University Classrooms

How many have taken a college class from an inexperienced and/or overworked graduate instructor, or from a tenured professor who showed up unprepared (if at all) and acted like he didn't really want to teach this extra class anyway? How many have not been able to find (or get admitted to) a class which was essential to meet graduation requirements? Unfortunately, such things are all too often a reality, even in the best schools.

Today, the majority of our college instructors in the technological fields are foreign born. That is not to degrade their abilities or contributions. Although many of them are there because they cannot get security clearances to work in the higher paying defense industries, an even greater number of them are there because they simply outnumber (and often outperform) the domestic graduates in our own universities. This says much about about our college preparatory education.

The field of Electrical Engineering is presently the largest user of satellite distance learning. Purdue University is one example of a school that has long used remote television transmission for classes at its regional campuses. Cal. State (Chico) has been one of the pioneers, offering a complete Masters Degree program in Computer Science by using satellite delivered classes to anywhere in the Nation. However, this requires a significant investment in a receiving system and substantial expense in satellite transponders.

By using the YES Networks, the Nation's best instructors can economically provide high-quality courses to any college campus regardless of location.

University of the Air

Correspondence courses have long been a mainstay and often the only option for distance learning. Occasionally, in the larger metropolitan areas, some general courses are offered through local television stations. Homework assignments are mailed in and, hopefully, are promptly graded and returned. Final exams are usually taken at some prearranged location. This type of study works well for the self-motivated student. Through the YES Networks, far more effective courses and much more variety can be offered for home math, science, and engineering study and they can be receiver anywhere in the Nation. Consider the following scenario:

> A college student returns home to her children after working half-day. Her husband is also a student and works the other half of the day. She has already finished her Bachelors degree (mostly through YES Network classes) and is now in medical school. Through

the YES Network and her home computer she is able to complete most of her classes without having to leave her young children with a baby-sitter.

She is presently taking a course in communicable diseases. This afternoon she especially wants to view a seminar on the latest research results on AIDS treatments. While she is watching the seminar, her computer disk is being down-loaded with a research paper written by the seminar speaker and containing the test results and statistical analysis being discussed during the seminar broadcast.

Later, for general interest, she audits a class on "Music Appreciation." Today's lecture on "the use of vocals within the symphonic form" is interspersed with excerpts from Mahler's 4th and Beethovan's 9th symphonies. The sound quality is the same as from her compact disk player.

It is easy to see how this concept would extend to any type of programming in math, science, or engineering.

University-Home Programs

As a natural extension of the previous two services, a new concept in formal college education can be derived. Instead of commuting every day (or at least several times per week) to a university the majority of class attendance could be from home by satellite. By developing programs with local (or regional) universities, physical class attendance could be limited to required laboratories and major exams. Question and answer sessions could be handled at prearranged times from the local university by modem or voice telephone lines or at any time by data or voice messaging. For example, the new NeXT computer has voice messaging built in.

By using recordable optical disks (also standard in the NeXT computer and soon to be available for others), text and reference books could be purchased by telephone and downloaded to the student through the YES Networks satellite. Less frequently used research references could be accessed through on-line data services such as the new Prodigy information utility system recently launched by Sears and IBM.

Teacher Class Preparation

In conjunction with the broadcast courses, separate broadcasts could be provided for the purpose of aiding a local instructor. This would include complete course planning; preview summaries of upcoming broadcasts and services; optional downloaded materials; exam answers and software for

automated grading; suggestions and aids for customizing the course; and references, supplementary materials and aids for handling questions from students.

Teacher Training

Courses could be provided specifically for the purpose of upgrading a teacher's credentials in the fields of math and science. On many occasions, a gym teacher or English teacher gets stuck teaching a math or science course for which he or she is not adequately trained simply because no one else is available. The YES Networks' broadcasts would allow many of these teachers to take classes specifically targeted for this situation and simultaneously be able to upgrade their credentials to qualify as certified instructors in these fields. Of course, as with all YES Networks broadcasts, this service would be available anywhere in the nation, even in the smallest and most remote communities.

School Administration

Many services and training courses could be available to school staff and administration to help with course scheduling, accounting, student records, student guidance counseling, PTAs, report cards, attendance records, relations with the school board and community, etc.

Vocational Training

Many types of vocational training are now available by correspondence and through local schools. For example, courses to train as an electronics technician or an electronics repairman are readily available by correspondence. Imagine how much more effective these could be if combined with a broadcast course which could be received at home. More advanced or specific courses (e.g., certain types of computers) could also be offered.

Adult Education

Adult education is also a very great need. Before someone can learn math and science he or she must be reasonably proficient in reading. Consider the following scenario:

> A blue-collar worker comes home from a frustrating day at work. It has been difficult, but he has managed somehow to get by all these years without being able to read. He realizes that he is at a dead-end for job advancement but is too embarrassed to enroll in a local adult reading class. He turns on the television to view the listings of tonight's programs on DBS (his satellite receiver with a 2' antenna--now as common as VCRs). He watches the videolog which shows a sequence of still-frames ads and has one or two sentence verbal descriptions of each of tonight's and tomorrow's programs. He sees (and

hears) that the YES Network has a beginning class starting tomorrow night on adult reading.

On the following nights he comes home, turns on the TV, and switches on the class. The class consists of still-frame images, reading text, animation, and an instructor's voice. The instructor gradually leads the new student through the basics of reading. Interspersed in the lecture are multiple choice questions, such as identifying the spoken word or sentence from the displayed written choices. He uses his TV remote control to respond. A visible or audible TV response tells him whether his choice is correct or not. At the end of the program, his percentage of first-time-correct selections is displayed, verbalized, and compared with his previous scores. He is now on the way toward becoming literate, enriching his life, and being a more productive member of society and industry.

Handicapped Education

Specific programming can be developed for home reception by those who are either mildly or severely handicapped and for whom daily travel to a distant classroom is difficult or impossible. For the deaf, optional captioning can replace the voice of an instructor. For those who are visually impaired, screen magnifier software is now a standard feature on some computers. For those who are totally blind, programming can be designed which uses tactile arrays to replace visual displays. Many types of handicap-specific control devices have been developed for interaction with a computer. Because of the YES Networks' digital nature, the control interface can be implemented quite naturally. By using the computer as the program delivery means, these devices can be easily interfaced to the computer to allow appropriate student interaction.

Businesses, Hospitals, Military

There is a great need for math, science, and engineering educational broadcasts to businesses, hospitals, and the military. Basic, advanced degree, and continuing education are often not available or timely for those employed full time in these areas. Many plants, hospitals, and military bases are physically isolated where access to institutions of higher learning is severely limited. Even those in the larger metropolitan areas are sometimes effectively isolated by severe traffic congestion which is continually getting worse.

Most of these institutions also have specialized needs that cannot be met by local general educational institutions. Dispersed geographical distribution and low local density often precludes running in-house educational programs. Consider, for example, companies with nationwide sales and service offices; hospitals or other health care facilities in smaller communities, and military bases

across the Nation The YES Networks system can economically serve all or these and provide the same general services that are available to the remainder of the country while also providing for the specialized needs of these institutions.

Seminars and Symposia

Although formal education in math, science, and engineering provides the basic foundation of our technology, seminars and symposia are the life blood of research, continuing education, technological advancement, and innovation. Timely dissemination of information is essential for the application of research and technological advancements and for influencing currently on-going work in these areas. However, access to such seminars is usually limited to those involved with (and near) major institutions. Access to symposia is often severely limited by time, travel, and budgetary constraints.

The YES Networks can provide Nation-wide broadcasts of these seminars and symposia, thus assuring access to all who so desire but are unable to physically attend. Besides eliminating the time and expense of travel, selective access can be exercised to limit the time involvement to those subjects and presentations which are of most interest. Selected conference papers and research results can also be downloaded to the user's computer for printing or for electronic access.

Libraries

There are many services that could be designed specifically for technical libraries. For example, many libraries are now using CD-ROM to manage their card catalog. Many publications are providing archival copies on CD-ROM. These can be augmented by current updates from the YES Networks satellite and captured on magnetic or recordable optical media for use between CD-ROM updates. The same is true for industrial catalogs and product availability information. Many additional services could be provided by using slack periods (e.g., middle of the night) to download specifically requested technical books, references, or research data. Of course, the libraries could also serve as a general learning center for reception of broadcasts.

Publications

Many of the comments that apply to libraries also apply to individuals. Instead of receiving printed publications by mail, an individual could subscribe directly to an electronic version of a technical publication. This has many potential ramifications on the concept of technical publications. The technical publication cycle is presently about one to two years between when the actual work is performed and when the information becomes generally available. Electronic publication and distribution via the YES Networks would allow a less formal format and more timely distribution.

The format would be totally flexible and would allow **multi-media hypertext** publications. Information could be presented in printed, audial, visual, and animated form. An article could contain a summary, detailed descriptions of various theoretical and implementational aspects, presentation of results and data summaries, and all of the raw data. Page limitations would not be an issue because the hypertext format would allow the subscriber to explore precisely the areas and depths that he or she desires.

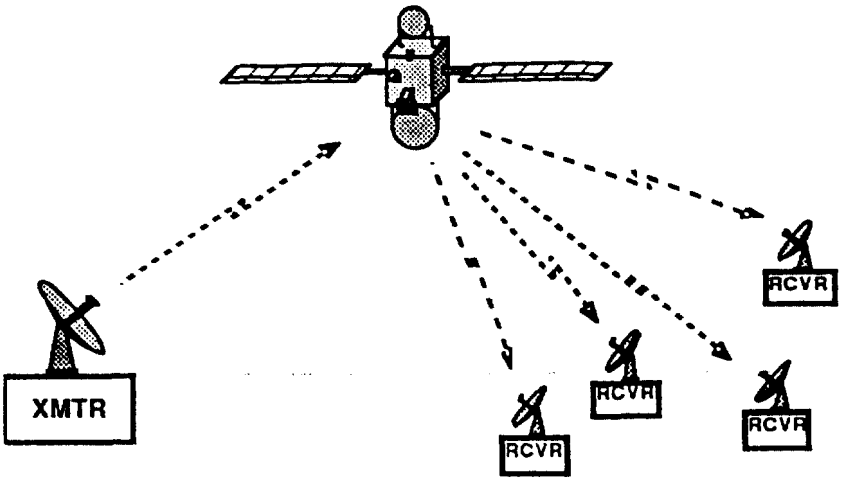
$ 125,000,000. Among Novacom's contract efforts was an innovative system design for audiograpjics distance learning by satellite in Indonesia. Mr. Dement is a member of many professional associations, a Senior Member of IEEE, and an Associate Fellow of AIAA. Among other awards and honors, he is a recipient of the Air Force Meritorious Civilian Service Medal.

Dr. Samuel A. Covington - Dr. Covington has over 20 years teaching experience in institutions of higher education where he has lectured in history, political science, human anatomy and physiology, wildlife management, and biology. He received BS and MS degrees in botany and microbiology (1967/1969) and MA and PhD degrees in history (1970/1976). He is presently a member of the graduate and undergraduate faculties of the University of Arkansas at Little Rock where he teaches history, environmental sociology and metropolitan planning. He was Director of Management planning for Metroplan, the Little Rock MSA regional council of governments, where he directed environmental planning projects and managed the council's public involvement programs. Also for the past five years he has been a consultant in private practice and president of Appraisal, Planning and Development Consultants, Inc. where he directs market and feasibility analyses for a wide range of clients including governments and industries. He has worked with many federal agency projects and programs in the past fifteen years including those regulated by the EPA, FmHA, EDA, Corps of Engineers, HUD, USGS, and F&WS. He has been project manager and grant administrator. Projects managed by Dr. Covington have included many involving complex arrangements among public and private interests. Dr. Covington has extensive experience in the areas of experimental radio and television programming, remote sensing (satellite and aerial photography), computer mapping, market analysis, and attitude sampling.

Dr. John McElroy.-.YES-P Technical Advisor. Dr. McElroy is currently Dean of Engineering at the University of Texas at Arlington. He received his BSSE from the University of Texas at Austin and his MSEE and PhD in electrical engineering from Catholic University of America. Prior to joining UTA as the engineering dean, he was Vice President of Technology at Hughes Communications, Inc. (HCI), Los Angeles. At HCI he was Director of Galaxy Mobilestar, and chief technical adviser to the President of HCI, and managed advanced space systems studies for civil and national security applications. Between 1982 and 1985 he was Assistant Administrator for Environmental Satellite, Data, and Information Services, NOAA, Washington, D.C. At NOAA he directed the national program in civil, operational earth observations satellites. From 1980 to 1982 he was Deputy Director, NASA Goddard Space Flight Center, Greenbelt, Maryland. He was the general manager of this important NASA center, supervising the work of 25 to 30 missions in stages of development simultaneously. From 1966 to 1980 Dr. McElroy held various other positions with NASA including Director, Communications and Information Systems Research and Development Programs, and Chief,

Communications Technology Division. He has many honors and scholarly publications to his credit and is a Fellow of the Washington Academy of Sciences, IEEE, and AIAA.

Dr. Norman Abramson - Technical Advisor to the Partnership. Dr. Abramson received his A.B. degree from Harvard University, an M.A. from UCLA and Ph.D. from Stanford University. Dr. Abramson was assistant professor and then associate professor at Stanford University between 1958 and 1962. He was visiting professor, University of California, Berkeley, Harvard University, 1965-1966, and professor at the University of Hawaii since 1966. He was visiting professor at M.I.T., 1981-1982. He is Chairman of the Board, Technology Education Associates, Sidney, Australia, and a director of the Public Services Satellite Consortium, Washington, D.C. He is a member of the Pacific Telecommunications Council, and a consultant to the International Telecommunications Union, Geneva, Switzerland. He is a respected author (Information Theory and Coding, 1963) and editor (co-editor, Computer Communications Networks, 1973). Dr. Abramson is a Fellow of the IEEE, and holds numerous patents in telecommunications.



Technology to Enhance the California Mathematics Framework in LA County

(PRELIMINARY PROPOSAL--NSF 88-103)

December 1988

Submitted to the National Science Foundation by:

Advanced Communications Engineering, Inc.

With:

Apple Computer
Causal Systems, Inc.
Los Angeles County Office of Education

Introduction, Background, and Need

During 1988 the Los Angeles County School System initiated a Ku-band educational satellite system, initially for teacher training and for later in distance learning. During the same year Advanced Communications Engineering, Inc (ACE) developed a radically new concept for efficient digital transmission of educational courses and materials via Direct Broadcast Satellites (DBS). Both organizations independently submitted proposals to the US Dept. of Education under the Star Schools program.[1,2] Neither received awards under this highly competitive solicitation (68 applicants, 4 awards).

It is relevant to note that all reviewers of the ACE proposal expressed very strong comments about the need for such a daring project which proposed to use a single DBS transponder to simultaneously provide as many as one hundred educational course broadcasts where only one is possible now. The school or home receiver would have used an inexpensive 2' dish or flat-panel antenna (the same as for DBS television) where present systems require a 8' or 10' dish antenna. Two types of services were proposed, one using compressed television transmission, the other using personal computers to efficiently transmit what is now being referred to as "desk-top video." The latter service, delivered by Ku-band satellite but using digital modulation, is the one of interest in this current NSF proposal.

Because this is a totally new concept in educational broadcasting, there is a pressing need to install an experimental system in an actual educational environment, develop trial courses, materials and aids for teachers, and to evaluate the system's economics, utility and effectiveness through actual usage. Although the system itself has extremely broad applicability to all aspects of education, the greatest need at present is in the enhancement of teacher capabilities in math and science. Therefore, the proposed pilot program will concentrate on the use of this new technology to improve teacher capabilities and to provide aids that can enhance teacher effectiveness in mathematics.

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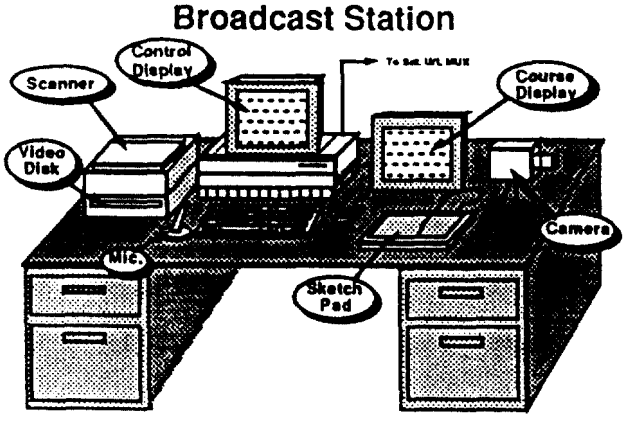
1 "STAR NET: A Pacific Rim Star Schools Collaborative Grant Application," Los Angeles County Office of Education, 1988.

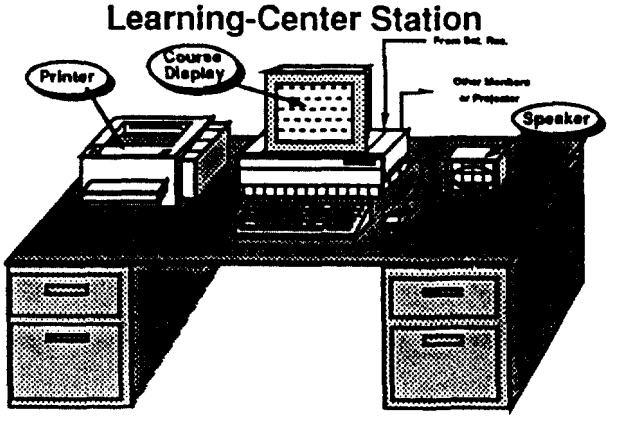
2 "Gutenberg II: Tomorrow's Revolution in Educational Services Today," YES Networks Partnership, 1988.

There is a presently a dearth of trained teachers in secondary mathematics and an almost total lack of local capacity to train such teachers. What is needed is a system that will provide **equal access** to all districts and to all teachers of mathematics and that will guarantee accessibility, uniformity of implementation, and utilization of available technology to all, especially the traditionally disadvantaged. The proposed program will not only use advanced technology to deliver of such training, but will provide an integrated system environment that will be highly effective in upgrading course content and in teaching the proper use of available technology for the enhancement of education in mathematics.

Proposed Program

1. System Technology Description--The following figures illustrate the type of hardware that would be used in the pilot project. The broadcasts would originate from a central station which integrates many of the hardware and software technologies which have used and studied separately in recent years. Each teacher training center that is included in the pilot program will have a setup similar to that shown as the "Learning-Center Station." Each computer contains a special plug-in card that provides the encoding or decoding of the images for the Broadcast Station (ETN) or Learning-Center Station (selected school sites) respectively. An additional external hardware unit is also required for the satellite modulation or demodulation. Signal transmission and reception will be provided through the satellite equipment already in place in 55 school districts in the LA County schools system.





Control software (probably based on Hypercard) will be developed for the source and destination computers which will allow the seamless integration of off-the-shelf multimedia hardware and software. The control software will be very user friendly and will require very little training of the person originating the presentation. High-quality voice transmission will be included.

Little or no training (or control) in receiving the transmission will be required. An NTSC video output will be provided at the reception end for distribution to video monitors, VCRs, or a projection system. Hard-copy output will optionally be provided at each receiver by using either a dedicated printer or by networking to an existing printer. Supplementary materials (e.g., programmed learning) will be provided by output to the new universal floppy disks or by LAN to other computers (e.g., Mac, IBM, or existing Apple IIs). Interactivity with the receiving sites will be provided by existing telephone or data links.

2. Training Program Description--The project will develop courseware and support training materials to enhance inservice staff development of mathematics teachers throughout the LA County School System To insure the quality and currency of program content, the project will make heavy use of personnel from universities who are well qualified and recognized for their contributions to the teaching of mathematics and who recognize and are interested in the enhancements to education that are becoming possible by the use of new technology in education.

Implementation of the system will be accomplished in a phased approach. The first phase will shake out bugs in the hardware and control software. The second will be a trial via the satellite to one remote location culminating in one or more seminar-type telecast. The third will be full implementation of the mathematics teacher enhancement program at multiple receiving sites. The first phase is in process since hardware development is already underway and will be used for in-kind contribution. It will be accelerated immediately upon notification of award.

The teacher training program will be developed mainly in the second phase of the program, although it is expected that as experience with this new media increases, additional program modifications and development may be desirable. Due to a late start on this pre-proposal, details plans of the specific training programs have not yet been formulated. More details of the planned training content and initially targeted areas are expected to be included in the full proposal.

Rational

Distance learning is an effective educational technique that is rapidly growing and still maturing in technology, program materials, course content, and methods of using this technology. Many

programs operate today with technology as primitive as a telephone line and electronic blackboard, yet are highly effective.[1] Many domestic and international satellite distance-learning programs have been and are being implemented and are too numerous to itemize and reference in this pre-proposal. The program that this project will implement and evaluate is highly innovative and will make effective and economical use of the latest presentation techniques, interactive media and tools **currently available** and will develop additional tools that do not now exist. It will also guarantee that the system can continually evolve to include future developments in hardware and software and will provide a nation-wide means of achieving a quantum jump in course content and effective use of technology in the teaching of mathematics and science.

The LA County Office of Education / ETN (Educational Telecommunications Network) has recognized the need for satellite delivery of many types of educational instruction and materials other than what can be delivered strictly by a television broadcast system. Although the present television system will remain in place and in use, the proposed system will provide much needed additional capabilities and, if proven successful as an instructional media, will greatly enhance the use of television as the primary instructional media for teacher training and later for direct classroom use.

The primary objective of the project is to demonstrate the applications of technology in mathematics to get the best possible training for the largest number of mathematics teachers in the LA County school system and later the entire state and the nation. Initial training will be for the "Math Cadre," a core group of mathematics teachers who work with the ETN Math Consultant that reach all 67,000 teachers in LA County alone and impact all 1,300,000 students in the LA County including the LA Unified School District. This program may evolve into the primary means of training teachers for full implementation of the California "Mathematics Framework"[2] and for bringing the system into full conformity with the NCTM Standards.[3] It may also serve as a national model and, being satellite delivered, could be expanded into nation-wide teacher training for implementing the NCTM Standards.

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1 E. Kent Ellertson, et al, "Report on Distance Learning, A National Effectiveness Study," Pennsylvania Teleteaching Project, 1987.

2 "Mathematics Framework for California Public Schools--Kindergarten through Grade Twelve," California State Dept. of Education, 1985.

3 "Curriculum and Evaluation Standards for School Mathematics," National Council of Teachers of Mathematics, (draft) 1987.

Organization

Advanced Communications Engineering, Inc. Redondo Beach, CA, a firm with expertise in computers, communications, and educational technology. Key personnel include G. Gordon Apple, PhD (previously of Bell Telephone Laboratories and TRW) and Mr. Donald K.Dement (previously of NASA). Directors include Mr. James Beggs (formerly head of NASA) and the Hon. Wilbur D. Mills (former chairman of the House Ways and Means Committee). ACE will act as the prime contractor and coordinating organization and will also provide systems engineering, control software, and satellite modems for the program.

Los Angeles County Office of Education Downey, CA, has an enrollment of approximately 616,000 students in addition to the 704,327 students in the LA Unified school system. In 1988, a Ku-band television satellite system was installed for teacher training by the ETN (Educational Telecommunications Network) the Executive Director of which is Patricia Heffernan-Cabrera, PhD who will be the main contact for the LA County Office of Education part of this program.

Causal Systems, Inc. (a minority owned firm) will provide signal processing boards and associated software for the source and destination computers which will allow transmission of computer screen images and data-compression-decompression. Primary contact and program participant will be Samuel B. Covington.

Apple Computer: Apple Computer's involvement with and dedication to education is well known. The precise extent of direct involvement in this program will be determined at a meeting in February with VP, Dr. Bernie Gifford (previously Head of Ed. Dept. of Berkley).

Others: Other potential participants include Cal. State Dominguez Hills and Cal State Fullerton but have not yet been confirmed.

Qualifications and Experience of Key Personnel

Inservice delivery to teachers of mathematics, through any mode, is closely tied to the content area. It is important, therefore, in and development of materials for teachers that members of the higher education mathematics community be closely tied to the project. As consultants, these educators can aid in the development of courses, course materials, and assessment instruments. In the State of California mathematics content for K-12 teachers should reflect the California Mathematics Framework along with the recommendations of the National Council of Teachers of Mathematics, the National Council of Supervisors of Mathematics, and other agencies and groups interested and concerned with the mathematics curriculum in the nation's public schools. The involvement of

mathematics educators can help to insure that the latest ideas in methodology along with the critical areas of mathematics which are needed to supplement and strengthen mathematics instruction nationwide. In order to insure that this happens, the following partial list of personnel will be involved:

Patricia H. Cabrera, PhD Executive Director of ETN. Extensive experience in writing producing and directing educational television and films and in educational management.

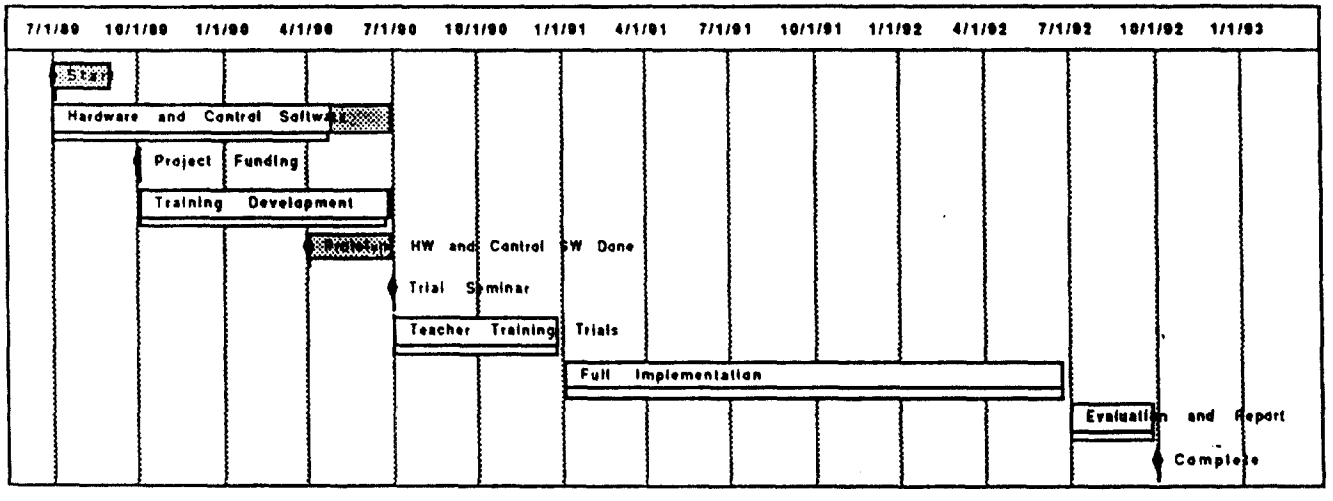
Alan C. Kay Apple Computer. Director of the Vivarium Project and well known worldwide for his visionary endeavors in the furtherance of computers and education. His qualifications are too extensive to even try to summarize here.

Eunice Krinsky, PhD Professor of Mathematics at Cal. State U. Dominguez Hills. Project Director of numerous programs involving teacher training.

David Pagni, PhD Professor of Mathematics at Cal. State U. Fullerton. Principle investigator, Calculator And Mathematics Project, Los Angeles (CAMP-LA, curriculum development). Dir. of Santa Anna-Fullerton Elementary Mathematics Project (SAFEMAP, teacher training).

Gerlena R. Clark Consultant of Mathematics, Div. of Curriculum and Instructional Programs, Los Angeles County Office of Education. Chairperson of the California Mathematics Framework Committee.

Schedule



Evaluation Plan

The evaluation plan will be provided by James Cooper, PhD, Professor of Education, Cal. State U. Dominguez Hills. Evaluation of the program by an external evaluator will include both

midprogram formative evaluation and end-of-program summative evaluation. The formative evaluation will focus on program characteristics capable of being changed in mid-course and suggestions for change will be acted upon by the in-service group.Specific program outcomes to be assessed will focus on the goals and objectives articulated earlier and, in particular, will include:

1. Increases in knowledge of mathematics content for the group as assessed by criterion referenced pre- and post-testing of the participants.
2. Increased use use of effective teaching strategies as assessed by observations of a subset of the participating teachers before, during, and after the program.
3. Analysis of data collected from participation via program satisfaction rating forms, which will cover all aspects of the program.

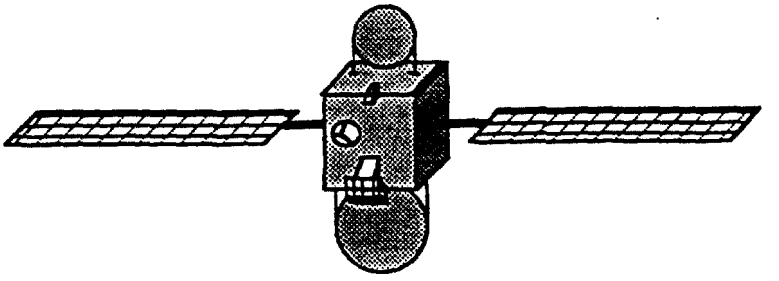
Budget

	·····1989-90·····			·····1990-91·····			·····1990-92·····		
Expenditure and Detail	NSF	In-Kind	Total	NSF	In-Kind	Total	NSF	In-Kind	Total
Dev. of HW & Control SW	50,000	150,000	200,000	0	0	0			0
Computers, Cards, Modems, Acc.	15,000	30,000	45,000	10,000	50,000	60,000	10,000	50,000	60,000
Transponder Time	4,500	4,500	9,000	25,000	25,000	50,000	25,000	25,000	50,000
Technical Consultants	50,000	50,000	100,000	20,000	20,000	40,000	10,000	10,000	20,000
Educational Consultants	50,000	20,000	70,000	50,000	20,000	70,000	50,000	20,000	70,000
Dev. of Training Prog. & Mat.	50,000	25,000	75,000	20,000	10,000	30,000	10,000	10,000	20,000
Preprod./Prod. Telecasts	20,000	10,000	30,000	50,000	20,000	70,000	30,000	20,000	50,000
Release Time for Teacher Training	60,000	40,000	100,000	120,000	80,000	200,000	240,000	160,000	400,000
Project Administration (10%)	29950	32950	62900	29500	22500	52000	37500	29500	67000
Overhead (15%)	49,418	54,368	103,785	48,675	37,125	85,800	61,875	48,675	110,550
Total	378,868	416,818	795,685	373,175	284,625	657,800	474,375	373,175	847,550

The only essential permanent equipment for which funding is sought is the computer peripherals for the Broadcast Station and the transmission interface card for each computer.

Concluding Statement

The proposed project could conceivably be one of the most significant trials ever conducted in the use of technology in education. It will establish a system and have an educational impact that will endure far into the future and has the potential of expansion into a nationwide or even worldwide program for training teachers of mathematics and science and eventually for direct teaching of students in schools and homes at all educational levels.



Digital DBS System Development

by: G. Gordon Apple, PhD

August 19, 1988

Prepared for: Advanced Communications Corporation

Introduction:

This paper was written for the purpose of summarizing past and ongoing work that we have done relative to Digital DBS, why we prefer digital transmission, and the projected schedule for achieving full-scale production of digital receivers.

Our current effort is in laying the foundation for a full-scale development of three related subsystems:

1. A digital DBS delivery system for encrypted transmission and controlled-access reception of a digital bit stream.

2. A digital encoder for standard (NTSC) television transmission.from the satellite uplink facility.

3. An economical digital decoder for home reception of standard television programming.

Why Digital Transmission is Desirable:

The above are the basic elements that comprise a Digital DBS television system. They will allow superior quality standard (or Advanced) television broadcasts and will allow complete, **totally effective control** of subscriber access, the latter being almost impossible to achieve with analog transmission.

We have done a considerable amount of work on transmission of HDTV (High Definition Television) using digital transmission. The FCC has recently mandated that, for terrestrial transmission, American HDTV must maintain compatibility with standard (NTSC) television. Many proposals have been made by those vying to be the one who establishes the standard for terrestrial HDTV transmission. Without exception, all of these are very kludged-up solutions which attempt, sometimes in vain, to cope with the bandwidth limitations of standard terrestrial analog TV channels. With digital DBS transmission, we don't have that problem. The extension from standard TV to compatible HDTV (regardless the ultimate standard) is very natural in the digital domain.

We have also done a considerable amount of work in researching (and designing) a multitude of additional services that only become possible through the use of digital transmission and technology. One example is the recent proposal by the YES Networks Partnership to use video data compression and personal computers to transmit **up to 100** educational course programs in place of **one** entertainment-type DBS television channel. This would be totally impossible without digital transmission. This concept was partly an outgrowth of work that we did for the NASA ACTS program (which would use an experimental satellite that NASA expects to launch sometime in the mid '90s).

The highly non-linear amplifiers in a satellite transponder make it difficult or impossible to offer a satellite version of an AM or FM radio band using analog technology. However, with digital transmission, we can offer 20 or more radio channels (in place of one TV channel) with exactly the same stereo audio quality as that of digital Compact Disks.

We have preliminary designs for a data and informational DBS broadcasting system that will ultimately revolutionize the entire publishing industry. Part of the beauty of this system is that it does

not displace any TV channels, but essentially goes along for a free ride. (It won't be free to the users--we plan to make a lot of money on this.) Again, this is only possible because of digital transmission.

The above is not intended as a sales pitch, but as a short summary of the reasons for desiring digital transmission. In the following paragraphs we will return to the three afore mentioned basic elements of a Digital DBS system and discuss what we are doing with them and the estimated development schedule.

Feasibility:

The first item is the digital transmission (and reception) subsystem. This is the system which selectively delivers a digital bit-stream to the user but does not turn it into a TV signal. The technical feasibility of digital transmission has been outlined and justified in a paper that we submitted to the FCC. In corroboration, this effort extends work done by the author and others (while at TRW) for CBS Television which examined the feasibility of digital DBS transmission of HDTV. The economic feasibility has been investigated through multiple contacts with satellite receiver manufacturers, component manufacturers and suppliers, and Integrated Circuit producers. In addition, we have designed an integrated circuit digital demodulator on which we will be filing a patent application. In particular, its major advancement over the prior art is in allowing the use of inexpensive (but highly unstable) signal-frequency converters which are mounted on the home receiver dish. A computer simulation effort on this device is presently underway which will allow us to evaluate its technical performance and to adjust design parameters to optimize its performance-to-cost ratio.

The second element is the television encoder subsystem which is used at the satellite uplink facility. This is the most technically difficult (but not insurmountable) component of the system. It will also be relatively expensive because it will not be mass-produced as the receiver will be. It is still a relatively small fraction of the cost of a satellite uplink ground station. However, it will account for a substantial portion of the system development costs. Preliminary designs of the encoder have been done and patent applications have been filed on some of its innovative aspects.

The technical feasibility of the digital decoder is probably best illustrated by the fact that there is a Japanese system presently in commercial operation through Intelsat at Ibaraki Station which operates at

the same transmission bit-rate (and optionally at half the rate) that we have proposed. Extensive subjective testing was done on this system and its subjective rating was superior to that of similar analog transmission. This system is not as technically advanced as what we are developing, but is rather expensive due to its two-way capability, ability to handle any of the three major world television standards (NTSC, PAL, and SECAM), and lack of custom designed integrated circuit chips.

The digital decoder subsystem is the most cost sensitive because it is the element which converts the digital bit-stream into a TV signal in millions of homes. Preliminary system designs have been done and basic circuit partitioning has been established. The exact design will require simulation on a large computer system with video facilities. A recent visit to MIT's Media Laboratory in Cambridge, Mass. indicated that they were quite interested in this system and would be willing and eager to provide access to their facilities for most of our required simulation. There are a number of other laboratories which also have this capability.

The decoder will also require the development of several custom IC chips. This is not as big a deal as in the past due to today's availability of gate-arrays, programmable-logic-arrays, and standard-cell designs. In addition, some of the required components, such as field-storage chips, are being used by the Japanese for digital processing in newer TVs and VCRs and are becoming commodity chips. In the US, TI is manufacturing similar chips for use in computer graphics (e.g., Apple Computer's Mac II) and could easily be a viable source of the required components.

Development Schedule:

The estimated schedules for prototype generation and production designs are shown in Figures 1 and 2 respectively. The project planning for these phases has actually been carried to one layer of detail beyond what is shown here and includes manpower loading and critical path scheduling.

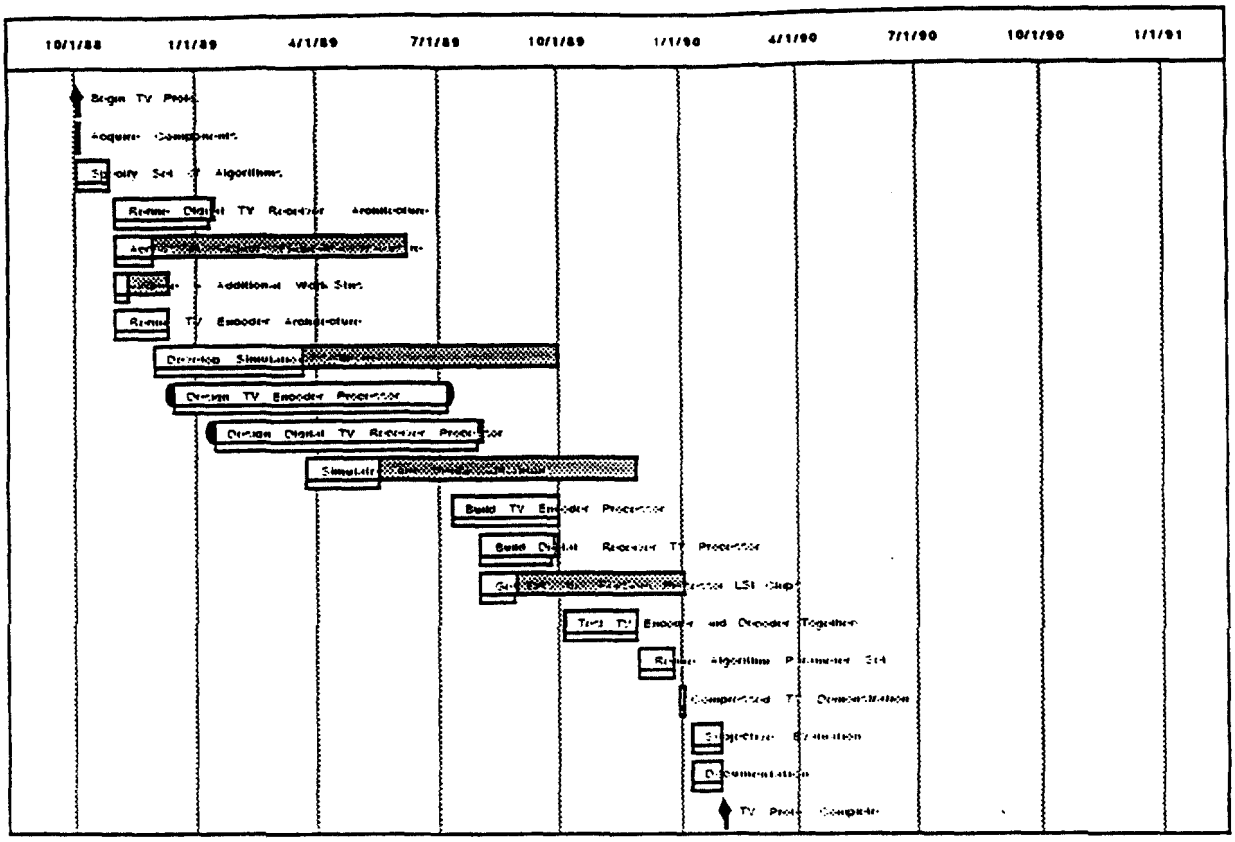


Figure 1 Prototype Development.Schedule

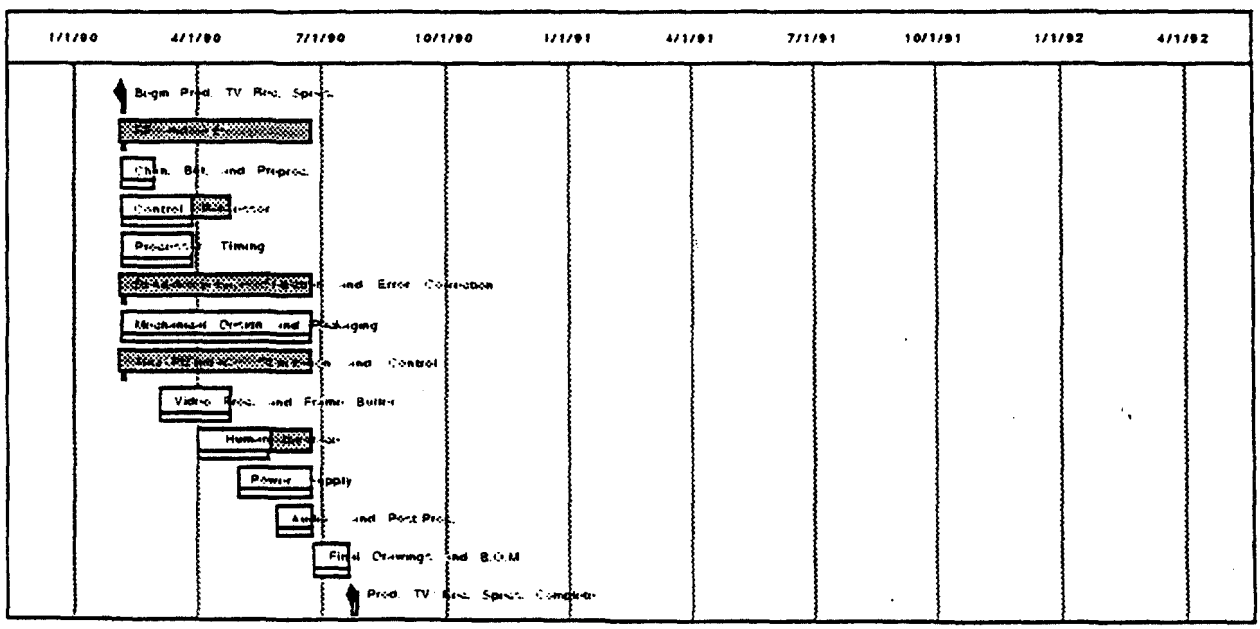


Figure 2 Production Design.Schedule

The overall schedule, including the above phases, is shown in Figure 3. Some aspects of the manufacturing can be done prior to volume production of the custom chips. It is obvious from Figure 3 that the real schedule driver is in getting to the first prototype, and the allotted time for that task may be overly optimistic. However, by doing a substantial amount of algorithm simulation and by using design work-stations which have circuit simulation capabilities, the design cycle could be shortened and could overlap the production design phase by several months.

It would also be advantageous to begin the initial design phase as soon as possible. Although some of the Phase 1 work is presently underway, significantly more manpower must be employed in order to constitute a full start of this Phase.

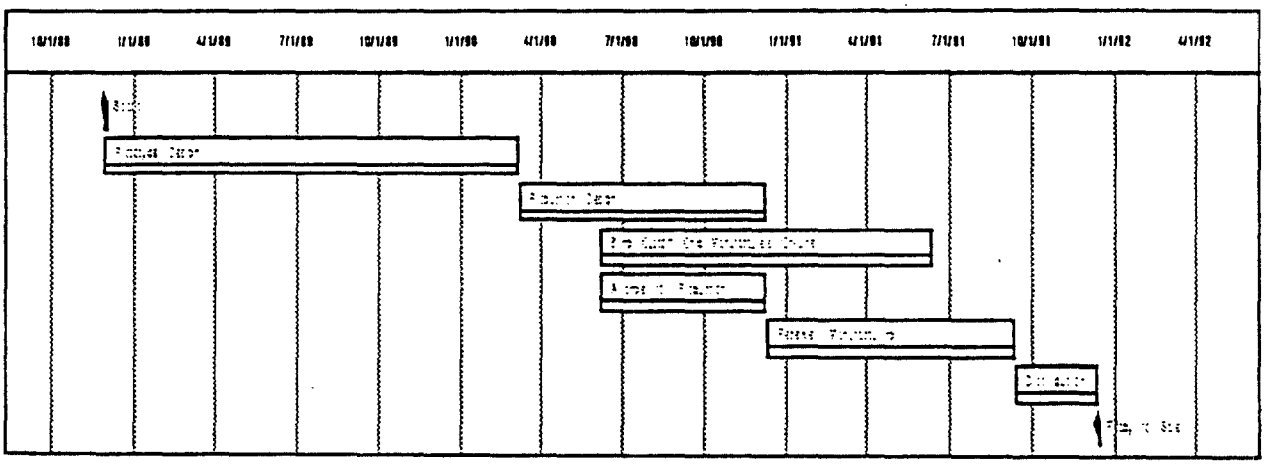
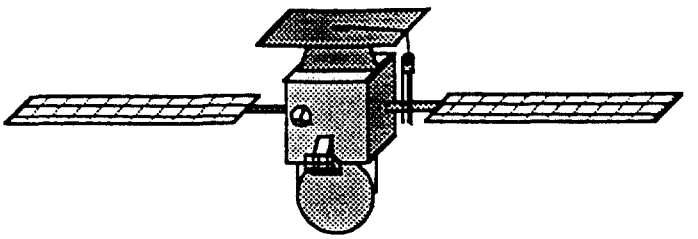


Figure 3 Overall Schedule: Design to Delivery

Summary:

Digital DBS transmission is clearly a superior technology for delivery of television and other services to the entire American public. A substantial amount of work has been done in the past and is presently underway towards that goal. The schedule for full scale production of receivers is tight but doable. The sooner we get started on full-scale development, the better off we all are in getting this exciting new delivery system into place.



The YES* Networks: Education for the 1990s

(* Your Educational Services)

Summary

A revolution is about to occur in educational broadcasting. For the first time in history, **every school** and **every home** will have access to a large number of innovative educational broadcast services. A complete spectrum of services will be simultaneously available-- from math and science to arts and adult education. Specialized services will also be available, such as research seminars. The **YES Network** (a marriage of digital satellite, software and microcomputer technology) is what makes all of this possible.

G. Gordon Apple. PhD
July 1988

Introduction

Digital satellite transmission and microcomputer technology -- What do they mean for the future of educational broadcast services? There are two answers. For the first time, we will have:

- **Complete USA coverage.**
- **Total flexibility of services.**

The designed flexibility of the **YES Network** will allow a complete spectrum of high-quality services to be offered to meet almost every need and budget. Services will range from:

- **Still-frames to full-motion video**
- **Voice to stereo-compact-disk quality audio**
- **Exams to full reference and reading materials**
- **Real-time self tests to off-line programmed learning**
- **Teacher outlines to complete course preparation**
- **Elementary to graduate school**
- **General to highly specialized**
- **School children to adult education**
- **Remedial courses to research seminars**
- **Pure academic studies to commercial training**
- **Classrooms to individual homes**

Satellite transmission will be at K-band using digital modulation. Direct Broadcast Satellites will provide the greatest capability and the most economical service directly to schools and homes.

Educational Broadcast Needs in the 1990s

The need for educational broadcast services has never been greater. This need will continue to grow through the 1990s and beyond. Teachers, faced with limited budgets, large classes, and sometimes uninterested or overworked parents, need all the help they can get. Limited school budgets have largely eliminated classes in art and music appreciation. Disparate salaries between teaching and industry have made math and science instructors a dying breed.

Technology and trade imbalances have resulted in a large demand for career retraining. A significant portion of the adult population can not even read. Rapid advances in science, technology and medicine have made professional retraining and specialized news services and seminars essential for preventing obsolescence.

A changing world with continuing regional conflicts, economic issues and concern for the environment has made an enlightened public necessary for intelligent electoral choices and the assurance of prosperity and world peace. The ravages of cancer and AIDS have made up-to-date in-depth information essential for both the public and for medical researchers and practitioners.

Video cassettes and classroom computers can fulfill some of the needs. However, the most economical and timely means of providing for many of these needs is through direct broadcast educational services. Many existing services are not available to much of the population due to transmission expense, limited air time, limited educational television coverage, or the specialized nature of the subject. Services which do exist are limited to transmission of course lectures without any of the supplementary materials and aids which are necessary for effective learning, especially in the lower grades. Innovative approaches and technology are mainly available only to select schools in certain areas of the country.

For these reasons, there is a pressing need for a flexible, economical, educational broadcast service with universal coverage. The **YES Network** will provide the means for delivering these services..