing is often an attractive alternative to purchasing (p. 17). According to Jones et al. leasing a fiber optic system is similar to leasing a car in that maintenance and operation are the responsibility of the lessor, while using the system is the only concern of the leasee.

Leased Fiber Optics System - Initial Costs. Costs for leasing fiber usually include the costs for all equipment with the exception of the device that converts the video signals generated in the IITV classroom into signals that can be transmitted through the fiber. This device usually costs $8,280-$11,040 (Jones et al., 1992).

A wide variation exists in the reported range of initial fiber lease costs. Jones et al. (1992), investigated the initial costs of leasing a fiber optics system, for two sites, for varying distances. Each of these costs reflected a one-time connection fee (See Table 12).

In contrast to Jones et al.’s (1992), reported lease cost of $74,520 for 50 miles, Hobbs (1993), found the initial cost of leasing fiber for 55 miles to be $36,432. This cost includes a one time cost of fiber terminals and installation per school (for five school sites). The nature of the telephone-school agreement, as reported by Hobbs, is as follows: fiber is leased from two local telephone companies for a multi-year period; the lease rate is set by negotiation (non-tariffed); analog fibers terminals are owned and maintained by schools; classroom equipment is owned and maintained by schools; schools may not use system as telephone by-pass (i.e. in lieu of telephone calls); specific use governed by legal agreement between parties; 15-year renewable lease agreement; and there is a 24-hour, 12 month use capability.

Table 12

Initial Costs for Leasing Fiber Optics System ($ Cdn 1997)

Distance	Lease Costs for Two Sites
3 miles	49,680
10 miles	52,440
20 miles	56,580
30 miles	66,240
50 miles	74,520
75 miles	104,880
115 miles	32,223

Note. Source: Jones et al. (1992) for 3 miles to 75 miles and Hobbs (1993) for 115 miles. Costs reflect a one-time connection fee. All costs converted to constant Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

Hobbs (1993), further reports the initial cost of leasing fiber for 115 miles to be $32,223. This figure is much lower than the initial lease cost for 75 miles, provided by Jones et al. (1992). According to Hobbs this cost includes a one-time cost of fiber terminals and installation per school (for ten school sites). The nature of the telephone-school agreement, as reported by Hobbs, is as follows: fiber is leased from four local telephone companies for a multi-year period; the lease rate is set by negotiation (non-tariffed); analog fibers terminals are owned and maintained by schools; classroom equipment is owned and maintained by schools; schools may not use network as telephone by-pass (i.e. in lieu of telephone calls); specific use governed by legal agreement between parties; and there is 10-year renewable lease agreement.

Leased Fiber Optics System - Ongoing Costs. The ongoing costs of a leased fiber optics system is another area in which there is a wide variation in the range of reported costs. Jones et al. (1992), investigated first year total lease costs and five year costs of leasing fiber optics for two sites, as well as, the average lease cost per year, for a five year period. All of these costs include maintenance or operating costs and were done for varying distances (See Table 13).

Table 13

First Year Total Lease Costs and Five Year Lease Costs of Leased Fiber Optics Systems for Two Sites ($ Cdn 1997)

Distance	First-Year Total Lease Costs	Five -Year Total Lease Costs	Average Costs
3 miles	66,240	248,400	49,680
10 miles	69,000	262,200	52,440
20 miles	73,140	282,900	56,580
30 miles	82,800	331,200	66,240
50 miles	91,080	372,600	74,520
75 miles	121,440	524,400	104,880

Note. Source: Jones et al. (1992) - Table 1. Costs include maintenance or operating costs. All costs converted to constant Canadian dollars based on $1 US = $1.38 Cdn.; inflation assumed to be inconsequential between 1992 and 1997.

In contrast to Jones et al.'s finding of $74,540 (average lease cost) for 50 miles (for two sites), Hobbs (1993), reports the ongoing lease costs of fiber optic system for 55 miles (for five school sites) to be $5280/site/year. This cost would be $14,572 for two sites per year. (a price variation of almost $60,000). Hobbs explains that this cost is based on $40/mile/month for fiber cable and includes fiber maintenance. Schools share equally in fiber lease and fiber terminal cost regardless of distance, with each school paying approximately $440/month for fiber lease.

Hobbs (1993), further reports the ongoing lease costs of fiber optic system for 115 miles (for ten school sites) to be $6624/site/year. This cost is based on $48/mile/month for fiber cable and includes fiber maintenance. Schools share equally in fiber lease and fiber terminal cost regardless of distance, with each school paying approximately $552/month for fiber lease. The schools in this network utilized a 10-year prepaid lease option.

According to G. Southgate of Southgate Communications Ltd. (personal communication, September 8, 1997) the monthly rental for fiber from MTS (Manitoba Telephone System) would typically be $1,000/hour. Southgate elaborates that this is a commercial rate and that an educational rate would probably be lower as determined by the CRTC (Canadian Radio Telecommunications Commission).

Section Summary

This section presented a review of the literature written concerning IITV classroom system costs. Literature on costs associated with IITV classroom systems and supporting transmission systems tend to suggest that there are no simple formulas currently available to help estimate the cost of a technology system. Literature on types of costs reveals that schools implementing distance learning systems will have both initial and ongoing costs. Initial costs include capital equipment and development costs. Information pertaining to initial costs, as well as, ongoing costs was located. However, literature outlining initial program development costs was not found.

Summary

This chapter provided a review of the literature relevant to: IITV Application, IITV Classroom System Design Considerations and IITV Classroom System Costs. Literature related to IITV applications tends to be presented by users describing their specific experience with IITV. This literature tends to suggest that IITV is chosen because: studies reveal that students taking courses via IITV achieve, in most cases, as well as students taking courses via traditional methods; and the benefits of IITV to rural school divisions outweigh its costs (i.e. the provision of equal educational opportunities for students and the assurance of rural school district survival, as well as, the simultaneous delivery of interactive teaching/learning strategies to geographically dispersed student bodies).

Considerable debate and disagreement exists in the literature concerning the need for a visual connection provided by video and the need for interactivity through two-way audio and video, considering the costs of such systems. A study detailing the reasons why IITV would be the technology of choice, in light of considerable expense and challenges, would be beneficial to future distance education planners.

A variety of literature concerning IITV classroom systems exists. However, only a limited amount of this material focuses on the physical design of an IITV classroom system. The literature which does exist tends to be presented by users describing their own specific classroom system design. It is suggested by the literature that a properly designed classroom enhances content objectives and increases acceptance by students and teachers.

IITV classroom systems, described in the literature, are consistent in terms of design and layout. None of the literature provides an analytical comparison between different design applications. A study conducting a comparative analysis of different IITV classroom system design applications would be beneficial to future distance education planners.

Literature on costs associated with IITV classroom systems and supporting transmission systems suggests that there are no simple formulas readily available to help estimate the cost of a technology system. The literature on types of costs reveals that schools implementing distance learning systems will have both initial and ongoing costs. Initial costs include capital equipment and development costs, while ongoing costs include: programming, transmission, operation and maintenance, and system expansion costs. Information pertaining to initial costs, as well as ongoing costs was located. However, literature outlining initial program development costs was not found.

Literature on distance education reveals that the issue of cost is an area of tremendous concern. The design and implementation, as well as the maintenance of a two-way interactive system are reputed to be expensive and complicated. For individuals contemplating the establishment of an IITV classroom system, information that identifies the costs associated with the installation and ongoing system operation is limited. Moreover, literature that provides a comparison between the costing of different IITV classroom system applications is sparse and difficult to locate.

Individuals considering the use of IITV require information that justifies its use. If the decision is made to establish an IITV system, then these same individuals need access to current and reliable information that presents several classroom system design options, as well as the related costs of each.

Besides IITV classroom system design, there are also transmission system costs to consider. The literature reveals that few studies exist that specify detailed costs for different transmission systems. A study which analyzes the specific variables which contribute to the total costs of an IITV classroom system would be beneficial to distance education planners.

The purpose of this study was to: identify conditions under which IITV is an appropriate choice of technology for delivering instruction in the K-12 environment; present an analysis of different IITV classroom system design applications and corresponding transmission systems; and provide estimates of the typical costs associated with the creation, as well as, ongoing usage, of such systems. The next chapter presents the methodology used for this study.

CHAPTER III

METHODOLOGY

The purpose of this chapter is to present the methodology used for this study. This chapter begins with a description of the study's design and participants, followed by a description of the interview procedure used while conducting the study, as well as the interview protocol used to obtain/measure the data. Next is the data analysis. Ethical considerations conclude the chapter.

Design

This study was designed to address the following key research questions:

1) Why choose IITV as an instructional technology?

2) What should the design of varying IITV classroom systems include?

3) How much do the varying IITV classroom systems cost?

This study conducted an observational case analysis of three IITV classroom system design applications designated as basic, intermediate and deluxe. A basic design was defined as an IITV classroom system where the equipment required for two-way audio and video interactive instructional television has been installed into a standard classroom with minimal provision made for remodeling. An intermediate design was defined as an IITV classroom system where the equipment required for two-way audio and video interactive instructional television has been installed into a standard classroom with provision made for remodeling into a flat-floored IITV classroom system design. A deluxe design was defined as an IITV classroom system where the equipment required for two-way audio and video interactive instructional television has been installed into a standard classroom which has been remodeled into a tiered IITV classroom system design. The three design applications used in the study are based upon literature review and previous work conducted in this area. They represent only one of several possibilities for range of design and cost.

Using the designation of basic, intermediate and deluxe IITV classroom system design applications as a framework, this study addressed key research questions 1, 2 and 3 through an investigation and analysis of 14 specific research questions (specified below). Key research question # 1 was addressed through an investigation and analysis of specific research question I. Key research question # 2 was addressed through an investigation and analysis of specific research questions II - V. Key research question # 3 was addressed through an investigation and analysis of specific research questions VI through XIV.

Specific Research Questions

I Why choose IITV as an instructional technology?

II What are the design characteristics of:

i) a basic IITV classroom system?

ii) an intermediate IITV classroom system?

iii) a deluxe IITV classroom system?

III Which elements are common to all three designs?

IV Which elements are not common to all three designs?

V What are the advantages and disadvantages associated with each design?

VI How much does it cost to remodel a standard classroom into:

i) a basic IITV classroom system?

ii) an intermediate IITV classroom system?

iii) a deluxe IITV classroom system?

VII How much does it cost to equip:

i) a basic IITV classroom system?

ii) an intermediate IITV classroom system?

iii) a deluxe IITV classroom system?

VIII What are typical recurring and maintenance costs for the classroom equipment in:

i) a basic IITV classroom system?

ii) an intermediate IITV classroom system?

iii) a deluxe IITV classroom system?

IX a) As opposed to other transmission systems, why would an organization choose to use a:

i) fiber optic transmission system?

ii) microwave transmission system?

b) What are the characteristics, advantages and disadvantages of a:

i) fiber optic transmission system?

ii) microwave transmission system?

X What steps are involved in setting up a:

i) fiber optic transmission system?

ii) microwave transmission system?

XI What does it cost to establish a multi-point transmission system using:

i) fiber optics?

ii) microwave?

XII What are the major cost considerations of a:

i) fiber optic transmission system?

ii) microwave transmission system?

XIII What are typical recurring and maintenance equipment costs of a:

i) fiber optic transmission system?

ii) microwave transmission system?

XIV What are the costs associated with the ongoing usage of a:

i) fiber optic transmission system?

ii) microwave transmission system?

Three interview questionnaires were used to gather data relevant to the specific research questions. One questionnaire dealt with specific research question I, a second questionnaire dealt with specific research questions II-V, while a third questionnaire dealt with specific research questions VI-XIV (See Interview Protocol for further explanation).

Participants

The participants in this study were the Superintendents and IITV Coordinators in Midland School Division, Souris Valley School Division and Evergreen School Division, three Manitoba school divisions which utilize IITV (See Figure 1).

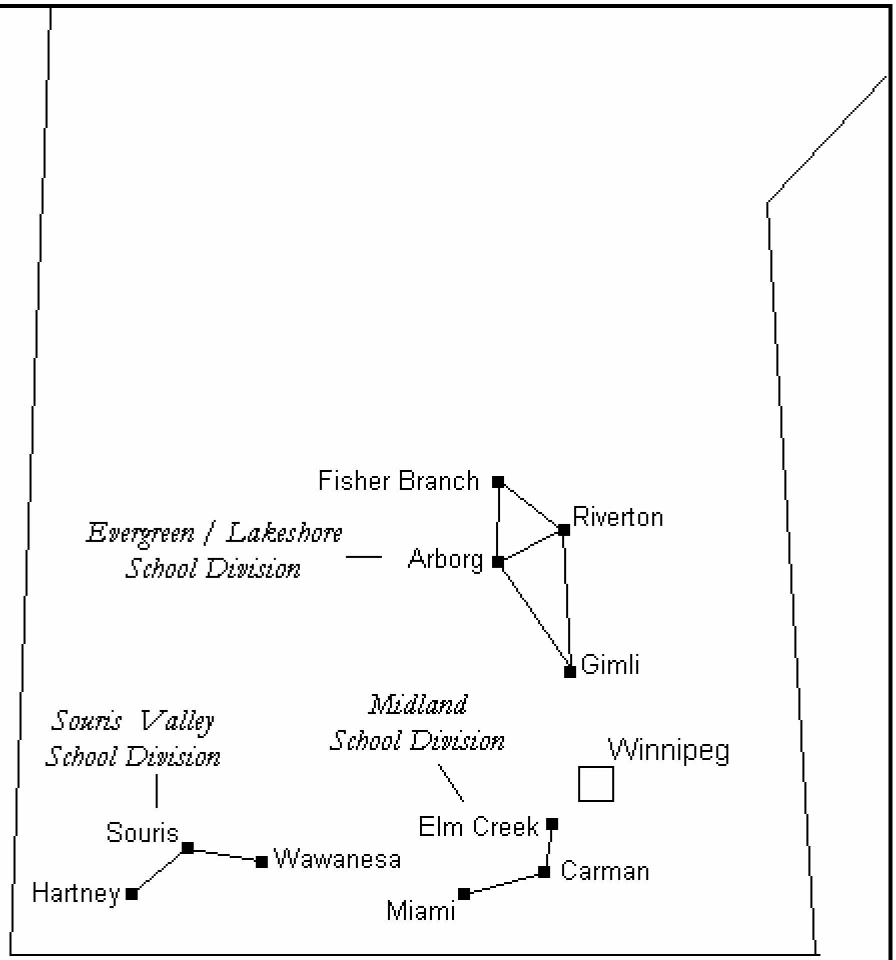

Figure 1
Three Manitoba School Divisions Utilizing IITV

1) The Midland School Division, the first school division in Manitoba to deliver courses using IITV, utilizes an analog two-way audio and video network running on microwave between three sites (the high schools in Carman, Elm Creek and Miami). Midland School Division began to broadcast via IITV in the fall of 1990. At that time a ham radio operators' band was used on an experimental permit issued by Industry Canada. In 1995, in response to Industry Canada's request for band change, Midland switched from the ham radio operators'

band to microwave transmission. The Superintendent of Midland School Division is Mr. Eugene Wiebe, while the IITV Coordinator for the division is Mr. Richard Lindsay.

2) The Souris Valley School Division's IITV system, established in September, 1997 is currently not fully operational. However, once completely functional, this system will utilize an analog converted to digital two-way audio and video network running on microwave to connect three sites (the high schools in Souris, Wawanesa and Hartney).

The Superintendent of Souris Valley School Division is Mr. Lloyd Paulson, while the IITV Coordinator for the division is Mr. Murray Zuk.

The Souris Valley School Division's IITV system is being installed as part of the Canada-Manitoba Infrastructure Works Agreement: Distance Education Project aimed at establishing interactive instructional television systems throughout the province. “This project was initiated because of a survey conducted four years ago which suggested the need for alternative technology to help with distance education in rural Manitoba” (Ken Rodeck personal communication, October 29, 1997). Under the Canada-Manitoba Infrastructure Works Agreement costs of total IITV system set-up are to be paid through a cost-sharing arrangement between the federal government, Manitoba government and participating school divisions whereby each party pays one-third of eligible costs (Manitoba Government, 1995).

“Phase one of the project will group some 80 schools into interactive clusters, each made up of two to six schools” (Manitoba Government, 1995 p. 2). Schools in each cluster will be able to send and receive live, full-motion video and audio, enabling one teacher to interact with several classrooms at once (Manitoba Government, 1995). “Phase two of the project will give the schools the opportunity to link to a provincial network that will enable them to receive educational programs from virtually anywhere in the world” (Manitoba

Government, 1995 p. 2). Classrooms linked to this larger network will be able to embark on "electronic field trips" to locations around the world, and serve as a community resource for videoconferencing, labor force training and community development (Manitoba Government, 1995).

Implementation of the Infrastructure Project is coordinated by MERLIN (Manitoba Education Research and Learning Information Networks), a special operating agency of Manitoba Education and Training. MERLIN provides school divisions with technical co-ordination and support.

3) The Evergreen/Lakeshore Interactive Television Network, established in 1993, is an analog two-way audio and video network running on fiber optics between four sites (the high schools in Arborg, Riverton, Gimli, and Fisher Branch). The first three sites are in Evergreen School Division while the last site is in Lakeshore School Division. For the purpose of this study only Evergreen School Division will be presented. The Superintendent of Evergreen School Division did not participate in the study. The division's IITV coordinator, Mr. Lloyd Roche assumed full responsibility for study participation.

Additionally the following individuals/companies were approached to supply data:

1) Mr. Bill Evans of E. B. Systems and TeleWave Communications Corporation (communications systems expert/engineer) - provided technical advise to Midland School Division during IITV classroom system installation. E. B. Systems installed Midland School Division's microwave transmission system, while TeleWave installed Souris Valley School Division's microwave transmission system.

2) Mr. Ken Rodeck of MERLIN (Infrastructure Project Manager) - responsible for the co-ordination and implementation of the Canada-Manitoba Infrastructure Works Agreement Distance Education Project (provision of IITV in rural Manitoba high schools).

3) Mr. Graham Southgate of Southgate Communications Ltd. (consultant) - designed and assisted with installation of Evergreen School Division's IITV classroom system.

4) Mr. Alain Arbez of Advance Electronics: Professional Division - Supplied/installed equipment for Souris Valley School Division's IITV classroom system.

Selection of Participants - Background Information

Introductory conversations with representatives of MERLIN and The Manitoba Department of Education and Training were held regarding the focus of the proposed study. Further telephone communications with MERLIN assisted in the identification of two IITV classroom systems, currently operational in Manitoba, that matched the basic and deluxe IITV classroom system categories. A third IITV classroom system, at that time in the construction phase, was determined to fit the intermediate category.

Preliminary contacts were made with the superintendents of each school district regarding the focus of the proposed study. The IITV coordinator was identified for each school district and initial contact was made over the telephone. Letters of invitation and consent forms were sent to the superintendent and IITV coordinator of each participating school district. Two on-site visits were made: one initially to tour the IITV classroom facilities in each district and another later, during the data collection phase.

Additionally the following individuals were contacted by telephone and sent letters of invitation with consent forms: the person responsible for the co-ordination and implementation of the Canada-Manitoba Infrastructure Works Agreement Distance

Education Project; consultants/technical experts responsible for IITV classroom system design and installation; persons responsible for the supporting transmission systems set-up; and vendors/suppliers of IITV equipment.

Interview Procedures

After the signed consent forms were received, questionnaires to be later answered during scheduled interviews were sent via e-mail to each person who had consented to participate in the study. These instruments were sent to each participant in advance of the interviews to ensure they would have sufficient time to obtain all necessary information. Data were collected through observational case analysis of the three IITV classroom systems. Information that addressed the research questions was obtained through the use of face-to-face interviews, telephone conference calls, on-site visits and personal communications.

Interview Protocol

An extensive review of the literature on IITV classroom system design and cost analysis did not provide appropriate measurement instruments relevant to the concepts central to this study. As a result, Phase one of this study consisted of developing and validating interview questionnaires appropriate for use in answering this study's research questions.

Based on a review of the literature, a pool of items for the following three interview questionnaires, was generated:

- Interview Questionnaire #1 - Why Choose IITV as an Instructional Technology? (See Appendix A),
- Interview Questionnaire #2 - IITV Classroom System Design (See Appendix B),

- Interview Questionnaire #3 - IITV Classroom System Design and Supporting Transmission System's Costs (See Appendix C).

Draft copies of Interview Questionnaires #1 and #3 were sent to two individuals noted for their expertise in IITV classroom design and application. These experts provided external review and feedback which was then incorporated into the final drafts of the first and third instruments. A draft version of Interview Questionnaire #2 had been used in a pilot study entitled Distance Education Classroom Design Consideration and Issues, conducted by the writer in 1996. Respondent feedback to the pilot instrument was taken into consideration during final completion of Questionnaire #2.

Ethical Considerations

This study commenced upon approval of the Thesis Committee and The Human Subjects Sub-Committee at Athabasca University. Prospective participants (See Appendix D) were contacted first by telephone to provide a brief overview of the study's purpose, as well as, the reasons for being approached to participate and to obtain permission to send a letter of invitation to participate in the study.

Two letters of invitation were developed. One was sent to employers/school division superintendents (See Appendix E), while the other was sent to IITV coordinators/teachers (See Appendix F). In both letters, subjects were informed of their rights as participants in the study. Subjects were also informed that in signing the letter, they were granting consent for the use of their name as a reference, when research findings were reported.

Data Analysis

Data were analyzed in relation to the research questions. Tables used to illustrate common and uncommon characteristics of the three design applications under study provide the opportunity for comparison and analysis. Diagrams of each IITV classroom's physical set-up provide for an "at a glance" comparison of all three designs. Tables used to illustrate the cost/technology relationships, as well as, summarize the cost data provide the opportunity for comparison and analysis.

Summary

This chapter presented the methodology used for this study which was designed to address the following key research questions:

1) Why choose IITV as an instructional technology?

2) What should the design of varying IITV classroom systems include?

3) How much do the varying IITV classroom systems cost?

This study's participants were: representatives of three Manitoba school divisions which utilize IITV; the person responsible for the co-ordination and implementation of the Canada-Manitoba Infrastructure Works Agreement Distance Education Project; consultants/technical experts responsible for IITV classroom system design and installation; persons responsible for the supporting transmission systems set-up; and vendors/suppliers of IITV equipment.

Data were collected through the use of questionnaires during scheduled interviews with study participants and analyzed in relation to the specific research questions. Based on this study's findings, the three key research questions were answered.

CHAPTER IV

RESULTS

The purpose of this chapter is to present the study's findings. The results of this study are presented in three sections corresponding to each of the following key research questions:

1) Why choose IITV as an instructional technology?

2) What should the design of varying IITV classroom systems include?

3) How much do the varying IITV classroom systems cost?

<u>Section (I) Why choose IITV as an instructional technology?</u>

The key research question: Why Choose IITV as an Instructional Technology? was answered by addressing the following factors: educational effectiveness, efficiency and long-range goals and objectives.

The educational effectiveness and efficiency of an IITV system was ascertained by asking the questions:

1) How does learning via an IITV system compare with learning in a traditional classroom?

2) How do benefits and costs of an IITV system compare?

Whether an IITV system assists the educational institution achieve its long-range goals and objectives was ascertained by asking the question:

3) To what extent does the system provide flexibility and efficacy in meeting the educational institution's goals and objectives?

1) <u>How does learning via an IITV system compare with learning in a traditional classroom</u>? Two out of the three school divisions sampled report conducting studies comparing learning via an IITV system with that acquired in a traditional classroom setting.

According to L. Roche (personal communication, October 9, 1997) “In a study conducted by The Distance Education Branch in Manitoba, Evergreen School Division students taking math and science courses were found to be doing just as well, and in some cases better, when taking courses via IITV as they were in their other courses taught traditionally.”

Midland School Division’s study revealed the same results. E. Wiebe (personal communication, October 7, 1997) explains “We did some statistical analysis, a number of years ago in which the results tended to present that students did as well as, and in some cases better than students in the traditional classroom.” L. Paulson (personal communication, October 6, 1997) was unable to answer for Souris Valley School Division stating “Our IITV System is currently not fully functional yet.”

2) How do benefits and costs of an IITV system compare? All three school divisions sampled agreed that the benefits of IITV far outweigh the costs associated with installing and using the technology. In answering this question the following issues were addressed by representatives of each school division: educational equality/ rural school district survival, promotion of interactive teaching strategies, reduced costs, ability to set higher goals in education and performance indicators.

Educational equality/ rural school district survival. In all three school divisions, the primary reason for establishing and using IITV systems was to ensure that rural students receive the same educational opportunities as their urban counterparts. All three school district representatives concurred that in achieving educational equality for rural students via IITV, rural school district survival was ensured, as well.

According to L. Roche (personal communication, October 9, 1997) “the Interactive Television Network (ITV) was initially researched and implemented to address the growing rural concern of education quality and access.” Roche explains that students attending schools within the Evergreen and Lakeshore School Divisions were placed in the position where all options were not available with respects to course selection. This was in part due to instructor scarcity in certain program areas compounded by insufficient student numbers to justify program offerings. “The ITV network provides the flexibility and opportunity to students who were limited to the types of courses offered at their home school by linking up with as many as four schools to garner the required number of students to justify the delivery of a specific course” (L. Roche, personal communication, October 9, 1997).

E. Wiebe (personal communication, October 7, 1997) concurs with Roche by stating:

> The primary reason for the installation and utilization of the equipment in Midland is that the student enrollments in our schools was, and continues to be, on the decline. There is a very high cost involved when you have a teacher teaching three or four students and that’s what we were finding happening in our two smaller collegiates (one in Elm Creek the other in Miami). Take for example: Physics 4OS class. In Miami there’d be three or four students requiring physics for what they wanted to go onto at university level and you would find the same situation at Elm Creek Collegiate and of course you would be tying up two teachers to teach lets say eight students. So that’s not very economic, is it? Basically what we realized could happen was that we could tie those two collegiates together, so now you have one teacher teaching eight students instead of two teachers teaching eight students. If you take a

look at that over three or four or four subject areas, over a number of years, yes there are some efficiencies to be gained by using IITV.

E. Wiebe (personal communication, October 7, 1997) further explains:

Our collegiates were shrinking in number necessitating staffing reductions and a r education in the number of courses being offered. The playing field between our larger collegiate in Carman (approx. 470 students) and our two smaller collegiates in Elm Creek and Miami was becoming less level (my use of the term 'playing field' is in relation to our students, even our smaller collegiates/schools, having access to programs that are roughly equivalent to the programs that their urban counterparts are getting. Again bearing in mind that we can't offer the specialized vocational programs in a small rural division like ours). Students were opting to go to Carman for courses they could no longer take in either Elm Creek or Miami. Was the closure of the two smaller collegiates just a matter of time? IITV was introduced in Midland to prolong the viability of our smaller collegiates. IITV allows us to share courses, particularly low enrollment courses between the schools.

M. Zuk (personal communication, September 9, 1997) agrees by stating that "one of the prime reasons an educational organization would choose to use IITV is to provide an equal opportunity for students to access courses regardless of their location, relative to the location of the instructor. If students cannot get access to the course offerings they need, they will often move to larger centers, thus compounding the problem small schools have in finding enough students to offer some courses. At the high school level, IITV helps to equalize opportunities for students in small schools where options are limited due to small enrollments." L. Paulson (personal communication, October 6, 1997) adds that "we in Souris

Valley are leveling the playing field between rural students and urban students. Use of IITV permits our ability to offer students the same kind of education as their urban counterparts, while at the same time enhancing our school district's survival."

Promotion of interactive teaching strategies. All three school divisions sampled report that they place a high value on interactive teaching strategies promotion. All three divisions agree that IITV usage promotes this.

L. Roche (personal communication, October 9, 1997) states that "two-way interactive television enables students from multiple, geographically separated schools to be technologically grouped into a single electronic classroom. Teacher-student communication is two-way and instantaneous. Students and teachers can both see and hear each other at all times. The potential for immediate and full interactivity is the difference between two-way interactive TV and other distance learning technologies. Two-way interactivity greatly improves the educational process since students are participating and not just observing."

E. Wiebe (personal communication October 7, 1997) concurs that "for many years Independent Study (correspondence) courses had been taken by students in smaller collegiates to make up for courses that could not be offered through regular instruction. However, the high failure/non-completion rate ruled out this approach in Midland. We feel that IITV is the best possible alternative to regular classroom instruction. Any course offering that is not "face to face" (student to instructor) is less effective."

M. Zuk (personal communication, September 9, 1997) agrees that IITV provides most of the characteristics of a regular classroom for students who are many miles apart. Zuk states "I believe it has been proven that most courses can be delivered with very little modification to curricula with the exception of some courses where hazardous hands-on experiences requires direct teacher supervision (i.e. Chemistry Laboratory). This technology provides students with the opportunity to interact on a personal basis with students in other schools, bringing the IITV class between schools almost to the same personal level as if the students were in one classroom together. Also the instructor and the students can utilize that extra medium of communication by viewing the communicator including their body language."

Reduced costs. All three school divisions sampled concur that IITV allows small rural school districts to realize cost savings while cooperating and sharing low-incidence courses without busing students or moving teachers from one school to another.

L. Roche (personal communication, October 15, 1997) explains "because students don't have to be traveling on buses costs are reduced. Reduced cost is evident through the travel money saved and productivity is increased because the time saved, in not traveling, can be used to work. If we didn't have IITV, we would have to be sending students back and forth between towns to take courses and busing costs are very high. They get higher every year."

E. Wiebe (personal communication, October 7, 1997) concurs with Roche by reporting that "Miami Collegiate is approximately 20 miles from Carman and Elm Creek collegiate is approximately 13 miles from Carman. Miami Collegiate has close to 135 students while Elm Creek has 115 students. If those two collegiates were to close, approximately 250 students would need to be transported to the larger collegiate in Carman. The number of additional buses required to transport those extra students would result in extremely high additional transportation costs."

The ability to set higher goals in education. All three school divisions sampled agree that IITV enhances the ability for rural schools to set higher goals in education.

According to L. Roche (personal communication, October 15, 1997) "Evergreen's long term strategy for the IITV network is to enhance the availability of post- secondary education to the Interlake region by partnering with the universities and community colleges to deliver their curriculum. This post-secondary distance education initiative will be available to all communities within the region including the First Nations under the Interlake Reserve Tribal Council."

Both E. Wiebe (personal communication, October 7, 1997) and M. Zuk (personal communication, November 7, 1997) are anticipating an additional opportunity IITV will provide to rural school divisions when Phase two of the Canada-Manitoba Infrastructure Works Agreement: Distance Education Project commences. This phase will give schools opportunities to link to a provincial network which in turn will enable them to receive educational programs from virtually anywhere in the world. Classrooms linked to this larger network will be able to embark on "electronic field trips" to locations around the world, and serve as a community resource for videoconferencing, labor force training and community development (Manitoba Government, 1995).

Performance indicators. In answer to whether or not the school divisions were looking for a return on investment (ROI) when the IITV systems were established, all three school divisions replied no.

E. Wiebe (personal communication, October 7, 1997) explains "what we are really looking at here is leveling the playing field between the large collegiate in our division and the two small collegiates because we cannot, in the smaller collegiates be offering courses for three or four students in a particular course.” Wiebe provides an example of physics 300: “we just can’t afford to tie up a teacher for three or four students, a period a day, for a full year. But if we combined that course with, let’s say Miami Collegiate together with Elm Creek Collegiate, now we have 10 or 12 students between the two collegiates. Better yet, if we use IITV to link the three collegiates together and have a class size of about 25, then the students in the small collegiates don’t have to take that program/course through independent study. They now get the next best thing to having the teacher right there in the classroom. IITV provides a teacher that they can see and hear and they in turn can be seen and heard by the teacher.”

E. Wiebe (personal communication, October 7, 1997) further elaborates that “Our setting up an IITV system was not so much economics or a return on investment as it was the ability to prolong the viability of smaller schools.” Wiebe explains “if we can’t offer some of these vitally needed programs in small schools, then kids from the small schools will tend to transfer over to the larger collegiate and it’s just a matter of time then before you start to see those small schools become unviable. You then get closer to the point of where we have to consider whether we have to close those small schools.”

L. Paulson (personal communication, October 6, 1997) concurs with Wiebe and states that “first of all, we did not look upon IITV as being a financial investment. We obviously need to be careful about how much money we spend, but we are not interested in, for example, replacing teachers with this system because we are not a profit generating agency. What we are doing is attempting to provide more options and more programs for our children to allow them to compete with urban students. So we are not really concerned about whether or not we are going to make money on this or even recoup our investment - in all likelihood, we probably won't. What we will do is bring more opportunities to our children."

Type of performance indicators used. All three school divisions use number of students being served and number of students pursuing further studies at university as performance indicators of whether the IITV system is achieving what it was intended to achieve.

E. Wiebe (personal communication, October 7, 1997) explains "If the rural school is unable to offer courses that students require, then the students will often move to the larger centers in order to access these courses. IITV allows rural school divisions to offer low frequency, specialized courses. Thereby preventing student enrollment decrease."

L. Paulson (personal communication, October 6, 1997) and L. Roche (personal communication, October 15, 1997) concur with Wiebe. Paulson states that "in using IITV we are leveling the playing field between rural students and urban students. Use of IITV permits our ability to offer rural students the same quality of education as their urban counterparts. This in turn allows them to compete equally for admission to university."

3) To what extent does the system provide flexibility and efficacy in meeting the educational institution's goals and objectives? All three school divisions sampled agree that IITV provides flexibility and efficacy in meeting their educational goals and objectives?

According to L. Roche (personal communication, October 22, 1997) IITV provides flexibility and efficacy in meeting "the goal of using IITV to improve quality education for all students by: supporting and expanding the K-S4 school curriculum; supporting and expanding continuing education and post secondary education; and supporting and expanding opportunities for professional development of K-S4 school staff."

E. Wiebe (personal communication, October 7, 1997) & L. Paulson (personal communication, October 6, 1997) concur with Roche by acknowledging that in Souris Valley School Division and Midland School Division "the overall goal of using IITV is to level the playing field between rural students and urban students. Use of IITV permits the ability to offer students the same kind of education as their urban counterparts."

However, it was found that Evergreen School Division is the only school division that has expanded IITV usage beyond that of the school. According to L. Roche (personal communication, October 22, 1997), "ITV from an institutional perspective provides a distinct service to the individuals within the education system. However, the Evergreen ITV system has enormous potential to assist in increasing the accessibility and diversity of offerings to all members of the community. Utilization of the network not only provides opportunities to investigate methods of retraining, but also provides opportunities to investigate methods of involving local businesses, industries and governments in the training process. The network is used for regional committee meetings, area counterpart meetings, non-credit courses and credit community college courses. Negotiations are ongoing with the universities to provide courses to residents of the region without having to travel to Winnipeg or Brandon."

<u>Section (II) What should the design of varying IITV classroom systems include?</u>

The key research question: What should the design of varying IITV classroom systems include? is answered through an investigation and analysis of the following specific research questions:

- What are the design characteristics of:

    i) a basic IITV classroom system?

    ii) an intermediate IITV classroom system?

iii) a deluxe IITV classroom system?

- Which elements are common to all three designs?
- Which elements are not common to all three designs?
- What are the advantages and disadvantages associated with each design?

What are the design characteristics of: a basic IITV classroom system, an intermediate IITV classroom system and a deluxe IITV classroom system? The findings for design characteristics of a basic, an intermediate and a deluxe IITV classroom system are presented in Tables 14 - 24. It is important to note that the basic system is found in the Midland School Division; intermediate system is found in the Souris Valley School Division; and the deluxe system is found in the Evergreen/Lakeshore School Division. Also noteworthy is the use of n/a to represent not applicable.

What are the design characteristics of a basic IITV classroom system? The basic IITV classroom system is a science laboratory classroom which has had minimal remodeling. The classroom is non-dedicated, meaning it serves the dual purpose of being a science laboratory when it is not used for IITV course delivery. Equipment required for two-way audio and video interactive instructional television has been placed wherever there was room for it (i.e. on countertops, desks, science lab teacher's station) (See Figures 2 and 3).

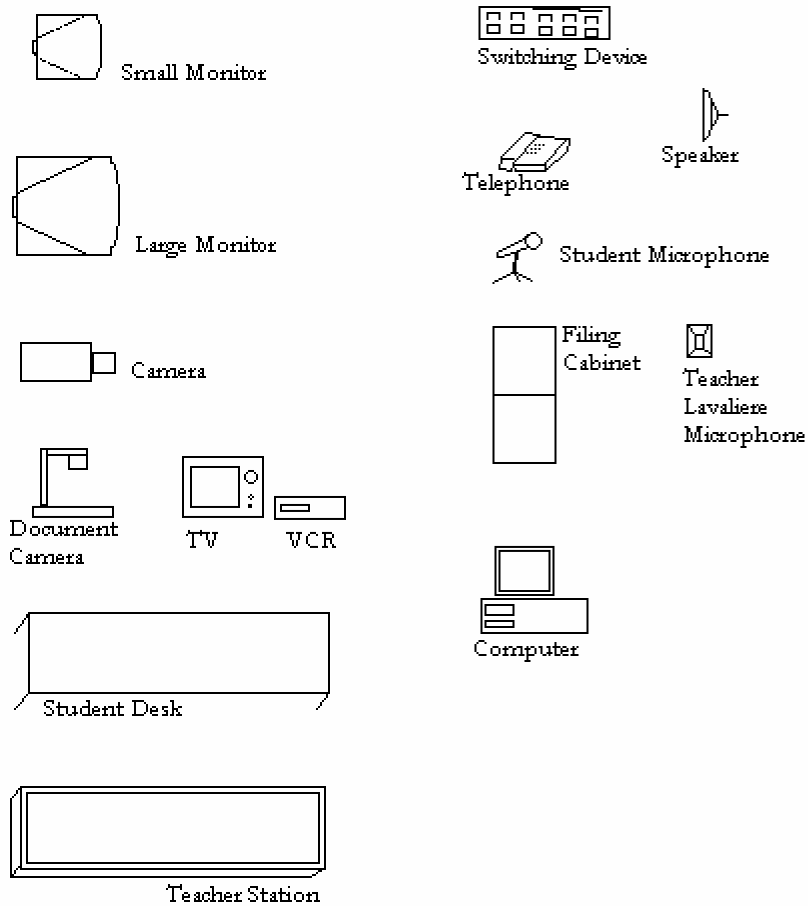

Figure 2
Key: Symbols used to designate IITV Classroom System Equipment shown in Figures 3, 4 and 5

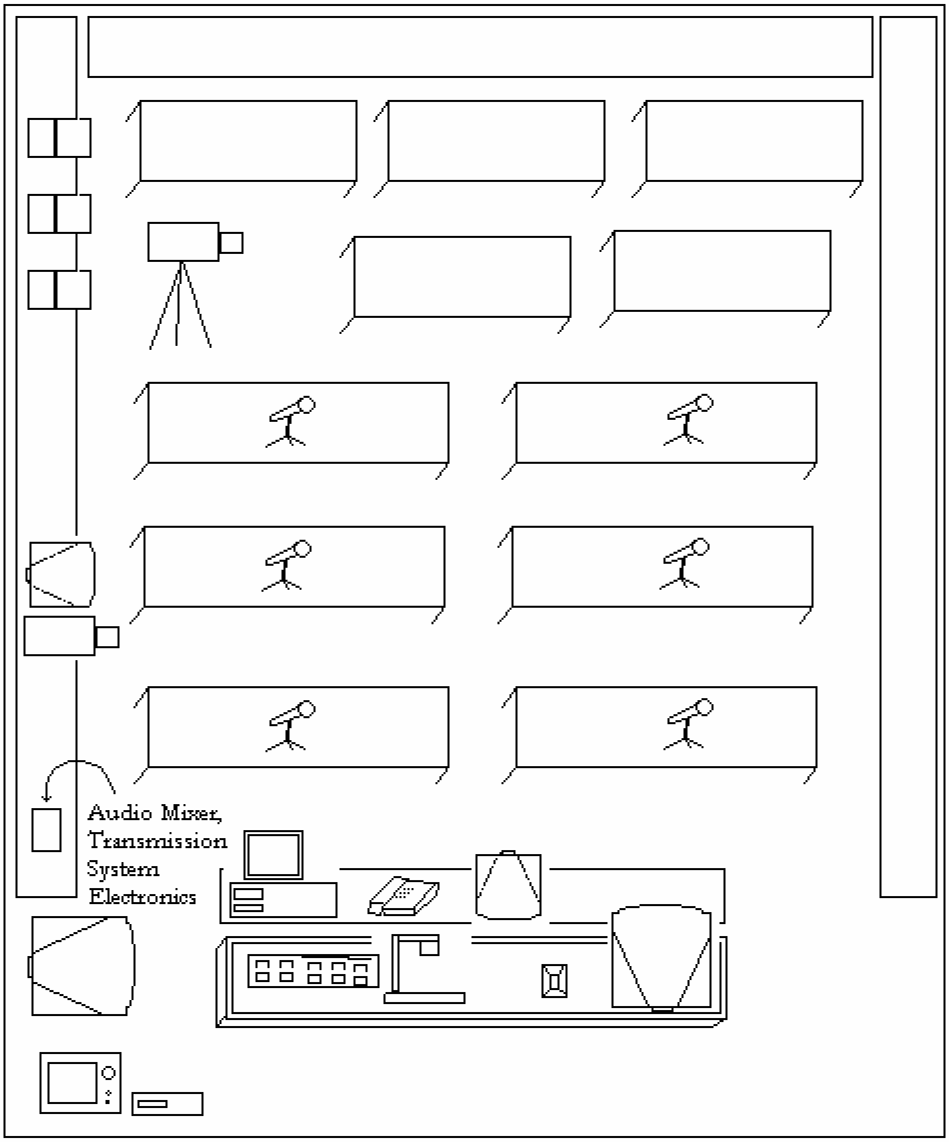

Figure 3
Basic IITV Classroom System Design

In this design, a total of four monitors are used, three for student viewing and one for the teacher viewing. One student monitor sits to the left of the students, on top of the teacher station and is used for students to view what is being displayed by the visual presenter/document camera. The other two student monitors are situated to the right of the students and are used for remote site viewing. A fourth, smaller monitor sits on a desk in front of the teacher station and is used by the teacher to monitor the outgoing signal.

This design utilizes a single camera with remote control pan and tilt capabilities to capture on video what the teacher wishes to have sent to the remote sites. This is accomplished through the use of six pre-set classroom locations (i.e. the teacher’s station is one location, the students in the home site classroom are another location, the document camera is another location, etc.). This camera is situated on top of a cupboard attached to the wall directly to the right of the students.

A total of seven microphones are used, six which are open (with manual off and on) are used by the students. While a wireless lavaliere microphone is used by the teacher. The student microphones are placed on counters to the side of the classroom, when not in IITV use.

In the basic IITV classroom system design student desks are not permanently attached to the floor. They are arranged in four rows of two desks and one row of three. The desks which seat two students each, are a variety of sizes with the majority being 6’ x 3’ in dimension.

What are the design characteristics of an intermediate IITV classroom system? The intermediate IITV classroom system is a standard classroom that has been remodeled into a flat-floored IITV classroom system design with additional consideration to wiring/electrical upgrading and acoustical treatment. Equipment required for two-way audio and video interactive instructional television has been installed with consideration to the maintenance of lines of sight and communication with all students at all locations. The classroom is dedicated solely for the purpose of IITV course delivery (See Figures 2 and 4).

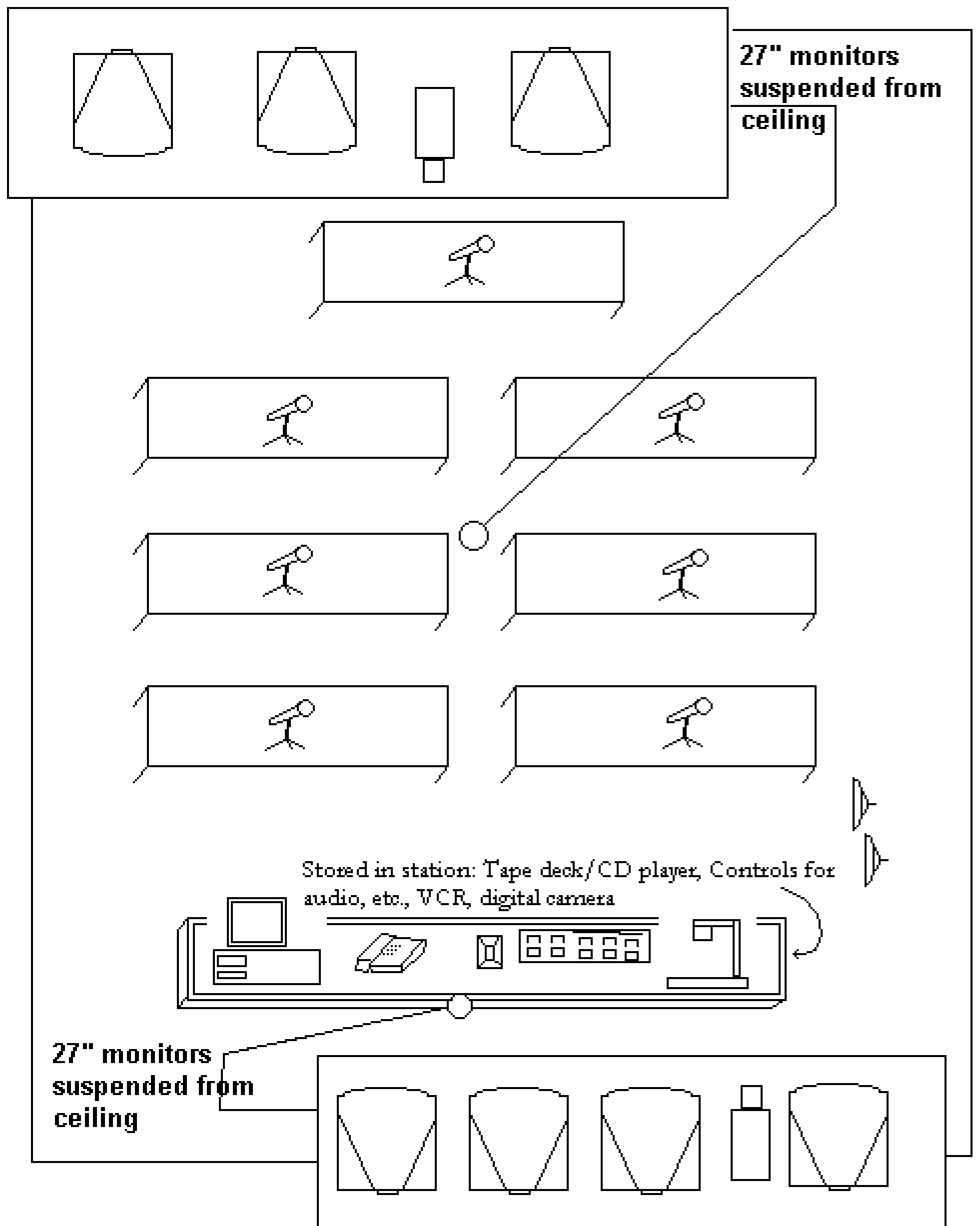

Figure 4
Intermediate IITV Classroom System Design

In this design, a total of seven monitors are used, four for student viewing and three for teacher viewing. Two student monitors provide remote site viewing, one is used to view the outgoing signal and the fourth one is used to view the document camera. Two teacher monitors are used to view the remote sites while the other monitor is used to view the outgoing signal. All monitors are suspended from the ceiling. The student viewing monitors are positioned above the teacher's station while the teacher viewing monitors are positioned above the students.

This design utilizes two cameras with remote control pan and tilt capabilities. The student camera is suspended from the ceiling and situated between the student viewing monitors. This camera is microphone activated (i.e. it zooms to the student who depresses a microphone first). The teacher camera is suspended from the ceiling and is situated between the teacher viewing monitors. This camera utilizes a follow function that remembers the teacher's flesh tones and will track the teacher as he/she moves. Camera switching is accomplished manually via a Crestron switching device.

A total of eight microphones are used, seven of which are push-to-talk are used by the students. While a wireless lavaliere microphone is used by the teacher. The student microphones are permanently attached to the student desks.

In the intermediate IITV classroom system design student desks are permanently attached to the floor. The desks are all uniform in dimension (6' x 2') and are arranged in three rows of two desks and one row of one desk. Each desk seats two students.

This design includes a teacher's station which is a custom made desk that houses all the audio/video/site switching equipment. This station also houses all of the auxiliary equipment (i.e. computer, tapedeck/CD player, one camcorder, one digital camera and a VCR) and has extra provision for equipment storage.

<u>What are the design characteristics of a deluxe IITV classroom system</u>? The deluxe IITV classroom system is the stage area of a former gymnasium that was initially remodeled into a multi-purpose classroom and then subsequently remodeled into a tiered IITV

classroom system design with additional consideration to wiring/electrical upgrading and acoustical treatment. Equipment required for two-way audio and video interactive instructional television has been installed with consideration to the maintenance of lines of sight and communication with all students at all locations. The classroom is dedicated solely for the purpose of IITV course delivery (See Figures 2 and 5).

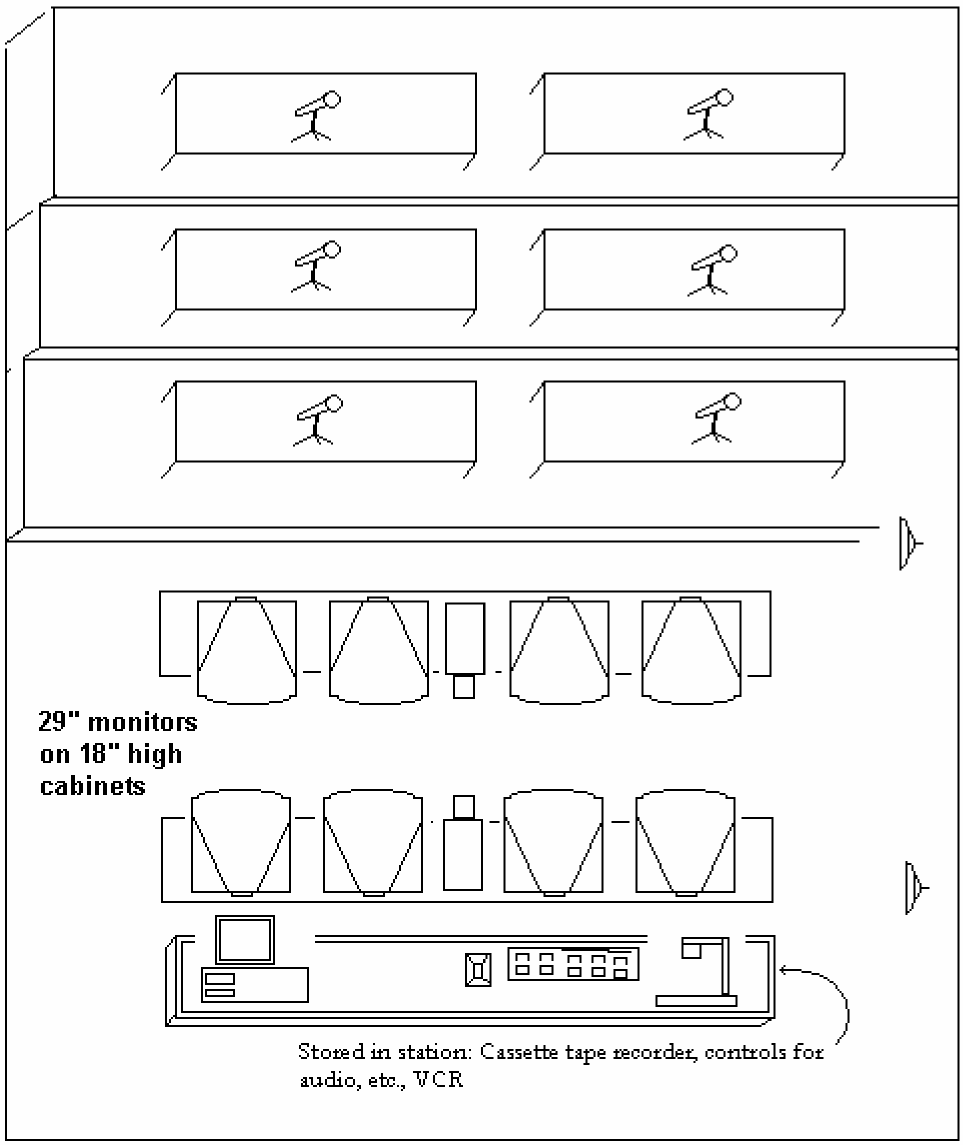

Figure 5
Deluxe IITV Classroom System Design

In this design, a total of eight monitors are used, four for student viewing and four for teacher viewing. Three student monitors are used to view the remote sites and one is used to view the outgoing signal. Three teacher monitors are used to view the remote sites while the other is used to view the outgoing signal. All monitors are mounted on cabinets (18” height) that sit on floor. The student viewing monitors are positioned directly in front of the teacher’s station (top of monitors is level with teacher station surface). While the teacher viewing monitors are positioned directly in front of the first row of student desks (top of monitors is level with student desk surface).

This design utilizes two cameras. The student camera is fixed (remains focused on students at all times) and is mounted on top of the cabinet between the student viewing monitors. The teacher camera has multi-function remote control pan and tilt capabilities. It is mounted on top of the cabinet between the teacher viewing monitors. Camera switching is accomplished manually via a HEDCO switching device.

A total of eight microphones are used, six of which are voice-activated, are used by the students. The remaining two are used by the teacher and consist of a wireless lavaliere microphone and a fixed microphone located at the teacher’s station. All student microphones are permanently attached to the student desks.

In the deluxe IITV classroom system design student desks are permanently attached to the floor. The desks are arranged in three tiered rows (15” tier), seat two students each and are all uniform in dimension (6’ x 2’).

This design includes a teacher’s station made from pre-existing remodeled cabinets. The teacher’s station houses all the audio/video/site switching equipment, as well as, all of the auxiliary equipment (i.e. computer, cassette tape recorder and VCR) and has extra provision for equipment storage.

What are the common and uncommon elements of all three designs? This section addresses the following specific research questions: Which elements are common to all three designs? and Which elements are not common to all three designs? For the purpose of presentation, these two questions have been combined into one question: What are the common and uncommon elements of all three designs?

Table 14 presents the findings for classroom size and room location of the three IITV classroom system designs under study. Of the eight considerations, three are found to be common among all three designs, while five are uncommon. The common considerations are: a policy is used to limit the maximum number of students permitted in a course offered via IITV; any of the sites can assume the role of initiating site; and to prevent an excessive noise level generated from hallway, recesses are timed and consistent between schools.

In all three IITV classroom systems the maximum number of students allowed at one site is 12 students. When considering the maximum number of students that can be taught using IITV, the total number for all sites is included. The basic system serves a maximum of 28 students; while the intermediate system serves a maximum of 24 students; whereas the deluxe system serves a range of 25-30 students.

In all three instances the site that is designated as “initiating” is determined by the location of the teacher teaching the course delivered by IITV. Since all schools in each of three IITV systems have teachers responsible for teaching at least one course by IITV, each of the schools becomes the initiating site at one time or another.

Table 14

Physical Considerations in IITV Classroom System Design: Classroom Size and Room Location

Consideration	Basic System	Intermediate System	Deluxe System
Classroom size			
Dimension	30’x40’ rectang. science lab	33’x24’ rectangular	35’x50’ rectangular
Ceiling height	About 10’	9’ (dropped ceiling)	15’ at highest point
One initiating site	No - All sites can be initiating site	No - All sites can be initiating site	No - All sites can be initiating site
Classroom location			
Relationship to other classes	Southwest corner in major hallway	Northern exposure reduces heat/glare; end of hall in 2; close to school office in 2	Middle of school - location of tiered room
Dedicated room	No	Yes	Yes
Acoustic advantage considered	No	Yes (purposely chose room with no lockers or new lockers outside)	No; traffic everywhere
Noise level from hallway traffic	Lockers outside, but not big problem during class time Timed recess to avoid noise	Timed recess to avoid noise	Timed recess to avoid noise

Uncommon considerations include: classroom dimension, ceiling height, relationship of classroom location to other classes, whether or not the classroom is dedicated solely for the purpose of IITV, and whether or not thought was given to acoustic advantage when the classroom was initially considered for IITV use.

The classroom dimensions of the three designs varies considerably. This is due to the basic system being a non-dedicated IITV classroom system with the additional function of science laboratory classroom. By virtue of the fact that this classroom is a science lab, it is larger than the standard type classroom in which the intermediate system is housed. The deluxe system, larger still than both the basic and intermediate classrooms, is housed in what was previously the renovated stage area of a former gymnasium. This room's dimensions permitted the installation of tiered steps. If the ceiling height had been lower, tiering reportedly would not have been possible.

Table 15 presents the findings for electrical service of the three IITV classroom system designs under study. Of the nine considerations, three are found to be common among all three designs, while six are uncommon. The common considerations are: none of the classrooms' wiring systems are located near motors or heating/cooling systems; all three IITV classroom systems have cords/wires running across the floor ; and all three report the presence of a crawlspace under the classroom rather than a wooden sub-floor.

In two designs, the intermediate and deluxe, cords/wires from monitors, cameras and microphones are encased in a plate/channeling which is permanently attached to the floor and runs down the center of the classroom, where it is reported that traffic is minimized, to prevent tripping or damage. In both of these situations, this particular location of cords/wires is attributed to the presence of thick concrete which precluded the ability to run cords/wiring

Table 15

Physical Considerations in IITV Classroom System Design: Electric Service

Consideration	Basic System	Intermediate System	Deluxe System
Number of circuits	unknown	3	3
Number of outlets	4	4	15
Located near motors or heating/cooling systems	No	No	No
Inner liners or conduits	Unknown	No (BX cable used - Industry Standard)	No
Surge/spike protectors	No	Yes	Yes
Dedicated circuits and panel	No	Yes - dedicated circuits (Panel located outside nearby)	Yes - dedicated circuits (Panel located outside nearby)
Cords/wires running across floor	Yes microphone cords stretch across floor	Yes monitors, cameras and microphone cords encased together in floor channeling running down center of classroom floor	Yes monitors, cameras and microphone cords covered with metal plate running down center of classroom floor
Access to ceiling wiring	No	Yes through drop ceilings	Yes through suspended ceilings

beneath the classroom floor. In the basic design, a non-dedicated classroom, student microphone cords run across the floor whenever an IITV course is being delivered. Cords/cables from the electronic IITV equipment trail across countertops, desks, teacher's station etc.

Uncommon considerations include: the use, number and location of dedicated circuits and breaker panels; the number of outlets; the use of inner liners or separate conduit for each connection; the installation of surge/spike protectors; and access to ceiling wire through suspended ceilings. The number of circuits and the use of inner liners or separate conduit for each connection were reported as unknown for the basic system.

Table 16 presents the findings for classroom arrangement of the three IITV classroom system designs under study. Of the nine considerations, one is found to be common among all three designs, while eight are uncommon. The common consideration is: the number of students seated per desk during a course delivered via IITV.

The uncommon considerations include: number of student desks used; number of student desk rows; amount of flexibility allowed for by each design; seating arrangement in relation to camera/monitors; monitor viewing distance; vertical angle view in relation to monitors; and number of classroom doors including their relationship to the camera.

In the basic IITV classroom system student desks are not anchored to the floor. In contrast the desks in the other two designs are anchored to the floor. This anchoring precludes the ability for flexibility in classroom arrangement (i.e. moving desks into a circle or horseshoe design is not possible).

Students are seated facing the teacher's station, in the basic system. The camera is located to the right of the students, the picture that the remote site students view on the

Table 16

Physical Considerations in IITV Classroom System Design: Classroom Arrangement

Consideration	Basic System	Intermediate System	Deluxe System
Number of desks	11	7	6
Rows of desks	4 rows of 2 1 row of 3	3 rows of 2 1 row of 1	3
Students per desk	2	2	2
Flexibility of design	Yes Desks are not anchored to floor	No Desks are anchored to floor	No Desks are anchored to floor
Seating arrangement in relation to camera/monitors	Students have to turn to face camera and/or to view monitors	Students face camera/monitors Teacher/students able to view remote sites in their entirety	Students face camera/ monitors Teacher/ students able to view remote sites in their entirety
Viewing distance	Approx. 10’ - 30’	Approx. 10’ - 25’	Approx. 10’ - 20’
Vertical angle view in relation to monitors	Students look to side	Students look up	Students look down
Classroom doors			
Number	2	1	2
Relationship to camera	Out of camera range	Within camera range	Out of camera range

monitors is a side view of the students’ faces unless they turn to face the camera and/or view the monitors. In contrast, the students in both the intermediate and deluxe systems face the camera and monitors. Therefore, the picture that the remote site students receive is the front view of the students (the students appear to be looking directly at the remote site students).

In the basic system the teacher/students are unable to view the entire remote site class. By comparison, both the intermediate and deluxe systems’ teachers/students are able to view the entire remote site class.

Both basic and deluxe systems have classroom doors which are not located within camera range. In contrast, the intermediate system’s door is within camera range. This is reported to allow for the surveillance of individuals entering and exiting the remote site classrooms. Representatives of both the basic and deluxe IITV system classrooms reported that surveillance of doors is not an issue requiring attention, at this time.

Table 17 presents the findings for decor, windows/walls and floors/ceilings of the three IITV classroom system designs under study. Of the seven considerations, three are found to be common among all three designs, while four are uncommon. The common considerations are: background; surface finishes; and the floor not being free of wiring/cords.

In all three designs the background picked up on video is a solid color, with no complex patterns. Each design is characterized by non-shiny finishes. In the basic system the perimeter glass cabinets do not pose a problem because they are excluded from camera view. all three IITV classroom systems have cords/wires running across the floor ; and all three report the presence of a crawlspace under the classroom rather than a wooden sub-floor.

In all three designs, the floor is not free of wiring/cords. Both the intermediate and deluxe systems have cords/wires from monitors, cameras and microphones which are

Table 17

Physical Considerations in IITV Classroom System Design: Decor, Windows/Walls and Floors/Ceilings

Consideration	Basic System	Intermediate System	Deluxe System
Decor			
Background	solid color; no complex patterns	solid color; no complex patterns	solid color; no complex patterns
Surface finishes	non-shiny	non-shiny	non-shiny
Windows/Walls			
Colour	beige/cream walls	light blue walls; three 4'x8' dark blue acoustical panels on wall opposite speakers	beige walls with acoustical panels on one wall
Coverings	no windows	two windows covered by dark blue, acoustically-treated blinds	no windows
Floor Colour/Covering	non-reflective grey asphalt tile	blue with blue fleck non-reflective carpet	greyish-blue non-reflective carpet
Floor free of wiring/cords	No	No	No
Ceiling colour/covering	1960s asbestos ceiling tile made of white non-reflective acoustical materials	Suspended 2'x 4' tiles made of white non-reflective acoustical materials	Suspended ceiling tiles made of white non-reflective acoustical materials

encased in a plate/channeling that is permanently attached to the floor and runs down the center of the classroom, where it is reported that traffic is minimized, to prevent tripping or damage. Student microphone cords run across the floor whenever an IITV course is being delivered in the basic system.

Uncommon considerations include: window/wall color and coverings; floor color/covering; and ceiling color/covering. The walls in both the deluxe and basic IITV classrooms have been painted a beige color while the intermediate wall is a light blue color. In all three designs the paint used is a flat non-glossy type. The intermediate and deluxe systems have acoustically treated wall paneling on one wall each. The floor in both intermediate and deluxe systems has been carpeted. In contrast, the basic system has no acoustically treated wall paneling nor has it been carpeted.

Table 18 presents the findings for private conference area, storage and security of the three IITV classroom system designs under study. Of the seven considerations, three are found to be common among all three designs, while four are uncommon. The common considerations are: no provision for a private conference area; and the absence of door sweeps, metal falanges and dead bolts.

Uncommon considerations include: provision of adequate storage; equipment marked with ownership designation; additional/other security measures; and experience with theft or vandalism.

The basic system has inadequate provision for storage. This is reportedly due to the room's dual function of science laboratory and IITV classroom. Prior to IITV usage this room had sufficient room for science equipment. However, its additional function compounded by the fact that the majority of IITV equipment is too large for the cabinets/drawers, has made

Table 18

<u>Physical Considerations in IITV Classroom System Design: Storage and Security</u>

Consideration	Basic System	Intermediate System	Deluxe System
Private conference area	None	None	None
Storage	Inadequate because classroom is not dedicated, i.e., too much science equipment and IITV equipment is too large for cabinets and drawers	Adequate - storage shelving across front of room - teacher station has capacity for storage	Adequate - extra storage area in room beside classroom - teacher station has capacity for storage
Security			
Door sweeps/metal flanges	No	No	No
Door dead bolt	No - standard lock	No - standard lock	No - standard lock
Marked equipment	No	Yes	No
Other measures	No additional security precautions have been instituted	- Door has motion-detector intruder alarm system and windows have locks. - Office monitor	Door has motion-detector intruder alarm system - Office monitor
Experience with theft or vandalism	Yes VCR stolen this summer and one microphone destroyed	No	No

the storage of equipment problematic. In contrast, both intermediate and deluxe systems have sufficient storage capacity.

Besides an ordinary classroom lock, the basic system has no additional security precautions. By comparison, both the intermediate and deluxe systems have motion detector intruder alarm systems, as well as, a monitor located in the school secretary's office. The basic IITV system has experienced theft and vandalism while the other two systems report no such incidences.

Table 19 presents the findings for environmental considerations of the three IITV classroom system designs under study. Of the nine considerations, four are found to be common among all three designs, while five are uncommon. The common considerations are: occurrence of exterior and interior noise; whether lights can be selectively switched off and on or dimmed; and non-inclusion of additional light source at teacher station. Uncommon considerations include: ventilation and temperature control; acoustical treatment; occurrence of echoes; type of classroom lighting; and presence of glare.

In all three designs, each set of lights can reportedly be selectively switched off and on. Neither of these systems incorporates the use of light dimmers. All three designs report the non-inclusion of additional light source at teacher station. The intermediate system reportedly has a need for more light at teacher station because the documents camera is casting shadows, which in turn are being picked up on video. This has been attributed to a problem with the location of the ceiling lights.

None of the IITV classroom systems report the occurrence of interior or exterior noises that might interfere with the audio transmission. Neither the basic nor the deluxe systems reportedly experience echoes. The intermediate system, however, does. These echoes

Table 19

Environmental Considerations in IITV Classroom System Design

Consideration	Basic System	Intermediate System	Deluxe System
Ventilation and temperature control	- New heating/air conditioning unit control in adjacent classroom. - Room temp. either too hot or too cold	- No air conditioning - IITV equipment components generate heat; heat buildup problem - Individual thermostat in classroom.	- No air conditioning - ceiling fan decreases heat buildup - Individual thermostat in rm.
Audio/Acoustical Treatment	None	Yes - One wall has acoustic paneling - Carpet - Acoustically-treated blinds - Acoustically-treated ceiling tile	Yes - One wall has acoustic paneling - Carpet - Ceiling tile made of acoustic material - High ceiling
Audio/Echoes	None	Yes	None
Lighting			
Type	4 sets of standard fluorescent lights	2 sets of digital fluorescent lights	6 sets of fluorescent lights
Glare	fluorescent lights create glare on monitor screens	None	None
Teacher Station Light	None	None	None

reportedly occur as a result of student microphones being accidentally left open and/or if the teacher microphone at a remote site is inadvertently left open.

The basic IITV classroom system has had no acoustical treatment. In contrast, both intermediate and deluxe systems have received acoustical treatment which includes: acoustically treated wall paneling, carpet, acoustically treated blinds (if applicable) and ceiling tiles made of acoustical materials.

The basic system experiences glare on the monitors which is created by the fluorescent lights. This glare is reportedly reduced by turning three sets classroom lights off and leaving one set turned on for students to see sufficiently to write .

Table 20 presents the findings for furniture considerations of the three IITV classroom system designs under study. Of the ten considerations, two are found to be common among all three designs, while eight are uncommon. The common considerations are: type of student chairs used and inclusion of a whiteboard at the teacher's station.

Uncommon considerations include: type and dimensions of student desks; use of a riser for the teacher's station; teacher station dimensions, type and function of switching device located at teacher's station; type and location of instructor chair; teacher's ability to view off-site monitors on the same line of sight as instructor camera; and the quality of the whiteboard's video transmission.

In the basic IITV classroom system the student desks, which are moveable, can seat two to three students, and are not of one standard size. They are of various type and size, ranging from 3'x 2' and 4' x 2' to 6' x 2', the majority being the latter size. In contrast, student desks in both intermediate and deluxe systems are standardized in size. In both of

Table 20

Furniture Considerations in IITV Classroom System Design

Consideration	Basic System	Intermediate System	Deluxe System
Student seating/type	Standard molded plastic	Standard molded plastic	Standard molded plastic
Teacher station			
Use of riser	Yes - 6” riser	No	No
Dimensions	8’x2’	10’x3’	12’x2.5’
Switching Device	Yes	Yes	Yes
Type/Function	Kramer - selects video source/signal sent to the transmitter	Crestron - controls audio and video	HEDCO - controls the video signal
Instructor chair	Science lab stool - height not adjustable	Regular instructor chair at desk height	Regular stool - not height adjustable
Site lines to monitors	Teacher views 1 remote site monitor on same line of site as camera; 2 monitors are to the left and right of teacher station	Teacher views remote site monitors on same line of site as teacher camera	Teacher views remote site monitors on same line of site as instructor camera
Whiteboard/Quality of transmission	Yes - Video transfer is good provided steps have been taken to eliminate prevailing glare, i.e., shutting off fluorescent lights	Yes - Video transfer is good except shadows present due to lights	Yes - Video transfer is excellent

these designs, student desks are: 6’ x 2’ in dimension; attached to the floor; and designed to seat two students.

The basic system makes use of a riser on which the teacher’s station is situated, while the other two systems do not. This inclusion of a riser is reportedly not by design. It is said to be due to the basic system making use of a pre-existing science lab teacher’s station which utilizes a riser to promote students’ ability to view science experiment demonstrations. However, in all three designs students reportedly are and would be able to see what is being done at the teacher’s station without the use of a riser. This is attributed to use of the document camera which enhances students’ visual ability, both at the initiating site and remote sites.

As previously mentioned, the basic system’s teacher station is a pre-existing science lab teacher’s station. The teacher’s station in the intermediate classroom was custom-made. While in the deluxe classroom the station is made from a remodeled set of cabinets.

Concerning site lines to the monitors the intermediate and deluxe systems reportedly have the same lines of sight. However, in the basic system the teacher is able to view only one remote site monitor on the same line of site as the camera is set on. This occurs when the teacher moves out from behind the station to a stand/sit among the students while turned to face the camera. Viewing the other remote site monitor requires that the teacher turn to the left to see it, removing the teacher from line of site with the camera. Viewing the monitor used to show the picture displayed by the document camera requires that the teacher face the teacher’s station while standing/sitting among the students. This also removes the teacher from line of site with the camera.

In the deluxe system the video transfer is reported to be excellent. In contrast, the video transfer in the basic system is reported to be good only when steps have been instituted to eliminate the prevailing glare produced by fluorescent lights. In the intermediate system the document camera is casting shadows onto whatever is being displayed. This has been attributed to insufficient lighting at the teacher station. Reportedly the video transfer is good only when all lights are shut off.

Table 21 presents the findings for equipment standardization and microphone considerations of the three IITV classroom system designs under study. Of the eight considerations, one is found to be common among all three designs, while seven are uncommon. The common consideration is: each design includes the lavaliere microphone option for teachers.

Uncommon considerations include: standardization of equipment for all sites; number and type of student microphones; use of an open microphone and speaker system; separation between microphones and speakers; speaker location; and number/type of teacher microphones.

Only the intermediate system has standardized the IITV equipment for all sites. The Evergreen School Division (deluxe system) has only one tiered IITV classroom. None of the other sites had ceilings high enough to permit tiering which reportedly requires a minimum of 15’. Subsequently the tiered classroom has monitors mounted on cabinets which sit on the floor (18’’ in height) and all other sites have monitors and cameras suspended from ceiling. The basic system lacks standardization because the electronics in the Carman site are reportedly used for other courses. This requires that the Carman site have more equipment

Table 21

Equipment Considerations in IITV Classroom System Design: Equipment Standardization and Microphones

Consideration	Basic System	Intermediate System	Deluxe System
Standardization of equipment for all sites	No	Yes	No
Student microphones			
Number	6	7	6
Type	Open microphones usually turned off until student speaks	Push-to-talk attached to desks	Gooseneck; voice-activated mounted on student desks
Open microphones and speakers	Yes	No (only if forget to shut one off)	No
	No speakers	Yes speakers	Yes speakers
Microphones and speakers separated	n/a	Yes	Yes
Speaker location	n/a	Speakers suspended from ceiling and Microphones attached to desks	Speakers suspended from ceiling and Microphones attached to desks
Teacher microphones/number	1	1	2
Lavaliere mic option	Yes	Yes	Yes

Note. n/a - not applicable.

with extra switching capacity to prevent the transmission of non-IITV course work, while the equipment is being used.

In the basic design a total of seven microphones are used, six which are open (with manual off and on) are used by the students. While a wireless lavaliere microphone is used by the teacher. The student microphones are placed on counters to the side of the classroom, when not in IITV use.

In contrast, the intermediate design uses a total of eight microphones, seven of which are push-to-talk are used by the students. A wireless lavaliere microphone is used by the teacher and the student microphones are permanently attached to the student desks.

The deluxe design also uses a total of eight microphones. However, what's different in this design is that six not seven are used by students and are voice-activated. The remaining two are used by the teacher and consist of a wireless lavaliere microphone and a fixed microphone located at the teacher's station. All student microphones are permanently attached to the student desks.

The basic system uses student and teacher microphones only. This is in contrast to the intermediate and deluxe systems which have two speakers each suspended from the ceiling to the right of the teacher station.

Table 22 presents the findings for cameras, monitors, visual presenter, telephone and facsimile equipment considerations of the three IITV classroom system designs under study. Of the eight considerations, one is found to be common among all three designs, while seven are uncommon. The common considerations is: use of a visual presenter/document camera.

Uncommon considerations include: number of cameras in use during an IITV class; function of each camera; how switching from one camera to another camera is accomplished;

Table 22

Equipment Considerations in IITV Classroom System Design: Cameras, Monitors, Visual Presenter, Telephone, and Facsimile Machine

Consideration	Basic System	Intermediate System	Deluxe System
Cameras Number and function	1 Remote control with pan-tilt using handheld remote	2 - 1 student (zooms to student who depresses microphone first); 1 teacher (utilizes "follow" function that "remembers" teacher flesh tones); identical multi-function remote control with pan and tilt	2 - 1 student -fixed; 1 teacher-multi function remote control with pan and tilt
Switching	Manual switching of six pre-set locations	Manual switching using Crestron computer	Manual switching using HEDCO device
Monitors	Total 3 - 2-33" and 1-27" monitors;	Total 7 - 27" monitors	Total 8 - 29" monitors
Visual Presenter Capabilities	Yes - Video labs Manual-controlled document camera	Yes - Elmo DT100 Document camera with zoom and auto focus functions; aux. sound and video inputs	Yes - Same as teacher camera Has multi-function remote control with pan and tilt-zoom and auto focus
Telephone	Yes	Yes	No
Facsimile machine	No (computer has fax modem)	Yes (also acts as a photocopier)	No

number of monitors in use during an IITV class - including monitor size and function; visual presenter brand and capabilities; inclusion of a telephone; and inclusion of a facsimile machine.

The intermediate and deluxe systems both have two cameras while the basic system has one. In the basic design a single camera with remote control pan and tilt capabilities is used to capture on video what the teacher wishes to have sent to the remote sites. This is accomplished through the use of six pre-set classroom locations (i.e. the teacher's station is one location, the students in the home site classroom are another location, the document camera is another location, etc.). This camera is situated on top of a cupboard attached to the wall directly to the right of the students.

The intermediate design utilizes two cameras with remote control pan and tilt capabilities. The student camera is suspended from the ceiling and situated between the student viewing monitors. This camera is microphone activated (i.e. it zooms to the student who depresses a microphone first). The teacher camera is suspended from the ceiling and is situated between the teacher viewing monitors. This camera utilizes a follow function that remembers the teacher's flesh tones and will track the teacher as he/she moves. Camera switching is accomplished manually via a Crestron switching device.

The deluxe design also utilizes two cameras. The student camera is fixed (remains focused on students at all times) and is mounted on top of the cabinet between the student viewing monitors. The teacher camera has multi-function remote control pan and tilt capabilities. It is mounted on top of the cabinet between the teacher viewing monitors. Camera switching is accomplished manually via a HEDCO switching device.

In the intermediate and deluxe designs switching from one camera to another is done manually using a sophisticated computerized switching device (Crestron and HEDCO respectively). Whereas, in the basic design this function is accomplished through the use of a reportedly inexpensive switching device. As previously mentioned, this device allows for manual switching to six pre-set classroom locations.

The basic design incorporates the use of four monitors, three for student viewing and one for the teacher viewing. One student monitor sits to the left of the students, on top of the teacher station and is used for students to view what is being displayed by the visual presenter/document camera. The other two student monitors are situated to the right of the students and are used for remote site viewing. A fourth, smaller monitor sits on a desk in front of the teacher station and is used by the teacher to monitor the outgoing signal.

In contrast, the intermediate design uses a total of seven monitors, four for student viewing and three for teacher viewing. Two student monitors provide remote site viewing, one is used to view the outgoing signal and the fourth one is used to view the document camera. Two teacher monitors are used to view the remote sites while the other monitor is used to view the outgoing signal. All monitors are suspended from the ceiling. The student viewing monitors are positioned above the teacher's station while the teacher viewing monitors are positioned above the students.

The deluxe design uses of a total of eight monitors, four for student viewing and four for teacher viewing. Three student monitors are used to view the remote sites and one is used to view the outgoing signal. Three teacher monitors are used to view the remote sites while the other is used to view the outgoing signal. (It is important to note that the deluxe system connects an additional fourth site. If only three sites were connected then the number of monitors would be reduced by two). All monitors are mounted on cabinets (18" height) that sit on floor. The student viewing monitors are positioned directly in front of the teacher's station (top of monitors is level with teacher station surface). While the teacher viewing monitors are positioned directly in front of the first row of student desks (top of monitors is level with student desk surface).

Variation also exists between the type of visual presenter/documents camera each design uses. The basic system utilizes a manual controlled document camera while the intermediate system uses one that has zoom and auto focus functions accessed through the switching device (also has both auxiliary sound and video inputs). In contrast, the deluxe system does not use a document camera, as such. Instead it reportedly uses an expensive camera that is the same type as the teacher camera and has multi-function remote control with pan and tilt, zoom and auto focus capabilities.

Table 23 presents the findings for video cassette recorder (VCR), auxiliary equipment and computer equipment considerations of the three IITV classroom system designs under study. Of the three considerations, two are found to be common among all three designs, while one is uncommon. The common considerations are: the use of a VCR and computer. The uncommon consideration is the types of auxiliary equipment in use.

All three designs make use of a VCR. However, in both the intermediate and deluxe systems, the VCR is wired directly into the system and is activated by the switching device. Whereas, in the basic system, the VCR is not wired into the system and must be used separately as a video input.

All three designs include at least one computer. In both the basic and deluxe systems,

Table 23

Equipment Considerations in IITV Classroom System Design: Videocassette Recorder (VCR), Auxiliary Equipment and Computers

Consideration	Basic System	Intermediate System	Deluxe System
VCR	1 VCR per classrm. - not wired directly into system	1 VCR per classrm. - wired directly into system; controlled by Crestron	1 VCR per classrm. - wired directly into system; controlled by HEDCO
Auxiliary Equipment			
Types	1 - additional camera on tripod	1 - additional digital camera shared between 3 sites 1 - camcorder 1 - tape deck/CD player	1 - cassette tape recorder
Computers	1 computer per classrm. connected to an AverKey 3 unit; takes video output from computer, processes it, and sends it on a standard TV signal used to go to transmitter and also sends a standard computer signal to monitor	1 - computer per classrm. with data link capabilities that allow interconnecting of the 3 school networks	1 computer per classrm. connected to AverKey apparatus; sends info. on computer screen to remote sites - each classrm. has instant response keypads and transmitters hooked to computer

the computer is connected to an AverKey Apparatus which takes the video output from the computer, processes it and sends it on a standard TV signal to the transmitter. this apparatus also sends a standard computer signal to the monitor. In the intermediate system, the computer which is a more recent model, assumes the AverKey functions.

Additionally, the deluxe system design is the only design to have instant response keypads, attached to the computer. Each classroom has a set of keypads and transmitter to receive instant responses from students. These instant response keypads look like little calculators, are wireless and have numbers on them. When a student presses on the keypad it sends signals to the computer. The computer tabulates the responses and shows the results on the screen instantly. Data can be saved into a file for analysis by the teacher at later time. Responses can be anonymous or non-anonymous. Students can receive instant feedback. Quiet students who are less likely to speak up in class, can respond anonymously through the use of the keypads. The remote students are able to send their responses to any one site if each is connected to the other through telephone lines. The system does not have a contract with the telephone system to send data over the fiber. Because of cost, there is not much use of the keypads from remote sites, but the ability is there for future use. Each site can use the system within the classroom itself

Table 24 presents the findings for classroom management considerations of the three IITV classroom system designs under study. Of the three considerations, one is found to be partially common among all three designs, while two are uncommon. The common consideration is: the methods for dealing with inappropriate behavior in an IITV class.

In all three designs, students must sign a contract prior to beginning an IITV course. The intermediate system differs from the other two designs in that students must also sign a

Table 24

Classroom Management Considerations in IITV Classroom System Design

Consideration	Basic System	Intermediate System	Deluxe System
Monitoring of inappropriate behavior in remote classroom	Teacher monitors students in remote site while teaching	Every classrm. has monitor in school secretary’s office; teacher monitors students in remote sites while teaching	Every classrm. has monitor in school secretary’s office; teacher monitors students in remote sites while teaching
Methods for dealing with inappropriate behavior	Students sign contract; specifies expectations and consequences of inappropriate behavior - Telephone used to call remote site	Students sign authorization to be video taped; students sign contact; only one warning, followed by removal from course - 1 button VCR controls available on CRESTRON and single button telephone dialing available	- students sign contract - VCR set up to record behavior at push of button
Experience with inappropriate behavior	Have not had to 1) warn, 2) remove student from course, or 3) remove student from school in 7 years	n/a; system not fully functional	Over 4 years have had a couple of instances of inappropriate behavior; used VCR recording as proof for parents

contract authorizing that they can be video-taped. In both the intermediate and deluxe systems the VCR is set-up so that one push of a button will result in a recording of the student's behavior. The basic system does not have this provision. In the basic and intermediate designs, the telephone can also be used to call the remote site if necessary. The deluxe system does not have this provision.

Uncommon considerations include: monitoring of inappropriate behavior in remote sites; and experience with inappropriate behavior. The intermediate and deluxe designs address the issue of remote site monitoring through the use of a monitor located in each participating school's secretary's office. In contrast, the basic design does not have provision for an extra monitor. However, in all three designs, monitoring of remote site students is available through the use of the monitors.

Of the three designs, the deluxe system reports to be the only one thus far, to have experienced problems with remote site students displaying inappropriate behavior. Since the intermediate system is not fully functional, this has not become an issue as yet.

<u>What are the advantages and disadvantages associated with each design</u>? The findings for advantages and disadvantages associated with each design are presented in Table 25. <u>Advantages</u>. The chief advantage reported for the basic design "is its utter cheapness" (R. Lindsay, personal communication, October 7, 1997). Mr. Lindsay also reported that the basic system is advantageous because it "offers versatility in using computers or any other type of equipment on air and the electronics in the Carman site can be used for other courses."

In contrast, M. Zuk (personal communication, November 7, 1997) reported that the intermediate design is advantageous because: "versatile cameras provide tracking, have pre-

Table 25

IITV Classroom System Design: Advantages and Disadvantages

Consideration	Basic System	Intermediate System	Deluxe System
Advantages	- cheap and inexpensive - offers versatility - electronics can be used for other courses	- versatile cameras - modern equipment/ technology - good sight lines - tidy and organized - effective sound absorption materials	- classroom functionality and cost - tiering allows students to see directly in front without obstructions - good sight lines - voice activated microphones promote interactivity - tidy and organized - effective sound absorption materials
Disadvantages	- awkward equipment location - moving student microphones out of the way when not in use is a "hassle" - room is untidy and unorganized - glare on monitors - insufficient equipment storage	- no air conditioning - shy students are reluctant to use push-to-talk microphones - echoes created when microphones are inadvertently left open - modern equipment has not had the "bugs" all worked out	- fixed student camera and only one remote controlled camera

set functions and are computer controlled; the system is comprised of modern equipment/technology; good sight lines exist between students/teacher and monitors/cameras; the classroom is tidy and organized in appearance; and sound absorption acoustical materials are effective."

In comparison, the deluxe design reportedly has the following advantages: "classroom functionality and low cost; the tiering allows students to see the monitors without having to peak around somebody in front of them; good sight lines between students/teacher and monitors/cameras; voice activated microphones promote interactivity by making it easier for reluctant students to get involved; voice activated microphones provide for better teacher monitoring of interactivity; classroom is neat looking; and sound absorption acoustical materials are effective" (L. Roche, personal communication, October 15, 1997).

<u>Disadvantages</u>. Disadvantages of the basic design are reported as follows: "awkward placement of equipment; student microphones are a hassle; room lacks certain esthetic values (it is untidy and unorganized); glare on monitors results in poor video unless steps are taken to minimize the glare ; and lack of adequate storage invites breakage/vandalism" (R. Lindsay, personal communication, October 7, 1997).

In contrast, according to M. Zuk (personal communication, November 7, 1997) the intermediate design has the following disadvantages: "no provision for air conditioning; shy students are reluctant to press the push-to-talk microphones and have the camera zoom in on them; echoes are also created by the push-to-talk microphones and teacher microphones, if left on; and the system is comprised of modern equipment but all the "bugs" are not out of it as yet."

In comparison, the deluxe system reportedly has only one disadvantage which is "the use of a fixed student camera. The classroom has only one remote controlled camera for the teacher" (L. Roche, personal communication, October 15, 1997). According to Mr. Roche the classroom system design would be enhanced if the student camera was also remote controlled.

Section III How much do the varying IITV classroom systems cost?

The key research question: How much do the varying IITV classroom systems cost? is answered through an investigation and analysis of the following specific research questions:

- How much does it cost to remodel a standard classroom into:

  i) a basic IITV classroom system?

  ii) an intermediate IITV classroom system?

  iii) a deluxe IITV classroom system?

- How much does it cost to equip:

  i) a basic IITV classroom system?

  ii) an intermediate IITV classroom system?

  iii) a deluxe IITV classroom system?

- What are typical recurring and maintenance costs for the classroom equipment in:

  i) a basic IITV classroom system?

  ii) an intermediate IITV classroom system?

  iii) a deluxe IITV classroom system?

- As opposed to other transmission systems, why would an organization choose to use a:

  i) fiber optic transmission system?

  ii) microwave transmission system?

- What are the advantages and disadvantages of a:

    i) fiber optic transmission system?

    ii) microwave transmission system?

- What steps are involved in setting up a:

    i) fiber optic transmission system?

    ii) microwave transmission system?

- What does it cost to establish a multi-point transmission system using:

    i) fiber optics?

    ii) microwave?

- What are the major cost considerations of a:

    i) fiber optic transmission system?

    ii) microwave transmission system?

- What are typical recurring and maintenance equipment costs of a:

    i) fiber optic transmission system?

    ii) microwave transmission system?

- What are the costs associated with the ongoing usage of a:

    i) fiber optic transmission system?

    ii) microwave transmission system?

<u>How much does it cost to remodel a standard classroom into: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system</u>? Tables 26 - 28 present the findings for initial capital costs of IITV classroom systems. Reported costs include expenses associated with actual remodeling, consultation services for design and/or equipment installation and acoustical treatment. A total remodeling cost figure

for each of the designs under study, is derived from an individual analysis of table information, followed by a synthesis of the three tables.

Table 26 presents the findings for each design's classroom remodeling or construction. In none of the designs was the classroom newly constructed. The basic design included minimal remodeling. Equipment was reportedly inserted into the classroom on countertops and/or tables wherever there was room for it. Electrical outlets were added and holes were drilled through the walls/concrete floor to run some of cabling/wiring. The total remodeling cost of the basic IITV classroom system design was $100.

In comparison, the intermediate design included provision for remodeling, described in Table 26. The total cost of remodeling was $5000. In contrast, the deluxe system, a tiered IITV classroom system cost a total of $13,000. to remodel (See Table 26 for remodeling description)

Table 27 presents the findings for consultation services costs for each design. A private consultant was not hired to design the basic IITV classroom system and/or install IITV equipment. As a cost saving measure, a teacher already employed by the school division, was additionally assigned the IITV Coordinator position. In receiving this assignment the teacher assumed responsibility for IITV classroom system design and equipment installation. As previously mentioned, this design had minimal remodeling. Based on this information, the total cost for consultation duties for the basic design was an estimated $6250.

Table 26

Initial Capital Costs of IITV Classroom Systems: Classroom Remodeling or Construction

Basic System	Intermediate System	Deluxe System
Minimal remodeling - IITV equipment simply inserted into classroom. - equipment stationed wherever counter space - cables running here and there - holes drilled through concrete floor for wiring - additional electrical outlets	Remodeled - Monitors suspended from ceiling - desks attached to floor - microphones attached to desk - teacher station installation - lowered ceiling - increased lighting - acoustically treated wall, ceiling tile and window treatments - floor carpet - painting - wiring/electrical upgrades	Remodeled - Monitors mounted on cabinets attached to floor -desks attached to floor - microphones attached to desk - teacher station installation - lowered ceiling - increased lighting -acoustically treated wall and ceiling tile - floor carpet - painting - wiring/electrical upgrade Addendum: Prior to IITV installation, room remodeled from gymnasium stage area into room with 3 rows of tiered steps IITV remodeling costs - $5,400 Tiered steps - $7,600
Total IITV Remodeling Cost - $100	Total IITV Remodeling Cost - $5,000	Total remodeling cost (IITV and tiered steps) - $13,000

Table 27

Initial Capital Costs of IITV Classroom Systems: Consultation Services

Factor	Basic System	Intermediate System	Deluxe System
Private consultant	No	Yes	Yes
Role in design/planning	n/a	Consultant designed/developed IITV classroom. system	Consultant assisted IITV coordinator with classroom. system design
Role in installation	n/a	Equipment supplier installed equipment according to design	Consultant and IITV coordinator installed equipment according to design
Cost	n/a	$5500 (equipment installation)	$20,000
Current school division personnel	Yes	Yes	Yes
Role	- Maintenance personnel helped with drilling holes, etc. - teacher assigned to coordinate IITV initiative (teacher received informal advice from a media consultant)	- Maintenance personnel helped with sound proofing - retired principal hired to coordinate system installation and classroom. remodeling	- Maintenance personnel, i.e., painters, electricians and carpenter - painting, laying carpet, electrical upgrading, constructing monitor cabinets, and remodeling cabinets into teacher station
Cost	$6,250	$12,500	n/a
Total Consultation Cost	$6,250	$18,000	$20,000

The intermediate design, however, incorporated the expertise of a consultant hired by MERLIN to design/develop the IITV classroom system (these costs were borne by MERLIN and were not reported). Another consultant was hired to install the IITV equipment at a cost of $5,500. A retired school principal, hired quarter time, acts as IITV Coordinator and coordinated the system installation and classroom remodeling (as well as, other initial and ongoing duties to be covered in later sections) at a total cost of $12,500. To minimize costs, school maintenance personnel assisted with soundproofing the classroom. Based on this information, the total cost for consultation duties for the intermediate design was an estimated $18,000.

In comparison, Evergreen School Division's Coordinator of Technology was assigned the additional duties of IITV Coordinator for the deluxe system. A consultant, hired to assist the coordinator with the classroom system design and equipment installation, conducted site visits, determined hardware requirements, and monitored equipment installation. As a means of minimizing costs, school maintenance personnel, i.e. painters, electricians and carpenter were also utilized (See Table 27 for description of duties). Based on this information, the total cost for consultation duties for the intermediate design was an estimated $20,000.

Table 28 presents the findings for acoustical treatment for each design. In the basic design there was reportedly no provision for acoustical treatment. The rationale for this decision is given in the table.

Table 28

Initial Capital Costs of IITV Classroom Systems: Acoustical Treatment

Factor	Basic System	Intermediate System	Deluxe System
Acoustical treatment	No - classroom. not dedicated; science lab with glass cabinets around periphery; modifying walls would have been expensive - cost saving measure	Yes	Yes
Description	n/a	- Acoustical wall paneling - blinds made of acoustical material - floor carpeted - acoustically treated ceiling tile - walls extend past ceiling	- Acoustical wall paneling - floor carpeted - ceiling is high - acoustically treated ceiling tile - walls extend past ceiling
Cost	n/a	Included in remodeling cost (see Table 23)	Included in remodeling cost (see Table 23)

Note. n/a - not applicable.

In contrast, both the intermediate and deluxe designs reportedly included acoustical treatment. The cost of which was reported to be included in the remodeling cost for these designs (See Table 26). A description of the acoustical treatment included in each design is given in Table 28.

Through the use of the preceding analysis of initial development costs for each design in relation to the: actual remodeling, consultation services for design and/or equipment installation and acoustical treatment, the question: How much does it cost to remodel a standard classroom into: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system? can now be answered.

Initial development costs for the basic IITV system were reported as $100. for minimal remodeling and $6,250. for total consultation cost. Based on this, it costs $6,350. to remodel a standard classroom into a basic IITV classroom system.

In contrast, initial development costs for the intermediate IITV system were reported as $5000. for remodeling and $18,000. for total consultation cost. Based on this, it costs $23,000. to remodel a standard classroom into an intermediate IITV classroom system.

In comparison, initial development costs for the deluxe IITV system were reported as $13,000. for remodeling and $20,000. for total consultation cost. Based on this, it costs $33,000. to remodel a standard classroom into a basic IITV classroom system.

<u>How much does it cost to equip: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system</u>? The findings for initial capital IITV classroom system equipment costs for each of the three designs under study, are presented in Table 29. When comparing the three designs, obvious differences in cost are apparent. These

Table 29

Initial Capital Costs of IITV Classroom Systems: Equipment Costs

Basic System ($)		Intermediate System ($)		Deluxe System ($)	
1 - Sony camera	1,800	1 - student camera	1,465	1 - student camera	2,000
		1 - teacher camera	1,465	1 - teacher camera	4,000
1 - Document Camera	1,600	1 - Document camera	2,100	1 - Document camera	2,500
2 - 33” TV monitors	8,000	7 - 27” TV monitors			
1 - 27” TV monitor	650	- c/w mounting brackets	6,538	9 - 29” monitors	5,850
		2 - JBL ceiling-mount		2 - ceiling mount	
		speakers	819.50	speakers	600
				1 - teacher speaker	250
6 - student microphones	480	7 - student microphones	3,272.43	6 - student microphones	1,200
1 -Lavaliere microphone	500	1 - Lavaliere microphone	950	1 - Lavaliere microphone	600
1 - switching device	800	1 - audio/video control unit	3,550	1 - audio/video control unit	7,000
1 - teacher station -				1 - teacher’s station -	
science lab desk	n/a	1 - teacher’s station	1,200	cost included in remodeling	n/a
1 - audio mixer		1 - IRP Modular Mic Mixer c/w			
- TOA mixer	1,200	2 Input Cards	2,754	1 - Audio Mixer	6,000
		1 - stereo power			
		amplifier	265	1 - Audio Component	4,000
1 - VCR	550	1 - VCR	349	1 - VCR	300
				1 - PC to TV apparatus	300
Total	15,580	Total	24,727.93	Total	34,600
Did not receive discount - always required to pay full market value		Received discount - amount unknown		Received discount - varied between 25-50%	

differences are primarily due to lack of consistency between the amount/type of equipment across the three designs. For example: the basic design uses less than half the number of monitors and cameras used by the intermediate and deluxe designs respectively; and the intermediate and deluxe designs use additional ceiling mounted speakers, whereas the basic design does not.

Also important to note, is that some equipment (i.e. 33” monitors) used in the basic design was purchased almost 10 years ago, when electronic equipment prices were higher. Although not as long ago, the equipment used in the deluxe system was purchased four years ago. Therefore, the influence of declining electronic equipment prices should still apply. Especially when comparing the costs of equipment purchased recently for the intermediate design with that of the other two designs.

With this in mind, the question of: How much does it cost to equip: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system? can now be addressed. As presented in Table 29 it costs $15,580. to equip a basic IITV classroom system; $24,727.93 to equip an intermediate IITV classroom system; and $34,600. to equip a deluxe IITV classroom system.

Tables 30 and 31 present the findings for other costs associated with the development of IITV classroom systems. These costs include: coordinator assignment/training and teacher training, as well as, miscellaneous and unforeseen costs.

The findings for teacher training, IITV Coordinator training, and sources of funding for the training are presented by Table 30. Estimates for total cost of teacher training relevant to each design are also presented. Of particular significance is that the cost of teacher training doubles with each successive design.

Table 31 presents the findings for miscellaneous costs and unforeseen difficulties of each design. All systems reportedly had no miscellaneous initial costs and no unforeseen difficulties during the initial IITV classroom system set-up except for the intermediate system. This design reportedly has a problem with echoes in the audio and excessive heat in the teacher station due to the CODEC generating too much heat (further explanation is provided by the table).

Table 30

Initial Development Costs of IITV Classroom Systems: Coordinator Assignment/Training

Factor	Basic System	Intermediate System	Deluxe System
Teacher Training	Yes - teachers received training re: how to teach using IITV equip.	Yes - teachers received 2 days training re: how to teach using IITV equip.	Yes - 10 teachers went to Minneapolis for some training re: how to teach using IITV equip.
System coordinator assignment /training	- Teacher was assigned additional duties of IITV coordinator - obtained ideas from visits to IITV sites in U.S. - learned primarily through practice and experience	- Retired school principal hired quarter-time as IITV coordinator - visited IITV sites in U.S. and received some training from annual conference coordinated by Deluxe System Coordinator - is self-trained	- Coordinator of Technology assigned additional duties of IITV Coordinator - visited IITV sites in U.S. - self-trained
Source of funding	Professional Development Fund paid by school division	Professional Development Fund paid by school division	Professional Development Fund paid by school division
Total estimated cost of teacher training	$1,000	$2,000	$4,000

Table 31

Initial Development Costs of IITV Classroom Systems: Miscellaneous Costs and Unforeseen Difficulties

Factor	Basic System	Intermediate System	Deluxe System
Miscellaneous initial costs	None	None	None
Unforeseen difficulties	None	Yes	None
		- audio problem (echo)	
		- CODEC in the teacher station generates extra heat	
		- plan to drill hole through cement floor; install fan to blow hot air into crawlspace	
Unforeseen initial costs	None	- Cost estimate unavailable	None

What are typical recurring and maintenance costs for the classroom equipment in: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system? Table 32 presents the findings for ongoing costs of the three IITV classroom systems under study. A complete report of ongoing costs for the intermediate system was unavailable given that the system was not fully functional at the time of data collection. Both the basic and deluxe systems are reported to require annual equipment repair. The cost of which is estimated at $3,000 for the basic system and $2,000 for the deluxe system. Neither system is reported to have a maintenance contract (the rationale and additional information is presented in the table). Annual cost for teacher training (refresher for existing staff and initial training for new staff) concerning the use of IITV classroom equipment was estimated at $1000. for both the basic and intermediate systems and $2000. for the deluxe system. Concerning unforeseen ongoing costs, the deluxe system reportedly had none; a cost estimate for the basic system was not provided; and the intermediate system reportedly had costs associated with hiring tutors for students needing courses to graduate. These costs for the intermediate system were attributed to the system not be functional. No cost estimate was provided.

Through the use of the preceding analysis of ongoing costs of IITV classroom systems the question: What are typical recurring and maintenance costs for the classroom equipment in: a basic IITV classroom system? an intermediate IITV classroom system? and a deluxe IITV classroom system? can now be answered.

Typical recurring and maintenance costs for a basic IITV classroom system include: annual equipment repair and maintenance estimated to cost approximately $3,000. per year; annual teacher training estimated to cost approximately $1,000. per year; and a monthly telephone rental (estimate not provided). Based on this, the typical recurring and maintenance costs for a basic IITV classroom system are estimated to be $4,000. per year.

As mentioned previously, a complete report of ongoing costs for the intermediate system was unavailable given that the system was not fully functional at the time of data collection. However, it was reported that the following annual recurring and maintenance costs are anticipated: hydro costs, routine repair/maintenance of equipment repair; teacher training costing $1000. annually; and monthly telephone rental. Based on this, the typical recurring and maintenance costs for an intermediate IITV classroom system are estimated to be $1,000. plus per year.

Table 32

Ongoing Costs of IITV Classroom Systems

Factor	Basic System	Intermediate System	Deluxe System
Equipment repair required	Yes - ongoing equipment repair (nothing major)	System is not fully functional	Minimal - equipment has been very reliable and stable
Annual repair and maintenance costs	$3,000 per year	Unknown - anticipating costs will be minimal - hydro costs and routine repair/maintenance of equipment	$2,000 per year
Maintenance contract	No - all equipment initially on warranty - off warranty now but repair/maintenance costs are not high - with more systems being established in province, expect to secure maintenance contract next year	Not yet - equipment will be on warranty for 1 year - MERLIN negotiating maintenance contract with vendors/suppliers on behalf of participating schools	No - equipment was initially covered by warranty - off warranty now, but repair/maintenance costs are not high
Recurring Teacher Training	$1,000 annually	$1,000 annually	$2,000 annually
Other ongoing miscellaneous costs	Monthly rental of telephone	Monthly rental of telephone	None
Total Ongoing Costs	$4,000 per year	$1,000 plus	$4,000 per year

Typical recurring and maintenance costs for a deluxe IITV classroom system include: equipment repair and maintenance estimated to cost approximately $2,000. per year; and teacher training estimated to cost approximately $2,000. per year. Based on this, the typical recurring and maintenance costs for a deluxe IITV classroom system are estimated to be $4,000. per year, the same cost estimate for the basic system.

<u>As opposed to other transmission systems, why would an organization choose to use a: fiber optic transmission system; microwave transmission system</u>? Table 33 presents the findings for supporting transmission systems: choice of system and system ownership. Both the basic and intermediate systems use microwave as the supporting transmission system. In both of these situations the microwave system is owned by the school division. In contrast, the deluxe system reportedly uses a leased fiber optic system which is owned by MTS Net Com. This is a five year lease which is due for renewal in 1998.

The rationale for transmission choice is as follows: Both E. Wiebe (personal communication, October 7, 1997) and L. Paulson (personal communication, October 6, 1997) report that they chose a microwave transmission system as opposed to a fiber optic system because: “microwave transmission is less expensive than fiber - that the ongoing costs of fiber are prohibitive.” In comparison, L. Roche (personal communication, October 22, 1997) reports that “a fiber optic transmission was selected because of its quality and stability. Fiber is the future.”

For each system the process of selection varied: the microwave system for the basic design was reportedly selected on the basis of cost and research into U.S. experiences with Microwave. The IITV Coordinator reportedly visited sites in Minnesota and North Dakota - spoke with coordinators and noted kinds of equipment in use; the microwave system for the intermediate design was selected “purely on the basis of cost” (L. Paulson, personal communication, October 6, 1997); the fiber optic system for the deluxe design was selected and approved by the School Board based upon the recommendation of the IITV Coordinator following visits to 8 sites in North Dakota and Minnesota using either fiber or microwave or combination of both.

What are the advantages and disadvantages of a: fiber optic transmission system; microwave transmission system? Table 33 presents the findings for advantages and disadvantages of both microwave and fiber optic transmission systems. E. Wiebe (personal communication, October 7, 1997) identifies the following three advantages of a microwave transmission system: “low cost; reliability and ease of use; high quality transmission. both audio and video.” Wiebe describes disadvantages of microwave to be: “lack of technical support in the immediate vicinity; and occasional weather interference with transmission.”

L. Paulson (personal communication, October 6, 1997) agrees with Wiebe that the “initial low cost” is one of microwave’s major advantages. Paulson also reports the following additional advantages of microwave: “low ongoing operating cost; and since the transmission system is owned and not leased, prices cannot be increased at a later time.” The disadvantages of microwave, as reported by Paulson are: “unknown true maintenance cost if equipment fails repeatedly; system is influenced by climatic changes; and it is not known whether the microwave transmission system will go out of date and/or become obsolete before the school division is prepared to entertain an upgrade or alternative transmission system.”

Table 33

Supporting Transmission Systems: Choice of System and System Ownership

Factor	Basic System	Intermediate System	Deluxe System
Type	Microwave	Microwave	Fiber Optic
Technology	Analog	Digital	Analog
Other technologies considered	Fiber Optic	Fiber Optic	Microwave
Rationale for choice	Less expensive than fiber; ongoing costs of fiber prohibitive	Less expensive than fiber; ongoing costs of fiber optic prohibitive	Quality and stability - fiber is "the future"
Satisfaction with choice (Scale: 1 to 5)	3.5	Unable to rate because system not fully functional	5
Three advantages of system	- low cost - reliability and ease of use - high quality transmission, both audio and video	- initial low cost - low ongoing operating cost - as system is owned (not leased), prices cannot be increased later	- audio and video is instant (no delay), reliable and full-motion - climatic changes do not affect fiber
Three disadvantages of system	- lack of technical support - occasional weather interference	- unknown true maintenance cost if equipment fails repeatedly - system is influenced by weather - unknown whether system might go out of date and/or become obsolete	- a little more expensive than other transmission systems

In comparison, L. Roche (personal communication, October 22, 1997) reports the following three advantages of a fiber optic system: “audio and video is constant with no delay; the system is reliable and full-motion video; and fiber is not influenced by climatic changes, as is microwave.” The disadvantages of fiber, as reported by Roche are that “the costs associated with leasing the system are a little more expensive than other transmission systems.”

Table 34 presents the findings for system characteristics of the three supporting transmission systems presented in this study. While these characteristics do not directly address any of the research questions central to this study, they have an indirect bearing and are included to provide for a more complete understanding of each IITV classroom system’s supporting transmission system.

Information pertaining to system characteristics, not presented in Table 34 includes: technical maintenance; system management and scheduling; overall system review; committee of users for feedback; sharing of infrastructure resources and programming costs with others; and expansion to user pay groups.

Technical maintenance. The basic system’s technical maintenance “is provided by E.B. Systems and TeleWave Communications Corporation, Winnipeg, Manitoba” (E.Wiebe, personal communication, October 7, 1997). In contrast, technical maintenance for the intermediate system “will be provided by TeleWave Communications Corporation” (L. Paulson, personal communication, October 6, 1997). In comparison, “MTS provides any technical maintenance required” for the deluxe system. “MTS ensures system is live all the time” (L. Roche, personal communication, October 22, 1997).

Table 34

Supporting Transmission Systems: System Characteristics

Basic System	Intermediate System	Deluxe System
3 classrooms connected	3 classrooms connected	4 classrooms connected (3 classrooms considered)
Carman Collegiate - (Gr. 7-S4) Miami Collegiate - (Gr. 7-S4) Elm Creek School - (Gr. K-S4)	Souris School - (Gr. K-S4) Hartney School - (Gr. K-S4) Wawanesa School - (Gr. K-S4)	Gimli High School (Gr. 8-S4) Arborg Collegiate (Gr. S1-S4) Riverton High School (Gr. 8-S4)
Carman to Miami - 16 km Carman to Elm Creek - 19 km Elm Creek to Miami - 35 km	Souris to Hartney - 35 km Souris to Wawanesa - 50 km	Gimli to Riverton - 40 km Riverton to Arborg - 25 km
All classrooms can be interconnected for two-way simultaneous instruction	All classrooms can be interconnected for two-way simultaneous instruction	All classrooms can be interconnected for two-way simultaneous instruction
4 courses offered annually	9 courses offered annually	6 courses offered annually
50-70 students enrolled annually	65-70 students enrolled annually	75 students enrolled annually

Note:

Gr. - Grades

Gr. K-S4 - Grades Kindergarten - 12

Gr. S1-S4 - Grades 9 - 12

System management and scheduling. According to E. Wiebe (personal communication, October 7, 1997) "the IITV Coordinator manages the basic system and the School Division Superintendent and principals do scheduling and oversee the IITV coordinator." In comparison, the intermediate system's "IITV Coordinator manages system including the scheduling of IITV courses. The IITV Coordinator receives direction from School Division Superintendent and principal concerning scheduling courses" (L. Paulson, personal communication, October 6, 1997). In contrast, the deluxe system's IITV Coordinator manages system and schedules courses based on input from principals and teachers of all sites. After school use of the system is booked through the school board office (L. Roche, personal communication, October 22, 1997).

Overall system review. According to E. Wiebe (personal communication, October 7, 1997) "a committee consisting of the school division Superintendent, IITV Coordinator, school Principals and one teacher for each site provide the overall review of the basic system." In contrast the overall system review for the intermediate system "will be conducted by the school division Superintendent" (L. Paulson, personal communication, October 6, 1997). In comparison, "an administrative group consisting of: the school division Superintendent, school Principals, IITV Coordinator and Coordinator of Special Education provide the overall review for the deluxe system" (L. Roche, personal communication, October 22, 1997).

Committee of users for feedback. In both the basic and deluxe systems a committee of users provides feedback in relation to the IITV system's use. In both these systems this committee consists of school division Superintendent, school Principals, teachers and IITV Coordinator. (E. Wiebe, personal communication, October 7, 1997 and L. Roche, personal communication, October 22, 1997). In contrast, this type of committee has not yet been established for the intermediate system. According to L. Paulson (personal communication, October 6, 1997) "when the IITV system is operational, a committee consisting of teachers, students, parent council members, principals and IITV Coordinator will be established."

Sharing of infrastructure resources and programming costs with others. Concerning the basic system, E. Wiebe (personal communication, October 7, 1997) reports that "sharing of infrastructure resources and programming costs with others has not occurred to date." In comparison, L. Paulson (personal communication, October 6, 1997) reports that for the intermediate system "sharing of infrastructure resources and programming costs with others has occurred because the entire cost of system is split a third, third and a third between school division, provincial government and federal government. Additional opportunities and coordination have occurred though Manitoba Council on Northern Technology and funding administration has been through MERLIN." In contrast, there is no provision for sharing of infrastructure resources and programming costs for the deluxe system. L. Roche (personal communication, October 22, 1997) reports "we do not share programming costs."

Expansion to user pay groups. Concerning the basic system, E. Wiebe (personal communication, October 7, 1997) reports that expansion of IITV system use to user pay groups "has not occurred to date." In contrast, L. Paulson (personal communication, October 6, 1997) reports that for the intermediate system "even though expansion of our IITV system use to user pay groups has not as yet occurred. The future intent is to expand system use to private business etc. (user groups) who will pay in exchange for use of system." In comparison, L. Roche (personal communication, October 22, 1997) reports that the deluxe system "is rented out after school hours to people in community, i.e. ambulance (first responders) rent classrooms every Tuesday evening for 10 months for training ambulance drivers; Community Future's Groups such as NEICOM, SuperSix and Selkirk Triple S rent classrooms in order to hold meetings with people in the different communities. This rental of IITV classrooms for these meetings prevents members from having to travel large distances to one particular meeting site."

What steps are involved in setting up a: fiber optic transmission system; microwave transmission system? This study dealt with a leased fiber optic system, not a purchased fiber optic system. Consequently information addressing the major cost considerations in setting up a purchased fiber optic transmission system was not acquired.

Table 35 presents the findings for the steps involved in setting up a microwave transmission system. Also included is information relevant to each system's: bandwidth and frequency, license fee cost, tower location in relation to the schools, total number of towers and method used to connect the transmission system from the tower to the school. In both designs, the information reported is similar with the exception of tower location relative to the schools; number of towers; and method of connecting the transmission system from tower to school. Cost estimates for license fee for both designs are as follows: Approximately $800. for the basic design's transmission system and $864. for the intermediate transmission system. Of particular interest that allow the intermediate system has an additional tower (repeater station) the difference in license fee between the two systems is only $64. No other cost estimates were provided for the remaining factors presented by this table.

Table 35

Microwave Transmission Systems: Set-up and Location

Factor	Basic System	Intermediate System
Steps in setting up system	- engineering study completed by EB Systems to determine best tower location - application to Industry Canada for operating license, system designed and towers constructed and erected - microwave equipment tested and installed on towers	- engineering study completed by TeleWave to determine best tower location - application to Industry Canada for operating license, system designed - towers constructed and erected - Microwave equipment tested and installed on towers
Bandwidth and frequency	2.5 - 2.596 GHz (2500 - 2596 MHz)	2.5 - 2.596 GHz (2500 - 2596 MHz)
Cost of license fee	$800 (approximate)	$864
Other protection	n/a	n/a
Towers: number and location relative to schools	- 3 towers - adjacent to each collegiate, as close to IITV classroom. as possible	- 4 towers- Hartney and Souris School towers are located on school property - adjacent to school - Wawanesa tower is 3 blocks away from school (highest point in town) - Carroll repeater tower is located on farm land
Connection of tower to school	Coaxial cable running off tower into school	- Wawanesa system connected to school by buried coaxial cable - Souris and Hartney: coaxial cable off tower into school

In both basic and intermediate designs the regulatory body is reported as Industry Canada. For the basic system “E.B. Systems applied to Industry Canada: the Spectrum Management Division for a license on behalf of Midland School Division. This license affords protection from interference. Industry Canada will not issue a license to another agency on the same channel without ensuring that appropriate engineering studies have been done” (B. Evans, personal communication, October 17, 1997). “This process was the same for the intermediate system, the only exception being that TeleWave Communications Corporation applied for the license, instead of E.B. Systems” (B. Evans, personal communication, October 17, 1997).

As presented in the table, the basic system uses a total of three towers (one per school), all of which are located on school property. According to E. Wiebe (personal communication, October 7, 1997) this location “permitted the installation of towers adjacent to the schools and as near to the IITV classroom as possible. Thereby eliminating the need to run excessive lengths of coaxial cable.”

In contrast, the intermediate system reportedly has a total of four towers with one acting as a repeater station, halfway between the longest distance between two sites. Two towers are located on school property, while the repeater tower is situated on farm land leased for the purpose of tower location. The fourth tower is located on property owned by the Town of Wawanesa. Since this community is in a valley, the tower was erected on the highest point, three blocks away from the school. In this situation, the transmission system is connected from tower to school through the use of buried coaxial cable.

Local ordinances did not play a role in the decision of tower location for either systems. However, according to E. Wiebe (personal communication, October 6, 1997) “the school division had to obtain clearance from each local government: the Town of Carman, R.M. of Grey (Elm Creek) and the R.M. of Thompson (Miami). The school division submitted an application to each jurisdiction indicating intent and requesting approval for tower erection. Approval was granted without any problem." In contrast, concerning the intermediate system, "the school division had to obtain permission from the Town of Wawanesa to cross their property where the cable was buried" (L. Paulson, personal communication, October 6, 1997).

What are the major cost considerations of: a fiber optic transmission system; a microwave transmission system? Tables 36 through 39 present the findings for major cost considerations of installing a microwave system which include: tower construction; equipment; land; building; equipment testing; consultation services; licensing, connections to the school; miscellaneous costs; and unforeseen costs. License fee and connections to the school cost considerations were dealt with in the previous section.

Table 36 presents initial capital costs associated with microwave towers and dishes. In both the basic and intermediate system, the microwave towers were constructed (existing towers were not used). The intermediate system reportedly has higher towers than the basic system and as mentioned previously, the intermediate system has an additional tower, a repeater, which is used as a booster station. Transmission system components for both microwave systems include: towers, antennas, antenna feed lines, transmitters/receivers, modulators and power units. The component cost for both systems was reported as imbedded in total transmission system cost.

Table 36

Initial Capital Costs of Microwave Transmission Systems: Towers and Dish

Factor	Basic System	Intermediate System
Number of channels	8	8
Height of towers	Carman and Elm Creek - 80' Miami - 64'	All towers are 96', except Wawanesa at 112'
Self-supporting or attached to building	Self-supporting - mounted directly on concrete base	Self-supporting - mounted directly on concrete base
Existing tower or new construction	New construction	New construction
Number of antennas	- 4 antennas on Carman's tower; need to transmit on 4 channels - 2 antennas each on Elm Creek and Miami towers	- 4 antennas on Souris' tower; need to transmit on 4 channels - 2 antennas each on Hartney and Wawanesa towers - 4 antennas on Carroll tower (booster station)
Length of antenna	18"	18"
Antenna dish		
Size	4' in diameter	3-4' in diameter
Cost	$200 each (approximate)	Imbedded in total cost of transmission system
Tower construction/ installation cost	$22,500 for three towers	Imbedded in total cost of transmission system
Cost of repeater towers	n/a	Imbedded in total cost of transmission system

Note. n/a - not applicable.

The costs of antenna dishes and tower construction/installation for the basic system were the only specific costs reported. A breakdown of the remaining cost considerations was not disclosed. E. Wiebe (personal communication, October 7, 1997) provides the reason for this stating “these remaining cost considerations were imbedded in the overall total transmission system price and can not be separated with any degree of accuracy.”

In comparison, all cost considerations for the intermediate system were reported to imbedded in the total transmission system cost. Individual cost consideration information was not disclosed. During interview, B. Evans (personal communication, October 29, 1997) refused to provide specific prices for transmission system cost considerations stating “these costs are proprietary and our competitors would just love to get this information.” Evans explained that “during the pilot stage of other projects we went through a very painful experience in both Manitoba and Saskatchewan where even though it was our ideas, other firms’ clients got the license and other firms have benefited from the use of our techniques, our knowledge and our reports. We just don’t want to see that happen with this educator area. Those same firms are right here in Manitoba and I’m sure that they would be very interested in again benefiting from our knowledge. And we just are not about to take any chances if we can help it on helping them along the way.”

Table 37 presents findings for initial capital costs of land, building, and equipment. In the basic system land was reportedly not a cost consideration because all towers were erected on school property. In contrast, although two of the intermediate systems towers were erected on school property and a third on town property for which no cost was involved, land is a cost consideration for this design because a repeater tower had to be erected on farm land. The cost of which involved an initial lease of $125.

Table 37

Initial Capital Costs of Microwave Transmission Systems: Land, Building, and Equipment

Factor	Basic System	Intermediate System
Land		
Type	All towers on school property	- Hartney and Souris towers located on school property - Carroll (repeater) tower is situated on leased land - Wawanesa tower is situated on Town of Wawanesa property
Area required for tower	3’ x 3’ (approximate)	10’ x 10’ (approximate)
Owned or leased	Owned by school division	2 towers on owned land 1 tower on Town of Wawanesa land
Cost		Carroll tower on land leased for 99 years at $125 per year
Building		
Required	Not required - all equipment in IITV classrm. or on tower (tower mount equipment and outdoor housings)	Not required; all equipment external to microwave tower in IITV classrm. - electronics and/or any equipment requiring weather proofing located inside tower - any equipment located outside tower is not influenced by weather
Equipment testing Cost	Imbedded in total transmission system cost	Imbedded in total transmission system cost
Total equipment installation cost	Imbedded in total transmission system cost	Imbedded in total transmission system cost

Neither the basic nor the intermediate systems reportedly required that a building be constructed for the storage of tower equipment. Therefore, building construction was not a reported cost consideration for either designs. The rationale for this is presented by Table 37.

Both systems reportedly had their transmission equipment tested prior to installation. The testing for both the basic and intermediate designs transmission systems was identical with exception of the companies conducting the testing. E. B. Systems completed the testing for the basic design and TeleWave completed the testing for the intermediate design. An explanation of the type of testing completed is as follows: actual path testing was not done, the design was based on using a computer to analyze path and to make predictions; the design was also based on terrain data and topographic maps; all paths were cleared of obstructions, and equipment was tested in one room (two sets of microwave equipment facing each other, 5 metres apart).

A breakdown of equipment testing and installation costs was not disclosed for either system because according to E. Wiebe (personal communication, October 7, 1997) and L. Paulson (personal communication, October 6, 1997) “these cost considerations were imbedded in the overall total transmission system price and can not be separated with any degree of accuracy.”

Table 38 presents findings for initial capital costs of consultation and licensing. Although costs were not reported, the findings for both systems are noted to be the same relevant to each factor. Consultation services for both basic and intermediate systems reportedly included: path profile to check for obstructions, frequency coordinates to determine other frequencies that might interfere, path analysis to determine how much power was necessary, completion of the licensing procedure and tower specifications to note items

Table 38

Initial Capital and Development Costs of Microwave Transmission Systems: Consultation and Licensing

Factor	Basic System	Intermediate System
Consultation services:		
Path profile	Yes	Yes
Frequency coordinates	Yes	Yes
Path analysis re: power	Yes	Yes
Licensing	Yes	Yes
Tower specifications	Yes	Yes
Cost of each service	Imbedded total transmission system cost	Imbedded total transmission system cost
Total consultation cost	Imbedded in total transmission system cost	Imbedded in total transmission system cost
Licensing		
Type of form	RSP 113 (Radio Standards Procedure 113)	RSP 113 (Radio Standards Procedure 113)
Application fee	None	None
Additional licenses for more than one hop	1 license issued for each school division regardless of number of hops	1 license issued for each school division regardless of number of hops
Exemption	n/a	n/a

Note. n/a - not applicable.

such as ice and wind load. A breakdown of cost for each consultation service was not reported, nor was a total composite for consultation cost. Rationale was provided by E. Wiebe (personal communication, October 7, 1997) and L. Paulson (personal communication, October 6, 1997) who report that “these cost considerations were imbedded in the overall total transmission system price.”

The process of applying and receiving approval for licensure of microwave transmission systems for both systems was reportedly conducted by the consulting firms responsible for transmission systems design and installation. This process, according to B. Evans (personal communication, October 29, 1997) included the following:

> A letter of Intent is sent to Industry Canada: The Spectrum Management Division outlining what is to be done, where and what frequencies are involved. If this meets with their approval a detailed application is completed, as well as, an engineering brief. The Application form includes: path profiles to check for obstructions, prediction of transmission; frequency coordination to identify other frequencies that might create interference and path analysis to determine amount of power required. While the engineering brief (approximately 50 pages) specifies: tower specifications for ice and wind load and the transmission to each school. The Ministry of Transport (aeronautical clearance form for tower clearance) and local municipalities (environmental concerns regarding towers) receive completed forms as well.

Additional findings pertaining to the type of form used for licensing, etc. are presented by Table 38. Whereas Table 39 presents findings for miscellaneous and unforeseen initial costs, as well as, total microwave transmission system costs. Miscellaneous costs were reportedly encountered during the initial set-up of both basic and intermediate systems.

Table 39

Initial Costs of Microwave Transmission Systems: Miscellaneous, Unforeseen and Total Transmission System Costs

Factor	Basic System	Intermediate System
Initial miscellaneous costs	Imbedded in total transmission system cost	Imbedded in total transmission system cost
Unforeseen difficulties	Yes - inferior transmission/picture quality constant problem - occasional breakdowns frustrating - lack of knowledgeable technical support people	Yes - system not functional yet: audio and video plagued with problems caused by mismatched equipment and equipment failure, i.e., CODECS that don't function and/or send data at incorrect band rate to modems, as well as incorrectly configured modems
Unforeseen costs	Yes - securing technical expertise to assist with difficulties - cost estimate unavailable	Yes - microwave towers built after freeze up; during cement pouring for tower bases, additional steps were required to keep cement from freezing (i.e., plastic application with heaters); cost approximately $3,000 extra for all towers
Total cost of transmission system	$140,000	$400,000

The costs of which were reported by E. Wiebe (personal communication, October 7, 1997) and L. Paulson (personal communication, October 6, 1997) to be “imbedded in the overall total transmission system price.”

Unforeseen difficulties and unforeseen costs were also reportedly encountered during the initial set-up of both basic and intermediate systems. A description of these experiences is presented in Table 39. However, an unforeseen cost figure is reported for the intermediate system only.

The findings for the total initial microwave transmission system costs presented by Table 39 are as follows: The microwave transmission system for the basic system cost a reported $140,000. This cost is based on 22 miles/35 kilometers, the total distance for three sites (three towers). In comparison, the microwave transmission system for the intermediate system cost a reported $400,000. This cost is based on 55 miles/85 kilometers, the total distance for three sites (four towers).

As mentioned previously, this study dealt with a leased fiber optic system, not a purchased fiber optic system. Consequently information addressing the major cost considerations in setting up a purchased fiber optic transmission system was not acquired. However, information pertaining to the initial cost considerations for a leased fiber optic system was obtained. The findings of which are presented in Table 40.

The initial lease cost of the fiber optic system based on 63 miles/105 kilometers, the total distance for three sites, was reported as a $60,000. service charge, payable over four years. A one time connection fee was included in this service charge. The cost of leasing the fiber reportedly includes the costs for all transmission equipment. The Manitoba Telephone System (MTS) supplies the total transmission system including: fiber optic cable, switching

Table 40

Initial Costs of Leased Fiber Optic System

Factor	Deluxe System
Initial lease costs:	
one site	Up-front service charge of $60,000
two sites	payable over 4 years
three sites	
One time connection fee	Yes - Connection fee included in service charge cost
Connection fee cost	n/a
Equipment included in lease	MTS supplies the fiber optic cable, switching mechanisms, etc.
Is leasing fiber analogous to	
leasing a car?	Yes
Explanation	MTS supplies the entire transmission system (car), Evergreen supplies/maintains the classrm. equipment (gas); our only concern is to use system (put gas in car, change oil, etc.)
Miscellaneous initial costs	None
Unforeseen Difficulties and Costs	Yes - Manitoba Telephone System (MTS) required more time to install equipment - installation was not completed until mid-August - training teachers to use system prior to September very rushed - no cost involved - MTS responsible for costs

Note. n/a - not applicable.

devices, etc. Since the transmission system is analog, the additional cost of a CODEC (device used for digital systems - it converts the video signals generated in the IITV classroom into signals that can be transmitted through the fiber) was not a consideration.

What does it cost to establish a multi-point transmission system using: fiber optics; microwave? Table 40 presents the findings for initial cost considerations of a leased fiber optic system. It reportedly costs $60,000 to establish a multi-point transmission system using fiber optics. This cost is based on 63 miles/105 kilometers, the total distance for three sites.

In contrast, based on the findings presented in Table 39 it reportedly costs $140,000 to establish a multi-point analog microwave transmission system. This cost is based on 22 miles/35 kilometers, the total distance for three sites (three towers). In comparison, it reportedly costs $400,000. to establish a multi-point digital microwave transmission system. This cost is based on 55 miles/85 kilometers, the total distance for three sites (four towers)

The unforeseen difficulties reportedly experienced during the initial set-up of the leased system are described in Table 40. There were no additional costs associated with these difficulties.

What are typical recurring and maintenance equipment costs of a: fiber optic transmission system; microwave transmission system? Table 41 presents the ongoing costs associated with the use a privately owned microwave transmission system. Within this table, the recurring and maintenance equipment costs are identified. A complete report for the intermediate system was unavailable given that the system was not fully functional at the time of data collection. However, it was reported that the following recurring costs are known: annual license fee of $864. and annual land lease of $125., while the following annual recurring and maintenance costs are anticipated: hydro, and maintenance/repair costs.

Table 41

Ongoing Costs of Microwave Transmission Systems

Factor	Basic System	Intermediate System
Situations requiring repair/maintenance	2 months of down time when system converted from Amateur system to current microwave system - faulty UPA (power amplifier) - other minor equipment failure usually costs between $500-$600 each time	Unable to answer - system not fully functional
Insurance, maintenance and repair costs[% total system cost]	Budget $7,000/yr for total ongoing system costs; repair and maintenance consumes approximately 50% of this figure	Unable to answer
Other ongoing costs	Hydro cost which is combined with hydro usage of entire school, the costs of which are borne by school and in turn paid by school division	Land lease - $125 per year
Annual license fee	$800 (approximate)	$864
Annual operating cost	$3,000 for 3 sites	Unknown; expecting costs to be hydro, annual license fee, annual land lease fee and annual maintenance/repair costs
1st year operating cost	$3,000	n/a
5th year operating cost	2nd year costs = $3,000	n/a
Expansion plans	Yes	No immediate plans

Note. n/a - not applicable.

The findings for typical recurring costs of microwave transmission for the basic system include: maintenance/repair of the transmission equipment, hydro, and an annual license fee of approximately $800. Situations requiring repair/maintenance are explained in Table 41.

The cost of a maintenance contract is not a consideration for the basic system. According to (E. Wiebe personal communication, October 7, 1997) “a service contract costs more than the actual costs incurred when a breakdown occurs. E B Systems analyzes and fixes problem and Midland pays for the cost of repair/service.”

As in the basic system, the cost of a maintenance contract is not a consideration for the intermediate system. However, L. Paulson (personal communication, October 6, 1997) reports that “once the system is functional we expect to have one year of warranty followed by maintenance contract coverage.”

<u>What are the costs associated with the ongoing usage of a: fiber optic transmission system; microwave transmission system</u>? Table 41 presents the ongoing costs associated with the use a privately owned microwave transmission system. A complete report of ongoing costs for the intermediate system was unavailable given that the system was not fully functional at the time of data collection. The total annual operating cost of microwave for the basic system is reportedly $3,000. for all three sites. This cost has reportedly been the same since the system’s inception, two years ago.

Expansion plans are reportedly being made to change the basic system’s analog microwave transmission system to partial digital in near future. E. Wiebe (personal communication, October 7, 1997) explains “Currently Midland uses 5 of the 16 available channels because it is analog. With more school divisions entering into the Canada Manitoba

Infrastructure Works Project Agreement more microwave systems will be in use. When this happens there will be more competition for the 16 channels available for audio and video. Conversion to a partial digital system will result in reduction of bandwidth usage (from 5 to 2 1/2 channels). This will free up more bandwidth for other school divisions. Additionally this conversion will allow Midland to link with other school divisions when Phase two of the Infrastructure Works Project commences."

In contrast, no immediate plans for system expansion are reportedly being made for the intermediate system. L. Paulson (personal communication, October 6, 1997) explains "At the moment we're just focusing on getting system fully functional. If after this is accomplished, the system proves successful, a dual system will be installed that will connect another classroom to the transmission system. However, this second system will not be as elaborate as the current one because the Infrastructure Works Project is over as of the current fiscal year end and Souris Valley will have to bear the entire costs, for which there are insufficient funds."

The ongoing costs associated with leasing a fiber optic system are presented in Table 42.

As previously identified in Table 40, the cost of leasing the fiber reportedly includes the costs for all transmission equipment. The Manitoba Telephone System (MTS) supplies the total transmission system including: fiber optic cable, switching devices, etc. and is responsible for all recurring and maintenance/repair costs. Consequently the only recurring cost reported was the ongoing lease cost of $5,000. per site per month ($60,000. annual lease

Table 42

Ongoing Costs of Leased Fiber Optic System

Factor	Deluxe System
Annual lease cost	$60,000 per year for 3 sites
Operation/maintenance cost	$20,000 per year per site
Frequency of payment	Lease cost $5,000 charged per month but paid on annual basis
Cost allocation among users	Money is allocated annually to IITV system use - school division pays MTS annually
Variation among sites	No - cost does not vary per site
criteria for variation	n/a
First year total lease costs (including maintenance and operating costs)	$60,000
Fifth year total lease costs (including maintenance and operating costs)	System has been operational for 4 years - costs for fourth year were $60,000
Miscellaneous costs	None
Unforeseen costs	None
Expansion plans	Expanding cable and installing cameras, monitors, etc. into other classroom, i.e., chemistry lab and gymnasium, so that teacher can use IITV to teach from these areas as well; anticipate linking with other schools when Phase two of infrastructure project commences

Note. n/a - not applicable.

cost including all three sites). This cost has reportedly been the same since the system's inception, four years ago.

Expansion plans reportedly are being made for the deluxe system which include expanding fiber optic cable and installing IITV classroom equipment into other areas of the school i.e. chemistry laboratory and gymnasium. This will permit teachers to teach to students at a distance from these areas as well. Additional expansion plans are being made to link the deluxe system with other school divisions when Phase two of the Infrastructure Works Project commences.

Summary

This chapter presented the study's findings in three sections corresponding to each of the following key research question:

1) Why choose IITV as an instructional technology?

2) What should the design of varying IITV classroom systems include?

3) How much do the varying IITV classroom systems cost?

Section I Why choose IITV as an instructional technology?

Information acquired from school division representatives suggests that IITV is chosen as an instructional technology primarily as a mechanism for ensuring that rural students receive the same educational opportunities as do their urban counterparts. A by-product of this is the assurance that rural school districts survive.

Section II What should the design of varying IITV classroom systems include?

The key research question: What should the design of varying IITV classroom systems include? was answered through an investigation and analysis of three specific research questions.

What are the design characteristics of: a basic IITV classroom system, an intermediate IITV classroom system and a deluxe IITV classroom system? The findings reveal that each design has its own set of defining characteristics. However, underlying these unique attributes some common elements are found which are fundamental to the delivery of two-way audio and video interactive instructional television.

What are the advantages and disadvantages associated with each design? The findings reveal that each design has its own particular associated advantages and disadvantages. The findings seem to suggest that as steps to remodel a standard classroom into a dedicated IITV classroom are instituted, associated disadvantages decrease.

What are the common and uncommon elements of all three designs? Data analyzed in relation to a total of 81 design considerations revealed that of this total, 24 design considerations are found to be common across all three designs, while 57 design considerations are found to be uncommon. A summary of these findings is presented in Table 43.

Table 43

Common and Uncommon Considerations Found to Exist Among Basic, Intermediate and Deluxe IITV Classroom Systems:

Consideration	Common	Uncommon
Classroom Size and Room Location		
Classroom Size		
Dimension		X
Policy stipulating maximum no. of students	X	
Ceiling height		X
All sites can be initiating site	X	
Classroom location		
Relationship to other classes		X
Dedicated room		X
Acoustic advantage considered		X
Noise level from hallway traffic	X	
Electric Service		
Number of circuits		X
Number of outlets		X
Wiring system not located near motors or heating/cooling systems	X	
Inner liners or conduits		X
Surge/spike protectors		X
Dedicated circuits and panel		X
Cords/wires running across floor	X	
Presence of crawlspace under classroom	X	
Access to ceiling wiring		X

Consideration	Common	Uncommon
Classroom Arrangement		
Number of desks		X
Rows of desks		X
Number of students per desk	X	
Flexibility of design		X
Seating arrangement in relation to camera/monitors		X
Monitor viewing distance		X
Vertical angle in relation to monitors		X
Classroom doors		
Numbers		X
Relationship to camera		X
Decor, Windows/Walls and Floors/Ceilings		
Decor		
Background	X	
Surface finishes	X	
Windows/Walls		
Colour		X
Coverings		X
Floor colour/Coverings		X
Floor not free of wiring/cords	X	
Ceiling colour/covering		X
Private Conference Area, Storage and Security		
Use of private conference area	X	
Adequate storage Provision		X
Security		
Use of door sweeps and metal flanges	X	

Consideration	Common	Uncommon
Use of door dead bolt	X	
Marked equipment		X
Other measures		X
Experience with theft or vandalism		X
Environmental		
Ventilation and temperature control		X
Audio		
Acoustical Treatment		X
Occurrence of exterior noise	X	
Occurrence of interior noise	X	
Occurrence of echoes		X
Lighting		
Type		X
Selectively switched or dimmed	X	
Presence of glare		X
Use of teacher station light source	X	
Furniture		
Student seating/desks		
Type of chairs	X	
Type/Dimensions of desk		X
Teacher Station		
Use of riser		X
Dimension		X
Switching Device		
Type		X
Function		X

Consideration	Common	Uncommon
Instructor Chair		X
Site Lines to monitors		X
Use of whiteboard	X	
Quality of transmission		X
Equipment Standardization and Microphones		
Standardization of equipment for all sites		X
Student Microphones		
Number		X
Type		X
Use of open microphone and speakers		X
Microphones and speakers separated		X
Speaker location		X
Teacher microphones		
Number/type		X
Use of Lavaliere microphone	X	
Cameras, Monitors, Visual Presenter, Telephone and Facsimile Machine		
Cameras		
Number		X
Function		X
Switching		X
Monitors		
Number, size and function		X
Use of Visual Presenter	X	
Brand name and capabilities		X
Telephone		X
Facsimile machine		X

Consideration	Common	Uncommon
VCR, Auxiliary Equipment and Computer		
VCR	X	
Auxiliary Equipment Types		X
Computer	X	
Classroom Management		
Monitoring of inappropriate behaviour in remote classroom		X
Methods for dealing with inappropriate behaviour	X	
Experience with inappropriate behaviour		X
Total	24	57

Note. Basic System is found in the Midland School Division; Intermediate System is found in the Souris Valley School Division; Deluxe System is found in the Evergreen/Lakeshore School Division.

Section III How much do the varying IITV classroom systems cost?

The key research question: How much do the varying IITV classroom systems cost? was answered through an investigation and analysis of ten specific research questions.

How much does it cost to remodel a standard classroom into: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system? The findings reveal that: costs to remodel a standard classroom into a basic IITV classroom system are minimal; and costs to remodel a standard classroom into intermediate and deluxe IITV classroom systems are approximately 3 1/2 times and 5 times respectively, the cost required to remodel a standard classroom into a basic IITV classroom system.

How much does it cost to equip: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system? The findings reveal that: it costs 1 1/2 times as much to equip an intermediate IITV classroom system as it does to equip a basic IITV classroom system; and more than 2 times as much to equip a deluxe IITV classroom system as it does to equip a basic IITV classroom system.

What are typical recurring and maintenance costs for the classroom equipment in: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system? The findings reveal that typical recurring and maintenance costs for IITV classroom equipment are the same for basic and deluxe IITV classroom systems. Whereas in the intermediate system (not completely functional at time of data collection) a rough estimate of such costs was provided.

As opposed to other transmission systems, why would an organization choose to use a: fiber optic transmission system; microwave transmission system? The findings reveal that a fiber optic transmission system was chosen by one school division because of its quality and stability. Whereas a microwave transmission system was chosen by two school divisions because microwave transmission is less expensive than fiber and the ongoing costs of fiber are prohibitive.

What are the advantages and disadvantages of a: fiber optic transmission system; microwave transmission system? The findings reveal that advantages of a fiber optic transmission system are: audio and video is constant with no delay; system is reliable and full-motion video; fiber is not influenced by climatic changes. In contrast, advantages of microwave were found to include: initial low cost; reliability and ease of use; high quality audio and video transmission; low ongoing operating cost; and since the transmission system is owned and not leased, prices cannot be increased at a later time.

The findings reveal that a disadvantage of a fiber optic transmission system is: that it is a little more expensive than other transmission systems. In comparison, disadvantages of microwave were found to include: lack of technical support; occasional weather interference; unknown true maintenance cost if equipment fails repeatedly; system is influenced by climatic changes; and it is unknown whether the microwave transmission system will go out of date and/or become obsolete.

What steps are involved in setting up a: fiber optic transmission system; microwave transmission system? This study was unable to obtain information specifying the steps involved in setting up a purchased fiber optic system. However, information detailing the steps involved in setting up a microwave transmission system was obtained. The findings reveal that setting up a microwave transmission system involves: an engineering study; obtaining an operating license; system design and construction; and equipment testing and installation.

What does it cost to establish a multi-point transmission system using: fiber optics; microwave? The findings reveal that: it costs almost 3 times as much to establish a multi-point transmission system for an intermediate IITV classroom system as it does to establish one for a basic IITV classroom system; and that establishing a leased fiber optic system costs approximately 1/6th of the cost to establish a multi-point transmission system for an intermediate system.

What are the major cost considerations of a: fiber optic transmission system; microwave transmission system? The findings reveal that major cost considerations for a fiber optic transmission system include: an upfront service charge and ongoing lease cost. In contrast, the findings reveal that major cost considerations for a microwave transmission system include: tower construction; equipment; land; equipment testing; consultation services; licensing, connections to the school; miscellaneous costs; and unforeseen costs.

What are typical recurring and maintenance equipment costs of a: fiber optic transmission system; microwave transmission system? The findings reveal that: there are no recurring and maintenance equipment costs of a leased fiber optic transmission system that the school division has to pay. The telephone system is responsible for fiber optic system equipment repair/maintenance. In comparison, the findings reveal that typical recurring and maintenance equipment costs of a microwave transmission system range from $2,000 to $3,500 per year for the basic system.

What are the costs associated with the ongoing usage of a: fiber optic transmission system; microwave transmission system? The findings reveal that the costs associated with the ongoing usage of a leased fiber optic transmission system include an ongoing lease cost. Whereas, the findings reveal that the costs associated with the ongoing usage of a microwave transmission system include the cost of: hydro; an annual license fee; and ongoing maintenance/repair of equipment. The findings reveal that the ongoing lease cost of fiber is 20 times that of the costs associated with the ongoing usage of microwave.

A summary of the costing for the systems under study is presented in Table 44.

Table 44

Summary of Costs

Factor		Cost
Remodeling standard classroom into:		
basic IITV system		6,350
intermediate IITV system		23,000
deluxe IITV system		33,000
Equipping IITV classrooms		
basic		15,580
intermediate		24,727.93
deluxe		34,600
Annual recurring/maintenance of classroom equipment		
basic IITV system		4,000
intermediate IITV system		1,000 estimate
deluxe IITV system		4,000
Establishment of multi-point transmission system using:		
leased fiber optics		60,000 based on 63 miles/105 kilometers
microwave	analog(basic system)	140,000 based on 22 miles/35 kilometers
	digital(intermediate system)	400,000 based on 55 miles/85 kilometers
Annual ongoing usage of:		
leased fiber options		60,000 for 3 sites
microwave	analog (basic system)	3,000 for 3 sites
	digital (intermediate system)	cost unavailable

Note. Basic System is found in the Midland School Division; Intermediate System is found in the Souris Valley School Division; Deluxe System is found in the Evergreen/Lakeshore School Division.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this chapter is to discuss the study's findings, draw conclusions, and make recommendations for further research. In the first section, a review of Chapters I, II, and III is presented. The second section considers the study's findings, in relation to the research questions. In the third section, conclusions are made and in the fourth section recommendations for future research are proposed.

Section I

Chapter I - Review. This chapter provides background information to the problem; followed by a statement of the problem; study's purpose; research questions; and significance. A glossary and definition of terms concludes the chapter.

Cost is one of the most important issues in distance education. The design, implementation, and maintenance of an IITV classroom system can be expensive. Therefore, it is vital that distance education planners understand why IITV would be the technology of choice in light of considerable expense and challenges.

The physical learning environment is an often neglected component of teaching with telecommunications. A variety of literature concerning IITV systems, exists. However, only a limited amount of this material focuses on the physical design of an IITV classroom. Furthermore, none of this literature provides an analytical comparison among different design applications.

"One major question asked by administrators, school boards, and policymakers is, How much does distance education cost?" (Jones, 1992 p. 8). For individuals contemplating the establishment of an IITV classroom system, information that identifies the costs associated with the installation and ongoing system operation is limited. Moreover, literature that provides a comparison between the costing of different IITV classroom system applications is sparse and difficult to locate.

Individuals considering the use of IITV often require information that justifies its use. If the decision is made to establish an IITV system, then these same individuals need access to current and reliable information that presents several system design options, as well as, the related costs of each. As part of IITV system design, there are also transmission system costs to consider.

This study is beneficial to distance education planners because it analyzes the specific variables which contribute to the total costs of an IITV classroom system. This study identified conditions under which IITV is an appropriate choice of technology for delivering instruction in the K-12 environment; presented an analysis of different IITV classroom system design applications and corresponding transmission systems; and provided estimates of the typical costs associated with the creation, as well as, ongoing usage of such systems.

Chapter II - Review. This chapter presents a review of the literature relevant to the concepts central to this study. The literature review was presented in three sections corresponding to each of the following key research questions:

1) Why choose IITV as an instructional technology?

2) What should the design of varying IITV classroom systems include?

3) How much do the varying IITV classroom systems cost?

Literature related to the use of IITV as an instructional technology tend to be presented by users describing their specific experience with IITV. This literature suggests that IITV is chosen because: studies reveal that students taking courses via IITV achieve, in most cases, as well as students taking courses via traditional methods; and the benefits of IITV to rural school divisions outweigh its costs (i.e. the provision of equal educational opportunities for students and the assurance of rural school district survival, as well as, the simultaneous delivery of interactive teaching/learning strategies to geographically dispersed student bodies).

Literature on IITV classroom system design tends to be presented by users describing their own specific classroom system design. The literature suggests that content objectives will be augmented and user acceptance increased by a properly designed classroom. Classroom systems described in the literature were consistent in terms of design and layout.

Literature on costs associated with IITV classroom systems and supporting transmission systems suggests that there are no simple formulas readily available to help estimate the cost of a technology system. The literature on types of costs reveals that schools implementing distance learning systems will have both initial and ongoing costs. Initial costs include capital equipment and development costs and ongoing costs include programming, transmission, operation and maintenance, and system expansion costs. Information pertaining to initial costs, as well as, ongoing costs was located. However, literature outlining initial program development costs was not found.

Chapter III - Review. This chapter presents the method used to conduct the study. This study was designed to address the three key research questions. Study participants were: representatives of three Manitoba school divisions which utilize IITV; the person responsible for the co-ordination and implementation of the Canada-Manitoba Infrastructure Works Agreement Distance Education; consultants/technical experts responsible for IITV classroom system design and installation; persons responsible for the supporting transmission systems set-up; and vendors/suppliers of IITV equipment.

Data was collected through observational case analysis of the three IITV classroom systems. Information that addressed the three key research questions was obtained through the use of face-to-face interviews, telephone conference calls, on-site visits and personal communications. Based on this study's findings, the three key research questions were answered.

Section II -Discussion of Study's Findings

The discussion of this study's findings is presented in three sections corresponding to each of the three key research questions.

Why choose IITV as an instructional technology? This study's findings substantiate the information presented in the literature concerning the question of Why Choose IITV as an Instructional Technology. As is reported in the literature, the findings for all three school divisions sampled suggest that the primary reason for establishing and using IITV systems was to ensure that rural students receive the same educational opportunities as their urban counterparts. All three school district representatives concurred that in achieving educational equality for rural students via IITV, rural school district survival was ensured, as well.

The issues raised in the literature concerning whether "being able to see the other person" and the promotion of interactive teaching strategies are advantageous considering the costs are validated by this study's findings. All three school divisions sampled reported that they place a high value on interactive teaching strategies promotion and are in agreement that IITV usage promotes this. IITV is viewed as the best possible alternative to regular classroom instruction. “Any course offering that is not “face to face” (student to instructor) is less effective” (E. Wiebe, personal communication, October 7, 1997).

The findings of this study confirm the reasons given in the literature for choosing to use IITV as an instructional technology. Information acquired from school division representatives suggests that IITV is chosen as an instructional technology primarily as a mechanism for ensuring that rural students receive the same educational opportunities as do their urban counterparts. A by-product of this is the assurance that rural school districts survive.

What should the design of varying IITV classroom systems include? This study’s findings revealed that each design has its own set of defining characteristics. However, underlying these unique attributes some common elements exist which are fundamental to the delivery of two-way audio and video interactive instructional television (i.e. monitors, camera, microphone, switching equipment, etc.).

The literature suggests that a properly designed classroom enhances content objectives and increases acceptance by students and faculty. This suggestion was not fully supported by the findings of this study. The basic IITV classroom system, considered in this study, received very little remodeling. The instructor/IITV Coordinator who uses this basic design states that he is “comfortable with this design” (R. Lindsay, personal communication, October 7, 1997). The school division superintendent for the basic design reports that “we did some statistical analysis, a number of years ago in which the results tended to illustrate that students did as well as, and in some cases better than, students in the traditional classroom” (E. Wiebe, personal communication, October 7, 1997). Based on this, it appears that teachers can be comfortable teaching in an IITV classroom that has received minimal remodeling and the students can learn as effectively in this type of IITV classroom system design, as they can in the other designs.

However, having said this, a cautionary note is in order. In contrast to both the intermediate and deluxe IITV classroom system designs, the basic system's IITV equipment has not been installed with consideration to the maintenance of lines of sight and communication with all students at all locations. In the basic system, the teacher is able to view only one remote site monitor on the same line of site as the camera is set on. This occurs when he/she moves out from behind the teacher's station to a stand/sit among the students while turned to face the camera. Viewing the other remote site monitor requires that the teacher turn to the left to see it, removing the teacher from line of site with the camera. Viewing the monitor, used to show the picture displayed by the document camera, requires that the teacher face the teacher's station while standing/sitting among the students. This also removes the teacher from line of site with the camera. The teacher is also reportedly unable to view the remote site students in their entirety. This lack of consideration to maintenance of sight lines and communication with all students at all locations generates the question of how well this design promotes full interactivity between teacher-to-students and student-to-student between all sites.

<u>What are the common and uncommon elements of all three designs</u>? Literature presenting a comparative analysis between the common and uncommon design elements of IITV classroom systems was not found.

The data collected as a result of this study was analyzed in relation to a total of 81 design considerations. The analysis revealed that of this total, 24 design considerations are found to be common across all three designs, while 57 design considerations were found to be uncommon.

Besides the most obvious differences found to exist between the basic design's physical environment and both the intermediate and deluxe designs, another distinct difference is the type and amount of equipment used in the basic design as compared to that used in both the intermediate and deluxe designs. For example: the basic design uses half the number of monitors and cameras that the intermediate and deluxe designs use; and both the intermediate and deluxe designs use additional ceiling mounted speakers, while the basic design does not have provision for additional speakers.

<u>What are the advantages and disadvantages associated with each design</u>? Literature presenting a comparative analysis between the advantages and disadvantages of IITV classroom systems was not found. Based on an analysis of the data collected during this study, it was determined that all three IITV classroom system designs have their associated advantages and disadvantages.

The chief advantage reported for the basic design is its "utter cheapness" (R. Lindsay, personal communication, October 7, 1997). However, this low cost IITV system design is not without its disadvantages; all of which appear to be related to the non-dedicated status of the classroom. The intermediate design's disadvantages appear to be related to the system not being fully functional at the of data collection. In contrast, to the other two designs, the deluxe system reportedly has no disadvantages other than its use of a fixed student camera, as opposed to one that is remote controlled.

<u>How much do the varying IITV classroom systems cost</u>? This study found initial capital costs of IITV classroom systems to include: expenses associated with actual

remodeling, consultation services for design and or equipment installation and acoustical treatment. A cost consideration identified in the literature, not found to be an issue for the three designs under study, was the cost associated with media specialist services. In both the basic and intermediate designs the reason given for not seeking a specialist's services was "a cost saving measure." In the deluxe design, the consultant hired to assist with the classroom design and equipment installation, was also responsible for carrying out the media specialists duties.

How much does it cost to remodel a standard classroom into: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system? This study's findings for the basic and intermediate IITV classroom system designs support the literature which suggests that standard classrooms can be adapted for IITV without significant remodeling costs. Even though the majority of literature recommends that IITV classrooms be dedicated, the basic design represents a non-dedicated classroom. According to L. Lindsay (personal communication, October 7, 1997) "the room was setup as a temporary thing but would have been changed into a more studio setup but funding problems have kiboshed that and the room has evolved into something I could live with."

This study's findings revealed that in designing tiered IITV classrooms, such as the deluxe IITV classroom system under study, there is a requirement that the classroom being remodeled, for the purpose of IITV, have a ceiling that is a minimum of 15 feet (L. Roche, personal communication, October 22, 1997). The ideal ceiling height is 24 feet and former school gymnasiums are ideal areas for tiering (G. Southgate, personal communication, October 24, 1997).

This study's findings revealed that the deluxe IITV classroom system's tiering was accomplished economically because the area, used for the purpose of IITV, was a former school gymnasium. Consequently this area had the proper dimensions to allow for tiered steps. This, coupled with the fact that the former gymnasium stage area was converted into the tiered steps with minimal additional construction, also assisted the school division in realizing a cost saving. Based on these findings, it was determined that if an area such as a former gymnasium is unavailable for remodeling, a standard classroom cannot be remodeled into the deluxe IITV classroom design, without significant remodeling and cost.

<u>How much does it cost to equip: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system</u>? As is reported in the literature, this study revealed that there is a wide variation in the cost of IITV classroom system equipment. Based on the reported costs for each design under study, the findings substantiate the claim found in the literature that IITV classroom equipment can be easily added or eliminated to fit budgets and needs.

This study identified the unforeseen difficulties and costs associated with initial IITV classroom system set-up. Information such as this was not reported in the literature.

<u>What are typical recurring and maintenance costs for the classroom equipment in: a basic IITV classroom system; an intermediate IITV classroom system; and a deluxe IITV classroom system</u>? As is reported in the literature, this study revealed that the typical recurring and maintenance costs of classroom equipment in both the basic and deluxe systems are minimal. In accordance with literature this was attributed to the IITV classroom equipment being reliable, requiring little maintenance. The representative for the intermediate system could not comment fully regarding typical recurring and maintenance

costs of classroom equipment because this system was not fully functional at the time of data collection. However, anticipated costs were provided for the intermediate system.

As opposed to other transmission systems, why would an organization choose to use a: fiber optic transmission system; microwave transmission system? This study's findings for rationale of microwave selection substantiates the literature which suggests that when choosing one particular medium, "some compromises may be required; budget constraints or environmental factors may force trade-offs" (Jones, 1992).

This study found that microwave transmission systems were selected by two of the three school divisions under study because microwave was deemed to be less expensive than fiber and the ongoing lease costs of fiber were prohibitive. In contrast, the third school division reportedly chose fiber because of the quality and stability fiber reportedly affords.

What are the advantages and disadvantages of a: fiber optic transmission system; microwave transmission system? This study's findings for advantages and disadvantages of a fiber optic transmission system and a microwave transmission validates those cited in the literature which claim that fiber optic transmission systems are more reliable than microwave transmission system. In the basic system which uses microwave transmission, the signal has reportedly been interrupted occasionally (which is reportedly "very frustrating" - R. Lindsay, personal communication, October 7, 1997). In comparison, the deluxe system which uses fiber optic transmission has never had its signal interrupted. "The system is reliable and climatic changes do not affect fiber" (L. Roche, personal communication, October 22, 1997).

What steps are involved in setting up a: fiber optic transmission system; microwave transmission system? A literature review did not reveal information that identifies the steps involved in setting up a fiber optic transmission system or a microwave transmission system.

This study dealt with a leased fiber optic system, not a purchased fiber optic system. Consequently information specifying the steps involved in setting up a fiber optic transmission system was not acquired. However, information detailing the steps to follow when setting up a microwave transmission system was acquired. Analysis of this data reveals that setting up a microwave transmission system is a complex process that cannot be accomplished without technical assistance.

What are the major cost considerations of: a fiber optic transmission system; a microwave transmission system? As mentioned previously, this study dealt with a leased fiber optic system, not a purchased fiber optic system. Consequently information specifying the major cost considerations of a purchased fiber optic transmission system was not acquired. However, information specifying the major cost considerations of leasing a fiber optic transmission system was acquired. These findings validate the information cited in the literature concerning the cost considerations of a leased fiber optic system.

This study found that the major cost considerations of a microwave transmission system include: tower construction; equipment; land; equipment testing; consultation services; licensing, connections to the school; miscellaneous costs; and unforeseen costs. These findings substantiated those found in the literature with the exception of FCC application and building construction at each tower. FCC is the regulatory body found in the United States. In Canada however, the regulatory body for licensing is Industry Canada. Neither systems considered in this study reportedly required the construction of a building for the purpose of equipment storage.

This study identified the unforeseen difficulties and costs associated with the initial installation of microwave transmission systems. Information such as this was not reported in the literature.

Information in the literature on the costing of towers was not substantiated by the findings of this study. The only tower costs obtained were those for the basic system's microwave towers. The tower costs for the intermediate system's transmission system were reported to be "imbedded in the total transmission system cost." The reason given for non-disclosure of tower costs for this system was that these costs are "proprietary" and because of the potential for competition from other vendors/suppliers these specific prices could not be provided.

The finding by Jones (1992), that "there are no 'package' prices for transmission systems, that almost every step in the process has a price i.e. consulting, installation, testing, maintenance, upgrades and services are all itemized costs" was not substantiated by this study. The majority of prices were reported as "imbedded in the total transmission system cost" and a breakdown of costs could not be obtained during interviews with participants.

This study's findings that in all situations except two the towers were constructed on school property (as close to the school as possible) verifies the literature that recommend the location of towers within a mile of the school. The exceptions were for the intermediate system where the tower in Wawanesa requiring a higher location and the repeater tower located on farmland at Carroll.

<u>What does it cost to establish a multi-point transmission system using: fiber optics; microwave</u>? As mentioned previously, this study dealt with a leased fiber optic system, not a purchased fiber optic system. Consequently information specifying what it costs to establish

a multi-point transmission system using fiber optics was not acquired. However, information identifying what it costs to establish a multi-point transmission system using a leased fiber optic transmission system was acquired. These findings do not validate the information cited in the literature, which recommends leasing for short term uses. The leased system under study is one which has been leased for four years (this system is reportedly going to be leased for the long term). Literature that report the initial lease costs to include a one-time connection fee was substantiated by this study's findings.

This study identified the unforeseen difficulties associated with the initial set-up of a leased fiber optic system. Information such as this was not reported in the literature.

This study's findings do not substantiate the literature reporting the purchase costs of microwave systems. Jones et al. (1992), investigated the purchase costs of microwave for two sites, for varying distances and found that the purchase cost of microwave was $229,080 based on 20 miles and $492,660 based on 50 miles. This study found that the purchase cost of an analog microwave system for three sites was $140,000 based on 22 miles/35 kilometers and the purchase cost of a digital microwave system for three sites (four towers) was $400,000 based on 55 miles/85 kilometers.

This study validates the literature that reports analog is less costly than digital. This study's findings reveal that the costs of setting up a digital microwave transmission system, for the intermediate system were almost three times the costs for setting up the analog microwave transmission system, for the basic system.

This study's findings do not validate the literature's report that "analog signals require about one-tenth the capacity of digital signals" (Jones, 1992, p. 26). In this study it was found that analog signals require more bandwidth than digital signals. The basic system's analog microwave transmission system reportedly "uses 5 of the 16 available channels because it is analog." Expansion plans are being made to change the basic system's analog microwave transmission system to partial digital in near future. "Conversion to a partial digital system will result in reduction of bandwidth usage (from 5 to 2 1/2 channels). This will free up more bandwidth for other school divisions" (E. Wiebe, personal communication, October 7, 1997).

What are typical recurring and maintenance equipment costs of a: fiber optic transmission system; microwave transmission system? This study's findings support those reported in the literature for typical recurring and maintenance equipment costs of leased fiber optic systems. It was found that the school division under study for the deluxe system using the fiber optic system was not responsible for any recurring and maintenance equipment costs. The telephone system is responsible for fiber optic system equipment repair/maintenance.

This study's findings validate the literature that reports that of the two transmission systems; microwave and fiber, microwave systems are the most susceptible for repair, because they are influenced by environmental changes, i.e. weather. In contrast, fiber is impervious to climatic changes. It was found that the basic system's microwave transmission system had recurring and maintenance equipment costs ranging from $2,000 to $3,500 per year. In contrast, the deluxe system's leased fiber optic system did not have recurring and maintenance equipment costs.

This study's findings did not confirm the literature which recommends that maintenance contracts should state clearly how readily the vendor is expected to provide service. In the basic system there is no contract between the school division and vendor. The reason given is that "the service contract costs more than actual costs incurred when a breakdown occurs" (E. Wiebe, personal communication, October 7, 1997).

What are the costs associated with the ongoing usage of a: fiber optic transmission system; microwave transmission system? This study's findings validates the literature that states the a microwave system is cost-effective for short distances. The costs associated with the ongoing usage of microwave in the basic system include: hydro, annual license fee, ongoing maintenance/repair of equipment cost a total of $3000. per year, based on 22 miles/35 kilometers, the total distance for three sites.

This study's findings for costs associated with the ongoing usage of the leased fiber optic system do not confirm those reported by Jones et al. (1992), and Hobbs (1993). This study's findings reveal that the cost associated with the ongoing usage of a leased fiber optic system is $60,000. per year based on 63 miles/105 kilometers, the total distance for three sites. This cost falls somewhere in between the costs identified in the literature. It is less than the cost identified by Jones et al. and more than that identified by Hobbs.

The findings of this study reveal that the ongoing costs of leased fiber are extremely high when compared with the ongoing costs of microwave.

Section III - Conclusion

This study provided an analytical comparison between three IITV classroom system design applications and their respective supporting transmission systems, as well as, the total costs associated with the creation and ongoing usage of such systems. Two limitations of this study are as follows:

1) This study did not conduct a comparative analysis of the costs for specific services associated with microwave transmission system design, construction and installation. These

costs were unobtainable because a very competitive market is said to currently exist in Manitoba. Consequently the vendor/supplier of the microwave transmission equipment was unwilling to disclose any specifics concerning individual transmission component costing.
2) Costing information was not obtained for a purchased fiber optic system. However, costing information pertaining to a leased fiber optic system was obtained.

This study identified the miscellaneous and unforeseen costs associated with the initial installation of microwave transmission systems. For example: the intermediate system's transmission system was not fully functional at the time of data collection. This system was scheduled to be fully functional as of September 1997. However, this system encountered audio and video problems caused by mismatched equipment and equipment failure i.e. CODECS that don't function and/or send data at incorrect baud rate to modems, as well as incorrectly configured modems.

This study revealed the following advise for future planners of IITV: ensure that the company hired to set-up the IITV system is large enough to provide complete installation without interruption and ensure that the system runs perfectly before attempting to use it to teach students.

The data obtained from doing this study should provide distance education planners with sufficient information to answer the following questions: Why choose IITV as an instructional technology? What should the design of varying IITV Classroom systems include? and How much do the varying IITV classroom systems cost?

Section IV - Recommendations for Future Research

This study found that the basic IITV classroom system has been designed with non-consideration to the maintenance of lines of sight and communication with all students at all locations. Future studies could:

1) compare the frequency of teacher to student and student to student interactivity observed in the basic IITV classroom systems as compared with that observed in either the intermediate or deluxe IITV classroom systems;

2) investigate remote site teacher and student satisfaction with the basic IITV classroom system design;

3) investigate how different teaching styles influence the success of the IITV student; and

4) analyze how well students, previously taught using IITV, are doing in post-secondary educational endeavors.

When Phase one of the Canada-Manitoba Infrastructure Works Agreement: Distance Education Project is completed approximately 80 schools (Grades K to S4) will be utilizing IITV. Future studies could be investigate the effectiveness of IITV for this group.

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APPENDIX A

Interview Questionnaire # 1

Why Choose IITV as an Instructional Technology?

1) Why would an educational organization choose to use IITV as an instructional technology?

When completing this question, please address the following sub-questions and specific components:

1a) How does learning via an IITV classroom system compare with learning in a traditional classroom?

- Have you completed any studies? Statistical analysis?

1b) How do benefits and costs of an IITV classroom system compare?

Please answer this question in relation to:

-Rural school district survival;

-Your thoughts re the extent to which IITV allows for interactive teaching strategies such as questioning and discussion that leads to motivated students who become active participants;

-The possibility of increased student-to-student exchanges occurring at different sites;

-Reduced cost;

-Productivity gain;

-Increased communication; and

-The ability to set higher goals in education.

1c)What performance indicators do you use to assist you to evaluate whether your system is assisting you achieve what you want to achieve?

- Are you looking for an ROI (return on investment) ?

- If you aren’t looking for an ROI, are you using proxies (other values) to obtain evidence that your money is being well spent (that you are getting your money’s worth)?

1d) To what extent does your IITV classroom system provide flexibility and efficacy in meeting the educational goals and objectives?

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APPENDIX B

Interview Questionnaire # 2

IITV Classroom System Design

Section I

IITV Classroom System Overview

For case study purposes, please provide an overview of your IITV classroom system. (i.e. when your system was established, why it was established and under whose directive, type of supporting transmission system used, any momentous changes/dates that have occurred since your system's inception, etc.).

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Section II

IITV Classroom System Design Considerations/Issues

1) What are the <u>physical considerations/issues</u> of your IITV classroom, in relation to the following characteristics?

a) Classroom Size?

- Classroom dimensions?

- How many students does your classroom seat?

- Do you have a policy re the maximum number of students permitted in a course offered via IITV (total number including all sites)?

- What does this policy state?

- How high is the ceiling in the classroom?

- Is one site designated the initiating/originating site?

b) Location of the Room?

-Where is your classroom located in relation to other classrooms in school?

- Is your classroom a dedicated IITV classroom?

- Was any thought given to acoustic advantage when this room was selected?

- Comment on the noise level generated from traffic in the hallway.

c) Electric Service?

- How many circuits does your room have?

- How many outlets does your room have?

- Is your classroom wiring system located near compressor motors, blower motors, elevator motors, heating, ventilating or air conditioning systems/wiring structures?

- Are inner liners or separate conduit used for each connection?

- Have surge/spike protectors been installed?

- Is this classroom serviced by a set of dedicated circuits with the breaker panel installed in the classroom and clearly labeled as to the control function of each breaker?

- Please comment re this classroom's wiring? Does it consist of complex networks of wiring that is attached to permanently fixed structures? Do any cords/wires run across the floor? If not how and where are they attached?

- Has a wooden sub-floor been instituted to permit access to floor wiring structures for upgrading and/or repair?

- Comment re the ceiling wire? Is access to ceiling wiring through a suspended ceilings?

d) Classroom Arrangement?

- How many tables and how many chairs are used?

- How many rows of desks?

- How many students per desk/table?

- Was this classroom designed to be as flexible as possible by avoiding the tendency to "nail things down"? Are seats fixed ? Are tables attached to the floor?

- Are students seated so they can see each other and do not have to turn to face the camera?

- Are all students able to be viewed at the same time by the students in the remote site and vice versa? Is the teacher able to view both remote classes in their entirety?

- Please comment re the viewing distance in your classroom.

- Please comment on the vertical angle view in your classroom. Do your students have to look up or to the side for any of the monitors?

- How many doors are in your classroom?

- Where is/are the doors situated in relation to the camera view range?

e) Decor?

- Is the background classroom color, transmitted via camera comprised of a complex pattern? If not what is the background?

- What are your surface finishes like?

- Does your room have any chrome, glass, and shiny plastics which create a distracting glare that is reflected onto monitor screens ?

f) Windows/Walls?

- What color are the walls?

- Windows? coverings?

g) Floors/Ceilings?

- What color is the floor and ceiling?

- Are the floor and ceiling made of non-reflective material?

- Was any thought given to carpeting the floors?

- Is the floor smooth and free of wiring and cords?

h) Private Conference Area?

- Do you have such an area?

i) Storage?

- Please comment re amount of storage in your IITV classroom.

j) Security?

- Please comment re any security measures you have instituted.

- Have doors been equipped with door sweeps and metal flanges covering door cracks?

- Does the door(s) have a deadbolt?

- Has equipment been marked?

- Have you experienced any theft? Vandalism? Please elaborate.

2) What are the <u>environmental considerations/issues</u> of your IITV classroom, in relation to the following characteristics?

a) Ventilation/Temperature Control?

- Please comment on the ventilation/temperature control in your classroom.

- Does your classroom have a HVAC?

b) Audio?

Has your classroom been acoustically treated?

If yes, please identify and describe each acoustical treatment.

If no, please explain why not.

- Please comment re the occurrence of exterior noise.

- Please comment re the occurrence of interior noise.

- Please comment re the occurrence of echoes.

c) Lighting?

- What type of lighting do you use?

- Are your lights able to be selectively switched off or dimmed?

- Do they include the provision for a highly concentrated light source at the teacher station?

- Is glare on the monitors an issue?

- If glare is an issue how do you deal with the glare?

3) What are the <u>furniture considerations/issues</u> of your IITV classroom, in relation to the following characteristics?

a) Seating/Desks?

- What type of chairs do the students use?

- How many chairs are in use?

- What type of student desks/tables are in use?

- How long and wide are the tables?

b) Instructor Area/Teacher Station?

- Is the teaching station situated on a riser?

- What are the dimensions of the teacher station?

- What type of chair has been allocated for the teacher? Is it located behind the station? Is it's height adjustable?

- Is the teacher able to view off-site monitors on the same line of sight that the instructor camera is set on?

- Is there a whiteboard located at the teacher station?

- If so please comment re the quality of video transfer of the information when written on the white board and viewed by the remote sites.

4) What are the <u>equipment considerations/issues</u> of your IITV classroom, in relation to the following characteristics?

- Is all classroom equipment and installation the same (has been standardized)for all sites? Please comment why or why not.

- What equipment is housed or located at/in the teacher station?

a) Microphones?

- How many student microphones do you use?

- What type are they?

- Are they open microphones and open speakers ? If so how do you deal with echoes and feedback?

- Have the microphones and speakers been separated?

- Do you have speakers? If so where are they located?

- How many teacher microphones?

- What type of microphone system does the teacher have?

- Do you have the option of wearing a small radio microphone (lavaliere mic)?

b) Cameras?

- How many cameras are in use during the IITV class ? What is the function of each camera?

- How is the switching from one camera to another camera accomplished?

(Do the cameras have infrared sensors?)

c) Monitors?

- How many monitors does each class have? (include size and function of each)?

d) Visual Presenter/Document Camera?

- Does your document camera have a particular brand name?

- Does your document camera have zoom, auto focus etc. capabilities?

e) Telephone?

- Do you have a telephone in the classroom?

- How many telephone jacks do you have in the classroom?

f) Facsimile Machine?

- Do you have a fax machine?

g) Videocassette Recorder (VCR)?

- How many VCRs are in an IITV classroom?

(Do you have one VCR per IITV classroom or two per classroom?)

h) Auxiliary Equipment?

- Please identify the equipment that is considered auxiliary i.e. a videodisk player, a tape recorder, and/or a record player.

- Where is this equipment stored?

- Is this equipment (or any other) connected to the system as an auxiliary input?

- Do you have switching devices to allow for easy switching between any of the cameras, VCR, or computers.

i) Computers?

- What type and number of computers are used during an IITV class?

- In order to make use of your computers as an auxiliary input in your IITV classes did you have to install special equipment? Please explain what type of special equipment was installed

5) What are the classroom management considerations/issues of your IITV classroom system, in relation to the following characteristics?

a) How is inappropriate behavior able to be monitored in the remote IITV classroom? (i.e. is there a monitor in each principal's office and in the superintendent's office?)

b) How is inappropriate behavior dealt with in the remote IITV classroom?

(i.e. is there a contract that student's must sign prior to the beginning of the course offered by IITV which identifies disciplinary policies?, is the VCR set up so that at the touch of a button it is capable of recording offensive behavior? Is the IITV classroom telephone set up so that only one button needs to be pushed to connect the originating site with the remote site of the student who is causing the disturbance?)

c) What has been your experience in relation to inappropriate behavior of students in the remote sites? How have you dealt with it?

****

Section III

General Questions

1) Identify the critical factors that influenced your ultimate decisions regarding the design of your IITV classroom system.

2) Identify any compromises that had to be made during the design of your IITV classroom system (i.e. perhaps your preference was for arranging student desks in a horseshoe design but because of classroom space limitations you had to arrange the student desks in rows).

3) What do you like about the design of your IITV classroom system? Why?

4) What are the advantages associated with the design of your IITV classroom system?

5) What don't you like about the design of your IITV classroom system? Why?

6) What are the disadvantages associated with the design of your IITV classroom system?

7) If you could change anything about the design of your IITV classroom system, what would you change? Why?

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APPENDIX C

Interview Questionnaire #3

IITV Classroom System Design &

Supporting Transmission System's Costs

Section A

IITV Classroom System Design

Initial Costs

1) Was your IITV classroom constructed completely from the ground up or was it a standard classroom remodeled for IITV classroom purposes?

2) If your IITV classroom was constructed from the ground up, what was the total design/ construction cost?

3a) If your IITV classroom is a remodeled classroom, explain what modifications were made to the standard classroom (i.e. lighting, wiring, and room dimensions modifications)?

3b) What was the cost of each modification?

3c) What was the total cost for remodeling a standard classroom into your IITV classroom?

4a) Did a private consultant design/develop a plan for the complete IITV classroom system?

4b) If yes, what was the total consultant cost?

4c) What did the consultant charge per hour?

4d) If a private consultant was not utilized, please explain.

5a) Was a consultant involved in the IITV classroom installation?

5b) If yes, what were his/her duties and associated costs?

5c) If a private consultant was not utilized, please explain.

6a) Was a media specialist(s) utilized for planning, design of the IITV classroom, determination of hardware requirements and monitoring installation?

6b) If yes, what was the cost?

6c) If no, please explain.

7a) Were currently employed school division personnel (i.e. maintenance personnel) able to perform any IITV classroom construction/development/coordination duties, as part of cost saving measure?

7b) If yes, please explain.

7c) If no, please explain.

8a) Was any other person(s) involved in the design/development/installation of the IITV classroom?

8b) If yes, what were the duties and associated costs?

9a) Was your IITV classroom acoustically treated?

9b) Please describe the acoustical treatment(s) and state the associated costs.

9c) If your IITV classroom was not acoustically treated, please explain.

10) Please list all equipment purchased for your IITV classroom (including the quantity, cost per unit and total cost of each equipment piece).

11) What was the total cost for installation of IITV classroom equipment?

12a) Do the IITV classroom equipment costs reflect the catalogue price or did your school division receive a discount from the vendors?

12b) If you received a discount, how much was it? (if possible express this discount in percentage of total equipment costs)

13) What type of training is provided for the teachers to use the IITV classroom equipment?

14) Did you have to hire any additional local staff to assist and/or train users of the system, or was someone already on staff given additional duties?

15) If someone was reassigned locally to care for the system, how were they trained?

16) What would you estimate to be the total cost of training teachers how to use the IITV classroom?

17) Please identify all other initial miscellaneous IITV classroom design/construction costs.

18a) Did you encounter any unforeseen difficulties during the installation and initial implementation of your IITV classroom system?

18b) Please explain.

19a) Were there any unforeseen costs?

19b) Please explain.

IITV Classroom System Design cont'd

Ongoing Costs

20a) Has your IITV classroom equipment been reliable, requiring no repairs?

20b) If your IITV classroom equipment has required repair, please explain the kind of repair, the cost of the repair and who was responsible for paying for the cost of the repair.

21a) Do you have an IITV classroom equipment maintenance contract?

21b) If you do, what is its cost expressed in a percentage of your system's purchase price?

21c) Is this an annual cost?

21d) What is the length of the contract (i.e. when does coverage expire?)?

21e) If you do not have an equipment maintenance contract, please explain.

22) What are the annual recurring equipment repair and maintenance costs for your IITV classroom? (Those costs not covered by equipment maintenance contract).

23) Please identify all other ongoing/recurring miscellaneous IITV classroom costs (i.e. equipment, facsimile paper, batteries, etc.)

24) Were there any unforeseen costs?

****

Section B

Supporting Transmission Systems

An overview

1) What type of transmission system do you use? (i.e. fiber optic, microwave, mix of both, other _______).

2) What transmission technology do you use on the system? (i.e. analog video, DS-3, T-1)

3a) Were other technologies considered for the system?

3b) Which one (s)?

3c) Why did you choose the technology you did?

4) How was the decision made to select the technology used for your system?

5) Rate your overall satisfaction with the transmission system you chose (from 1 to 5).

6) What have you found to be the three primary advantages of the technology you chose?

7) What are three disadvantages?

8) What are three important characteristics of the technology you chose?

9a) Is the transmission system owned by the district or are the services leased?

9b) If owned, what is the expected life of the technology/hardware used for the system?

9c) If leased, for what number of years?

10) How many IITV classrooms are connected to the system?

11a) What are the names of the communities, school divisions and schools served by your transmission system?

11b) What is the distance in miles and kilometers of each school from one another?

12) How many IITV classrooms can be interconnected for two-way instruction at the same time?

13) How many classes are offered using the IITV system per year?

14) How many students are in those classes?

15a) Can your transmission system be interconnected to another system in the same province?

15b) If so, has that ever been used?

16) How is technical maintenance of the transmission system provided?

17) How is the transmission system managed/scheduled?

18) Who provides overall review of the system management? (i.e. district administrator, committee of users, others?).

19) Is there any committee of users to provide ongoing feedback on the management and operation of the network?

20) Has there been any opportunity to share infrastructure resources and programming costs with other districts, educational agencies, private business, higher education and/or government?

Please explain why, or why not.

21) Have you expanded the uses of your distance learning system to include other user groups who will pay in exchange for use of the system?

Please explain why, or why not.

****

If your transmission system is microwave please complete Section C

If your transmission system is fiber optic please complete Section D

****

Section C

Microwave Transmission System

An Overview

1) What steps were involved in setting up your microwave transmission system?

2) What bandwidth and frequency does your microwave system operate at?

3a) How is your microwave system regulated (i.e. are microwave frequencies regulated by the FCC with licensing required).

3b) What is the cost of the license fee?

4) If your microwave system is not regulated by the FCC how do you protect the system from interference concerns and protect receive sites from possible new source of interference?

5a) Where is your microwave tower located in relation to the school?

5b) How many towers does your microwave system have?

6) Did any local zoning ordinances affect your decision regarding placement of your microwave tower(s)?

7) How is the system connected from the tower to the school?

Microwave Transmission System

Initial Costs

8) How many channels does your microwave system operate on?

9a) List all the components of your microwave transmission system (i.e. if relevant, include: tower(s), antenna(s), antenna feed line(s), transmitters/receivers, modulators/multiplexors and power units at each transmit/receive site).

9b) Please provide the costs of each component.

10) Were you able to use an existing microwave tower(s) or did you construct your own?

11) Did you place multiple antennas on one tower?

12) If you had to construct your own microwave tower, what was the total cost of construction for the microwave tower(s)?

13) If you constructed more than one microwave tower, how much did each repeater tower cost additionally for equipment and tower construction?

14) What was the total cost of installing your microwave system (including transmitters, receivers, and all electronics)?

15a) What were the total consultation costs for your microwave system?

15b) Did the consultation services include any or all of the following:

- Path profile to check for obstructions?
- Frequency coordinates to find other frequencies that might interfere?
- Path analysis to determine how much power was required?
- Completion of the FCC application (or other applicable regulatory/licensure)?
- Tower specifications to note items such as ice and wind load?

15c) Please explain.

15d) Identify the cost of each service

15e) What other services were provided by consultants in relation to your microwave system?

15f) What was the cost of each additional service?

16) What is the height of your system's microwave tower(s)?

17a) What is the length of the antenna on both ends?

17b) If you have an antenna dish, what is the dish size?

17c) What is the cost of the dish?

18a) Is your microwave self-supporting or one that is attached to a building?

18b) Please explain.

19a) What type of land is your system's microwave tower(s) situated on (i.e. town property, farm land, etc.)?

19b) How much land does your tower(s) require?

19c) Is the land owned or leased by the school division?

19d) If the land is leased, what is the annual lease cost?

19e) If the land was purchased, what was the cost?

20) What were the equipment costs for both ends of your microwave system?

21a) Was it necessary to construct a building to house all the electronics at each tower site?

21b) If so, what was the total cost of building construction for both sites?

21c) If not, please explain.

22a) What was the cost of connecting the tower to the school?

22b) Was any special equipment needed (i.e. an amplifier)?

22c) If so, what was the cost of this equipment?

23a) Before you purchased your microwave system, was the equipment placed on trucks and a test transmission performed of the point-to-point locations in order to verify that there was no interference?

23b) If so, what was the cost of the testing?

23c) If not, was any type of testing done prior to system purchase?

Please explain.

24) What was the total cost for installation of your microwave system's equipment?

25a) If FCC licensure application was required, what was the process for license application?

(please explain if different licensure was required)

25b) What type of form was used to make application?

25c) Was there an application fee? If so, how much was the fee?

26) If your system consists of multiple hops, did you require more than one license?

27a) Are you exempt from regulation and/or charges?

27b) If so, please explain.

27c) Was any action necessary to request a fee exemption?

27d) Were frequency coordination's completed by microwave technical experts?

27e) If so, what was the cost?

28) If you have more than one tower, what is distance between towers?

29) Please identify all other initial miscellaneous costs.

30a) Did you encounter any unforeseen difficulties during the installation and initial implementation of your microwave system?

30b) Please explain.

31a) Were there any unforeseen costs?

31b) Please explain.

Microwave System

Ongoing Costs

32) What percentage of total system cost per year are the insurance, maintenance, and repairs costs of your microwave system?

33) What types of situations have required maintenance on your microwave system?

34a) Do you have a maintenance contract with a vendor that states clearly how readily the vendor is expected to provide service?

34b)What percent of total system purchase price is the maintenance contract for your microwave system?

35) What does it cost to operate the entire transmission system (including all sites) per year?

36) What is the cost per site per year for operation/maintenance?

37) How are the transmission system costs charged? Per use or yearly cost?

38) How are the transmission system costs allocated among users?

39) Does each site pay the same or does it vary per site?

40) What is the criteria?

41) Including maintenance/repair and operating costs, what were the first year total costs of your microwave system (for one site, two sites and for three sites)?

42) Including maintenance/repair and operating costs, what were the costs of the fifth year of your microwave system (for one site, two sites and for three sites)?

Please note! If your system has not been operational for five years simply provide information for the last complete year of operation.

43) Please identify all other ongoing/recurring miscellaneous microwave equipment costs.

44)Were there any unforeseen costs?

45) Please identify all other ongoing/recurring miscellaneous costs associated with the ongoing usage of your microwave system?

46) Were there any unforeseen costs?

47a) Do you have any plans for system expansion in the near future?

47b) Please explain why or why not

48) What words of advise would you give to future planners of IITV?

****

Section D

Fiber Optics System

An Overview

1) Is your fiber optics system purchased or leased?

2) Please explain why you chose to purchase your fiber optics system instead of leasing one (or vice versa).

3) What steps were involved in setting up your fiber optics system?

4a) Did you encounter any unforeseen difficulties during the installation and initial implementation of your fiber optics system?

4b) Please explain.

If you purchased your fiber optics system please complete section D-1

If you lease your fiber optics system please complete section D-2

****

Section D-1

Purchased Fiber Optics System

Initial Costs

1) Including labor and fiber only, what was the cost per mile of constructing your fiber optics system?

2a) Please list all of your fiber optics system's equipment/hardware (i.e. if relevant, include: multiplexor, codec, optical transmitter, optical receiver or photodetector, fiber cable, repeater(s), and laser modulators)

2b) What was the cost of each piece of equipment/hardware?

3a) What were the purchase costs and end point costs for two sites?

3b) Please identify which sites and the distance between the two sites.

Please note! Purchase costs refer to all construction, material, and equipment (not end point) costs involved in building the system, while end point costs include transmission equipment, hardware, cables, and power supply, plus codices which change analog signals to digital signals and compress the signal.

4a) What were the total consultation costs for your fiber optics transmission system?

4b) Did the consultation services include any or all of the following:

- Feasibility studies
- Route surveys
- Coordinate specifications
- Right-of-way checks
- Route designs with drawings (including a mapping of the entire distance).
- Staking the route
- Supervising the construction
- Crew scheduling

4c) Were any other services (than those listed directly above) performed by consultants?

4d) Please explain.

4e) What was the hourly consulting rate?

5) What were the labor construction costs per foot?

6a) Did construction work take place in rural and/or urban areas?

6b) If construction was necessary in urban areas, was extra field work, engineer work, concrete work, and easement attainment necessary?

6c) Please identify the cost per foot of this extra construction work.

6d) What was the total costs of materials (i.e. fiber, manholes, warning signs, and splices)?

6e) Was this cost different for rural construction than it was for urban construction?

6f) In urban areas were additional duct costs incurred and additional splicing and manhole costs are required?

7a) Did fiber optics construction cross roadways or railroads?

7b) If so, was an application required to obtain an easement right-of-way?

7c) How was the easement obtained?

7d) Was a license required to place the fiber optics cable in this right-of-way.

7e) What was the cost per foot per year for the easement?

8a) Did fiber optics construction cross private land?

8b) If so, was it necessary to pay for easement rights to the private individual?

9) What is the speed of transmission and capacity of your fiber optics system?

10a) Is your fiber optic system's end point equipment digital or analog?

10b) If digital, what was its cost, including installation for one site? two sites? three sites? (for the purpose of this study, digital end equipment is usually one unit that functions as the codec, laser transmitter, optical receiver, and multiplexor/demultiplexor [MUX/DEMUX])?

10c) If analog, what was its cost, including installation for one site? two sites? three sites?

11) Please identify all other initial miscellaneous costs.

12) Were there any unforeseen costs?

13) How is your fiber optics system regulated?

Purchased Fiber Optics System

Ongoing Costs

14a) Has your fiber equipment been reliable, requiring no repairs?

14b) If your fiber optics system has required repair, please explain the kind of repair, the cost of the repair and who was responsible for paying for the cost of the repair.

15a) Do you have an end point equipment maintenance contract?

15b) If you do, what is its cost expressed in a percentage of your system's purchase price?

16c) Is this an annual cost?

17) What does it cost to operate the entire transmission system (including all sites) per year?

18) What is the cost per site per year for operation/maintenance?

19) How are the transmission system costs charged? per use or yearly cost?

20) How are the transmission system costs allocated among users?

21) Does each site pay the same or does it vary per site?

22) What is the criteria?

23) Excluding maintenance and operating costs, what were the first year total costs of your fiber optics system (for one site, two sites and for three sites)?

24) Excluding maintenance and operating costs, what were the costs of the fifth year of your fiber optics system (for one site, two sites and for three sites)?

Please note! If your system has not been operational for five years simply provide information for the last complete year of operation.

25) Excluding maintenance and operating costs, what were the average costs per year for a five year period of your system's operation (for one site, two sites and for three sites)?

26) Please identify all other ongoing/recurring miscellaneous fiber optics equipment costs.

27) Were there any unforeseen costs?

28) Please identify all other ongoing/recurring miscellaneous costs associated with the ongoing usage of your fiber optics system?

29) Were there any unforeseen costs?

30a) Do you have any plans for system expansion in the near future?

30b) Please explain why or why not.

****

Section D-2

Leased Fiber Optics System

Initial Costs

1a) What was the initial cost of leasing your fiber optics system for one site? two sites? three sites?

1b) Does this cost reflect a one time connection fee?

1c) What is the cost of this connection fee?

1d) If this cost does not include a one time connection fee please explain.

2) Leasing a fiber optics system has been compared to leasing a car in that maintenance and operation are the responsibility of the lessor, while using the system is the only concern of the leasee. Do you agree or disagree? Please explain.

3a) What does the cost of leasing your fiber optics system include (i.e. does the lease cost include the costs for all equipment except for the device that converts the video signals generated in the IITV classroom into signals that can be transmitted through the fiber)?

3b) What is this device called?

3c) What was its cost?

3d) Are there any ongoing costs associated with the use of this device?

4) Please identify all other miscellaneous costs.

5)Were there any unforeseen costs?

Leased Fiber Optics System

Ongoing Costs

6) What does it cost to operate the entire transmission system (including all sites) per year?

7) What is the cost per site per year for operation/maintenance?

8) How are the transmission system costs charged? per use or yearly cost?

9) How are the transmission system costs allocated among users?

10) Does each site pay the same or does it vary per site?

11) What is the criteria?

12) Including maintenance and operating costs, what were the first year total lease costs of your fiber optic system (for one site, two sites and for three sites)?

13) Including maintenance and operating costs, what were the costs of the fifth year of your fiber optics system (for one site, two sites and for three sites)?

Please note! If your system has not been operational for five years simply provide the last complete year of operation.

14) Including maintenance and operating costs, what were the average lease costs per year for a five year period of your system's operation (for one site, two sites and for three sites)?

15) Please identify all other ongoing/recurring miscellaneous fiber optics equipment costs.

16) Were there any unforeseen costs?

17) Please identify all other ongoing/recurring miscellaneous costs associated with the ongoing usage of your leased fiber optics system?

18) Were there any unforeseen costs?

19a) Do you have any plans for system expansion in the near future?

19b) Please explain why or why not.

20) What words of advise would you give to future planners of IITV?

****

APPENDIX D

Prospective Participants

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APPENDIX E

Letter to Employers

Group 410 Box 6
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Telephone (204) 725-0642
March 15, 1997

To Whom It May Concern:

Hello
Your school division/agency/organization has been selected to participate in my study entitled: Interactive Instructional Television (IITV): An Application and Cost Analysis.

The purpose of my study is to acquire information relevant to the following key questions:

1) Why choose IITV as an instructional technology?
2) What should the design of varying IITV classroom systems include?
3) How much do the varying IITV classroom systems cost?

In consideration of human ethics, I am required to obtain permission to interview and/or send a questionnaire to yourself and/or employees in order to procure information relevant to the questions specified above.

By signing this letter and returning it to me, you will be granting consent for yourself, as well as, your employees to be interviewed and/or sent a questionnaire by me and authorizing the use of your name, school names, and employee names as references, when I report the research findings in my thesis document.

Please sign the bottom section of this letter and return the entire letter to the above address. Please retain a copy for yourself.

Thankyou.
Kindest regards,

Kim Ryan-Nicholls

I ____ hereby grant Kim Ryan-Nicholls consent to approach the employees of ____________________ School Division to be interviewed and/or sent a questionnaire by Ms. Ryan-Nicholls. I further authorize the use of my name, the name of the school division and the names of the schools contained therein to be used as references, when Ms. Ryan-Nicholls reports the research findings in her thesis document.

Signed by: ______________________________________

Designation: ___________________________________

Date: ____

APPENDIX F

Letter to Employees

Group 410 Box 6
R. R. #4
Brandon, Manitoba
Canada
R7A 5Y4
Telephone (204) 725-0642
March 15, 1997

To Whom It May Concern:

Hello
You've been selected to participate in my study entitled: Interactive Instructional television (IITV): An Application and Cost Analysis.

The purpose of my study is to acquire information relevant to the following key questions:

1) Why choose IITV as an instructional technology?
2) What should the design of varying IITV classroom systems include?
3) How much do the varying IITV classroom systems cost?

In consideration of human ethics, I am required to ensure that your participation in my study is both a) voluntary and b) not demanded by your employer. Furthermore, I am obligated to inform you that during the interview and/or questionnaire process: i) you may refuse to answer any of the questions; ii) you may terminate the interview at any time; and iii) you have the right to view the draft report for accuracy, if you wish, since your name will appear in my thesis.

By signing this letter and returning it to me, you will be verifying that all conditions have been met and that you have a complete understanding of your rights, as a participant in my research. Your signature will also provide consent for the use of your name as a reference, when I report the research findings in my thesis document.

Please sign the bottom section of this letter and return the entire letter to the above address. Please retain a copy for yourself.
Thankyou.
Kindest regards,

Kim Ryan-Nicholls

I ____ hereby consent to participate in Kim Ryan-Nicholls’ study and verify that my participation is both voluntary and has not been demanded by my employer. I am also aware that in agreeing to participate in this study, my rights during the interview and/or questionnaire process are as follows: i) I may refuse to answer any of the questions; ii) I may terminate the interview at any time; and iii) I have the right to view the draft report for accuracy, if I wish, since I am authorizing the use of my name as a reference, when Ms. Ryan-Nicholls reports the research findings in her thesis document.

Signed by: ______________________________

Designation: ____________________________

Date: ___________________________________