Committee V
Cross-Culturization: The Role of
Transportation and Communication

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COMMUNICATION ADVANCES PROMOTE CROSS-CULTURIZATION?

by

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REVISED ABSTRACT

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Advances in electronic and optical communications have promoted the concept of the Global Village into a near term reality. Optical communications actually preceeded the age of electronic communications by more than three thousand years. In ancient Israel, signal fires on the mountain tops of Judea and Samaria were used to transmit the advent of the new month throughout the length and breadth of the land. More recently, smoke signals (at a bit rate of perhaps 0.1 bits per second) were extensively used by the North American Indians as optical communications line-of-sight through the atmosphere. The bit rate today in optical communications has increased by 100 billion fold to 10 gigabits per second and together with the merging of data and telecommunications, the cost of sending information around the world has been reduced from about 10 dollars per minute in the 1970's to about 1/20 that amount today. The mid 1990's are in process of becoming the age of visual communications. Picturephone (which was demonstrated at the Seattle World's Fair in 1960) will add a significant dimension to cross-cultural development whose greatest barriers are the language differences between people (although English has become the lingua franca of the Western

World). One large carrier is now providing an on-line translation service for international telephone conversations at a rate of about $100 per hour.

The most exciting developments are occurring in the fusion of what used to be separate and disparate disciplines: CATV, data communications and telecommunications

Using mostly fiber optics (for getting the greatest distance - bandwidth product), vivid, real time images at resolutions of 100 times better than current television can be transmitted at great distances with manifold applications. For example, medical specialists and diagnosticians sitting in a hospital in Boston, Mass. will be able to view and analyze high resolution x-rays of a patient in Bombay, India, and recommend appropriate action. We already have five million people in the U.S.A. who are doing tele-commuting, that is working at home via their personal computer linkages to the world. The author has had his own direct experience with the miracle of global communications during the Gulf War. On the night of January 17, 1991, he and his wife were awakened at 2:30 a.m. to the sound of sirens. While the wailing sirens were still sounding the alarm, the telephone rang. It was his breathless son calling from Los Angeles, 10,000 miles away. He simply said, "Get to your sealed room, eight missiles just hit Tel-Aviv."

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

COMMUNICATION ADVANCES PROMOTE CROSS-CULTURIZATION?

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On the Nature of Information and Communications

Information is generally defined as a patterned arrangement or relationship between events or objects which can be tranmitted between the generators of such patterns and the users. The act of such transmission (between transmitters and receivers) is called communications. The word "communicate" comes from the Latin root communis, signifying communion or the idea of a shared understanding of, or participation in, an idea or event. In this original sense, the word communication was used as a noun of action that meant "to make common to many (or the subject thus made common)."[1] Toward the end of the 17th century, the notion of imparting, conveying, or exchanging information and materials was incorporated into the concept. Although modern dictionaries tend to adhere to the latter definition, both connotations continue to survive in everyday speech.

The Shannon-Weaver model of communication characterizes the process of information transfer from an engineering viewpoint. See Fig. 1, which is a schematic diagram of a general communication system.[2] The model has been found lacking by those political and social scientists who find that the sender/transmitter may also formulate or modify the information content according to its own agenda and where the receiver may wish to interpret a message in terms of an established set of biases and prejudices (Fig. 2).[3]

The classic definition of information content, C, as given by Shannon[4] in terms of bandwidth, B, and SNR (signal-to-noise) ratio is:

$$C = B\ (1 + \log SNR). \qquad \text{(Equ. 1)}$$

The information content in television pictures (frames) is significantly greater than voice transcriptions, so that, for example, frequency response (defined as 3 dB bandwith) for standard TV needs to be 5 to 7 MHz (NTSC/PAL), whereas good voice quality is achieveable at bandwidth 1,000 times less. Consequently, carrier frequencies for AM radio are in the range 550-1600 KHz, whereas television stations broadcast at the 100 MHz level.

The breakthrough invention of the telegraph annihiliated the distance factor and the dependency on transportation. Electromagnetic waves even along wires travel faster than

horses, iron or otherwise. The last 150 years have witnessed an astonishing increase in the rate and means of information transfer via radio, wire cables, television and fiber optics.

FIGURE 1

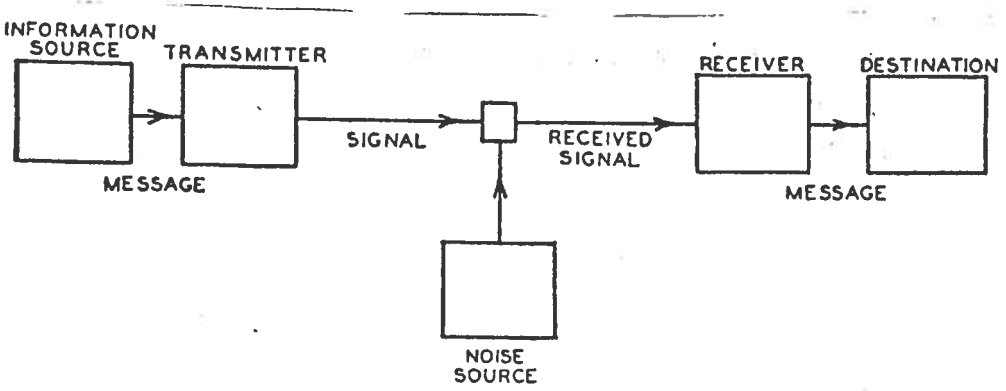
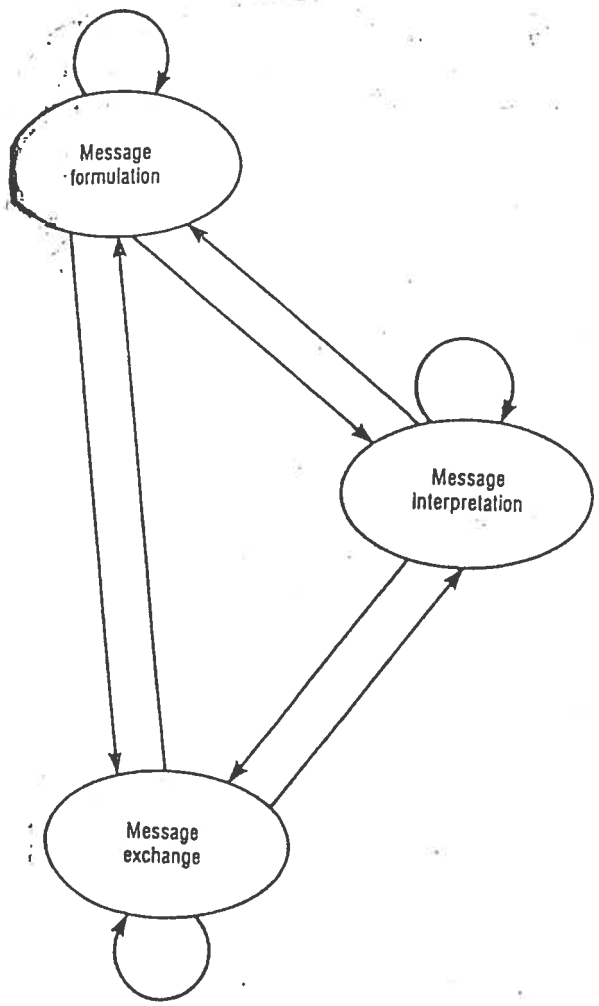


Fig. 1—Schematic diagram of a general communication system.

FIGURE 2

Communication Process

Office of Technology Assessment, 1990.



Although we are constantly regaled by glowing descriptions of the futuristic Global Village resulting from this fantastic acceleration of communications, there are a few skeptics who do not derive much pleasure or comfort from such a prospect. As early as 1854 Henry David Thoreau wrote, "We are in great haste to construct a magnetic telegraph from Maine to Texas, but Maine and Texas, it may be, have nothing important to communicate." What about the message? What does Maine say to Texas in 1854 or what will Maine say to Ouagadougou in the last decade of the twentieth century?

Optical communications actually preceeded the age of electronic communications by more than 3,000 years. In ancient Israel signal fires on the mountain tops of Judea and Samaria were used to transmit the exact date of the advent of the new month throughout the length and breadth of the land and even beyond. More recently, smoke signals (at a bit rate of perhaps 0.1 bits per second) were extensively used by the North American Indians as optical communications line-of-sight through the atmosphere. The bit rate today in optical communications has increased by 100 billion fold to 10 gigabits per second.

The current era presents a unique opportunity to provide the peoples of the world with those "facts" which Abraham Lincoln deemed as essential for the growth of a democratic infrastructure. He made the following observation:

> If given the truth, they [the people] can be depended upon to meet any national crisis. The great point is to bring them the facts.[6]

Will necessary and even vital information be distributed to all who need and thirst for it? Or will much of the information transfer turn out to be a meaningless babble, or even worse, a purposefully distorted version of reality serving the ends of those in control of the media of communications? In this paper we shall analyze the interplay of technologies, economics, politics, and culture in an attempt to answer such questions.

The Communications Infrastructure

The international flow of information depends on the following channels:[7]

a. mail, telephone, facsimile, telegraph, telex and related telecommunication channels;
b. tourism, travel and migration including other personal contacts;
c. diplomatic and political channels including military and related conferences and organizations, religious missions;
d. educational, artistic and cultural exchanges (persons and exhibits, etc.) including conferences and sports events;
e. satellite and planetary resources -- including transborder data flow, computers and related technologies;

f. newspapers, magazines, books, technical and scientific journals and news agencies;
g. radio and television and direct broadcast satellite;
h. film, recording and video; marketing, advertising and public opinion polls.

Changes in the communications infrastructure are occurring at both domestic and international levels. With the watershed, seminal action of divestiture (as ATT in 1984) privatization of many national/government organizations has accelerated. Communication is essential to the business, political, and cultural life of a society, and to the individuals in such society.

The societal effects of a nation's communication infrastructure are determined by its overall technical capabilities, their availability to groups and individuals, and their patterns of use. Three aspects of the infrastructure are relevant:

1. the technical characteristics of the communication facilities themselves;
2. the economic interdependencies among producers, distributors, and users of communication facilities; and
3. the policy goals and rules that define and constrain these relationships.

The following advances in communication technologies are generating changes in all three aspects:

* improved technical performance in transmission, encoding, decoding, storage and retrieval, and content production, at decreasing costs;
* convergence of communication function, as well as communication products and services;
* decentralization of intelligence and control throughout communication systems with the development of software-driven and software-defined communication facilities;
* the availability of some discrete communication services that were previously provided only as part of a package (unbundling);
* increased portability of products and services;
* improved ease of use through better software design;
* increased networking capability; and,
* increased capability to target messages to specific individuals or groups.[8].

Communications and Culture

In government and politics the impact of new communication technologies will be determined to a large extent by the rules, norms, and skills that govern access to them. The emergence of new political "gatekeepers," and who they are, will be of critical importance. Traditional political gatekeepers are being replaced by new kinds, such as political consultants, media consultants, private sector

vendors, and international newscasters. Whereas the traditional gatekeepers were guided by political rules, these new gatekeepers are governed and motivated by market criteria. **Where markets dominate the allocation of communication resources -- such as information, a speaking platform, or access to an audience -- political access may become increasingly dependent on the ability to pay. Thus, the economic divisions between individuals and groups may be exacerbated by this trend.**

In some cases multinational news agencies are replacing government officials as gatekeepers in areas such as international diplomacy. The ability of a nation to exercise its sovereignty through traditional diplomatic channels may be compromised as a result. Even individual powerhouses can exert an inordinate influence, viz. Barbara Walters in catalyzing the meetings which led to Camp David.

The new information and communication technologies provide many opportunities to enhance the world's culture by expanding the infrastructure for information-sharing and exchange. Because these technologies are decentralized and widely available, they can provide the opportunity for many more people to become actively involved in creative activities. The opportunities for people to participate in economic, political, and cultural life depend on their ability to access and use communication and information

services. Individuals need skills and tools to locate the communication pathways, information, and audiences in a timely fashion and in an appropriate form. Unequal access to communication resources leads to unequal advantages, and ultimately to inequalities in social and economic opportunities.[9]

The major challenge, therefore, facing most of the world is not technology, but the establishment of two essential and necessary conditions:

1) easy access to the communication resources being developed; and
2) creation of a pool of highly trained technicians drawn from the local human resources who will provide the proper guidance, attitude, and education so that the people can access and deal with these advanced tools and techniques.

A case study of telecom in India is illuminating.[10] India is unique in the developing world. It has an enormous population of 850,000,000 people, nearly seventy percent of whom live in 575,000 villages.

As a historical matter, there has been significant underinvestment in the telecom sector in India. It has five million telephones, of which nearly ninety percent are in urban centers. The sheer magnitude of the task of providing

telecom service in India should make the Indian experience relevant to other countries in the developing world and present a contrast to the developed world. New policies, organizational structures, technologies, service provisioning, and management are being devised in India. These should prove to be useful paradigms which other nations might adapt to their own national environment.

Unlike the network of the developed countries, the Indian network is characterized by:

* low telephone density -- 0.5 percent compared to an average of twelve percent of population in the rest of the world;
* long waiting time for new applications -- two million applicants wait listed; two- to ten-year waiting period;
* heavy congestion on local and long-distance routes during busy hours -- two to three attempts per successful call; five to six attempts per successful long-distance call; fifteen call units traffic per line per day; eight to ten BHCA/line;
* high urban bias -- ninety percent of telephones are in urban areas (one-third concentrated in four metros) serving only ten percent of the country's population;
* minimal rural and public telecom services -- only about 48.000 of 575,000 villages have telephone facilities; only 100,000 public telephones;

* diverse type of switching, signaling and transmission systems -- over ten types of switching systems and a variety of transmission systems and terminal apparatus.

The Indian telecommunications network is vast and currently is built around nearly 15,000 echanges to provide local service and over fifty exchanges for long-distance service.

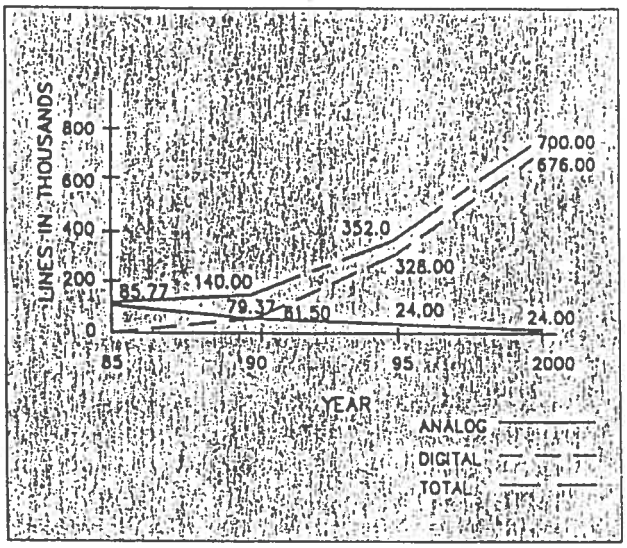
The past history and expected growth in lines is shown in Table I and Fig. 3.

TABLE I

Parameter	1948	1990
Local Exchange	321	14285
Equipped Capacity (Million Lines)	0,1	5.3
Working Connections (Millions)	0.08	4.6
Long Distance Public Telephones	338	30,800
Public Telegraph Office	3,324	36,400
Telex Exchanges		325
Telex Capacity (Lines)		52,000
Telex Connection		42,400
Toll Exchanges Capacity (Million Lines)		0.78
Direct Distance Dialing Stations		867
Coaxial Cable (Route Km) A D		22,948 1769
Microwave (Route Km) A D		30,047 2,540
UHF (Route Km) A D		12,747 2,335
Fiber (Route Km)		1,615
Satellite Earth Station Fixed Mobile		67 178
A: Analog D: Digital		

■ Table *Progress of telecom since independence*

FIGURE 3



■ Figure *Growth pattern of tax capacity*

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A corporate structure for the telecom service sector is being recommended to replace the state-run domestic carrier. In addition to modernization of the equipment and changing the nature of the carrier (corporatization), a fundamental far-reaching strategy for achieving the two essential conditions above is being formulated. This will result in a slow but inexorable process of societal and cultural exchange with the developed countries of the West and North, which mechanism and implications for the future can be only dimly perceived.

It is informative to compare the state of telecom in India with Southeast Asia (see Table II).[11] Singapore and Hong Kong, while comparable to much of the most developed

TABLE II

Table 2 Major Carriers in Southeast Asia

Country	Main carriers	Phone density per 100 population	Digital lines (percent of total) 1990	1995	Leased lines 1989
Hong Kong	Hongkong Telecommunications Ltd.	57	60%	90%	67,000[1]
Singapore	Singapore Telecom	39	48	100	45,000
Malaysia	Telekom Malaysia	9	75	85	8,000[1]
Thailand	Telephone Organization of Thailand (domestic) Communications Authority of Thailand (international)	2.50	72	93	300
Philippines	Philippines Long Distance Telephone Co. Eastern Telecommunications Philippines Inc. RCA Global Communications Corp. Globe-McKay Cable and Radio Corp.	1.10	60	72	1,000
Indonesia	Perumtel	0.67	49	87	1,000

1. Figures are for 1988.

SOURCES: International Telecommunication Union (Geneva, Switzerland) and Pyramid Research Inc. (Cambridge, Mass.)

nations, are unable to solve the dismal state of affairs in telecom which is prevalent in their neighbors of Malaysia, Thailand, the Philippines and Indonesia. These nations are still struggling to provide basic voice and data services over inadequate domestic networks. One solution to such poor terrestrial service may be the use of privately owned satellite data networks.[12]

Virtual communities, supported by electronic networks, create the opportunity for providing new sources of contact and interaction among peoples, widening their circle of friends and making it easier to connect with others like themselves. Like the "communities of interest" supported by the postal system and telephone, virtual communities comprise groups of geographically dispersed people, united by a common

interest or purpose and supported by computer communication such as bulletin boards, conferences, and electronic mail.

To participate in a virtual community does not necessarily require a familiarity with computers and computing. The French Minitel system, for example is extremely user-friendly, linking people through networks of dumb terminals and providing them with easy-to-use gateways and menus. As a result, many French people take advantage of the system.

One appeal of virtual communities is their relative anonymity. Users do not encounter the usual nonverbal cues to help them interpret messages from others. Because members of virtual communities can be anonymous, some believe that such electronic communication can be a "medium without prejudice." Anonymity also allows user "the risk-free opportunity to become someone else," and/or to let down barriers and face-maintaining behaviors that exist in face-to-face conversations. Online interactions allow individuals to share life concerns and participate in debates and discussions for which there is no neighborhood forum. Members sometimes arrange face-to-face meetings, further supporting their relationships.

Virtual communities, however, are neither a panacea nor a perfect substitute for face-to-face contact. To the extent

that they replace neighborhood ties, they could contribute to the loss of sharing, interdependence and mutual concern that neighborhoods have traditionally provided. Moreover, if they required users to have a sophisticated technical knowledge or were available only in a text-based form, their usefulness would be limited to those with the requisite skills.[13]

The lack of both familiarity and technical skills has also served to discourage the general public's use of electronic networks. These kinds of barriers can eventually be overcome, however, as it is clearly evident from the successful development of Minitel in France, cultural differences notwithstanding. What was critical in France was the government's proactive efforts to move the country forward into the information age by subsidizing and supporting the development of a national information infrastructure. Having access to easy-to-use terminals provided by the government, French citizens have not hesitated to establish online connections.

In the United States remote learning (provision of instruction at a distance) has been cited as the panacea for reducing educational disparities among regions. It has been estimated that more than thirty percent of the country's school children are poorly educated due to limited staff and resources in small geographically isolated schools. The following recent papers are illustrative.[14, 15]

Dichotomies that must be addressed if U.S. schools are to succeed in globalizing studies and perspectives are examined and an alternative learning model is presented. The dichotomies are (1) teacher-centered vs. student-centered learning, (2) subject-centered vs. problem-centered learning, (3) disciplinary vs. interdisciplinary learning, (4) cognitive vs. affective learning, (5) time-sequenced dissemination vs. development learning, (6) situational vs. societal needs, and (7) vocational training vs. liberal education. The model for education, 1984-2000, substitutes learning centers for schools. There will be four types of centers: priority centers -- from birth to age eight, community centers -- replacing the high school, national centers, and global centers. The latter two will replace the college and university. Emphasis will be on analyzing problems at the community, national, and global levels; an interdisciplinary approach will be used. Television and computer networks will be used to transmit information to students. Educators will serve as change agents through the facilitation of problem-solving groups and will produce most of the information for the media.

Differences in journalism education across the world reflect differences in political, economic, and social environments. Journalism education in the United States, which began in the age of progressivism and reflected values of the time, has emphasized the press' objectivity and

independence, and independence built on its reliance on advertising rather than on political or governmental funding. The stress on practical training so evident in U.S. journalism schools is only beginning to be found in Western Europe, largely because of European papers' traditional concern with political ideology. Reflecting Leninist principles and supported by the government or the Communist Party, the Soviet press sought to inform, teach, and motivate others to action. Due to its training courses and its reputation for what some might call unbiased reporting and others call its obsequiousness in catering to the prevailing winds in Islam, the British Broadcasting Corporation (BBC) has had a lasting influence on journalism education in Asia and Africa. The United States has provided Third World nations with a model for journalism education and has impressed students from those countries with the technical quality of its broadcasting. Advancing nations protest, however, against the cultural penetration of western programming. Unwilling to be influenced simply by American or Soviet beliefs, Third World countries see the press and their media as "partners" with the government in organizing public thinking, which of course means that all feeble attempts at democratization in these countries are stillborn.

Extensive analysis of the influence of technology on culture would need to include such items as:

a. public/community access CATV;

b. religious networks;

c. entertainment and news;

d. pay-per-view (PPV); and,

e. desktop publishing.

The reader is referred to pages 183-208 of reference 3 for a detailled discussion of the influence of communications technology on American culture.

A recent satellite hook-up between Latin America and Spain is illustrative of the uneven results to be expected at globalization. On page 54 of the June 15, 1992, issue of Time Magazine, we read that a satellite link-up called Cadena de las Americas, was established between eighteen Latin American countries and Spain for six months (starting in April 1992) with daily telecasts by the participating countries. Programs include descriptions of each country's customs, culture and tourist attractions. Roundtable discussions of topics of mutual interest by experts are highlighted. So far, everyone's enthusiasm seems to be well under control, e.g. M. Souza of La Razon (La Paz, Bolivia), calls the program "more propaganda than communication.

Technology Trends

Using the convergent technologies of digitalization and photonics, the three disparate fields of data communications (computers), telecommunications and television broadcasting

are rapidly fusing so that the traditional distinctions between point-to-point interactive systems (computers, telephones) and distributive systems (radio and television) are becoming increasingly blurred. The different regulatory structures for these regimes have become significant hurdles to be overcome before a single broadband network is established supporting telecom and broadcast services.

Information content of TV broadcast programming is heavily regulated, but telecom information services are treated comparatively lightly. In general, video-based services such as videoconferencing and other business TV applications supported by telecom networks are not subject to information content regulation, while content in entertainment TV programming for general reception is regulated extensively in many countries.

On the whole, the regulatory models for telecoms and CATV are different, and unless these models are harmonized and many of the current restrictions removed, the commercial convergence of telecoms and CATV programming services will be adversely impacted.[16]

Advances in computer technology are having a significant impact on the communications infrastructure (VLSI). The evolution of computer capabilities over the past fifty years is quite astonishing. In 1945 it cost about $1,000 to do one

million operations on a keyboard extending over one month, whereas in 1990 computers do ten million operations a second at a cost of 0.1 cents. The greatest influence is in the switching architecture. A major barrier to further progress lies in the soft underbelly, namely software development and productivity, which lags behind hardware advances. A switching machine which required 100,000 lines of code in 1965 currently needs 2,000,000.

There are no longer any significant technical hurdles which need to be overcome by telecom providers who wish to transmit high quality video images. It is currently estimated that a single Broadband Integratred Services Digital Network (B-ISDN) could provide a single universal medium for transmission of voice, data, and video at speeds up to 150 Mbps. The acceptance of B-ISDN on a broad scale is slowed by the usual factors of prior imbedded investment in incompatible networks, the glacial pace of standardization, and initial high costs. Deployment of Intelligent Networks (where users exert control over the services received) has been postponed until the mid-1990s. People will be able to do their own publishing by using interactive, intelligent terminals to compile, process, and formulate information. As Ithiel de Sola Pool described the situation:

> The technologies used for self-expression, human intercourse, and recording of knowledge are in unprecedented flux. A panoply of electronic

> devices puts at everyone's hand capacities far beyond anything that the printing press could offer. Machines that think, that bring great libraries into anybody's study, that allow discourse among persons a half-world apart, are expanders of human culture. They allow people to do anything that could be done with communication tools of the past, and many more things too.[17]

As noted earlier, the combined technologies of digitalization and fiber optics are having manifold impact in a wide range of applications. Transmission of high resolution real time computer graphic images with resolution fifty to 100 times that of standard television requires three channels (R, G, B) each with analog information bandwidths greater than 100 MHz. Some graphics engine generators and monitors have been designed that approach film quality resolution. In these cases it is impossible to send such information for more than ten meters on even the best coaxial cable due to the frequency dispersion and attenuation characteristics. Also, digitalization at these speeds is still in a fairly primitive state, so that transmission over single mode fiber at long distances is the only feasible alternative. In the author's former laboratory (MERET Optical Communications, Santa Monica, CA, U.S.A.) we developed a system for HDTV where each 50 MHz RGB component was placed as frequency modulation on three different carrier

frequencies, which were then frequency division multiplexed. The entire FM-FDM bandwidth was greater than one GHz. High quality HDTV could be transmitted at distances up to twenty kilometers using wavelength division multiplexing for two-way transmission. The frequency bandwidth is still beyond the capability of most satellite transmission systems (see Table III).[16] For medical diagnostics where real time image transmission requires the sending of echocardiograms, X-rays, CAT scans and similarly still or slowly changing images, the technique of digital signal compression has made it possible to boost the data-carrying capacity of ordinary wire telephone lines by almost two orders of magnitude. Ever since the first videophones were displayed at the Seattle and New York World's Fairs in the early 1960s, doctors have dreamed of "healing by wire."[17] The case of a five-year old girl in Indianola, Mississippi (pop. 12,000) who was saved by having her CAT scan viewed by a group of radiologists in Durham, North Carolina, is graphically illustrative. Experiments combining satellite transmission and HDTV (of lower quality and bandwidth than described earlier) have allowed doctors in Boston, Massachusetts, to study patients in Belize. In spite of the high initial costs for installation (two-way video at $500,000) the savings in money, comfort, and convenience for every patient who does not need to be transported to a special hospital will be quite significant. Also, the teaching possibilities for specialists to remote practioners are vast.

TABLE III

Table: PRINCIPAL COMMUNICATION SATELLITE RF BANDS

Band	*Bandwidth*	*Transmit (Downlink)*		*Receive (Uplink)*
6 and 4 GHz	500 MHz	3.7 to 4.2 GHz		5.925 to 6.425 GHz
14 and 12 GHz	250 MHz to 500 MHz	DOMESTIC	11.7 to 12.2 GHz	14.0 to 14.5 GHz
		INTERNATIONAL	10.95 to 11.2 GHz and 11.45 to 11.7 GHz	
29 and 19 GHz	2.5 GHz to 3.5 GHz	17.7 to 21.2 GHz		27.5 to 31.0 GHz
2.5 GHz BROADCAST	35 MHz	2500 to 2535 MHz		2655 to 2690 MHz
1.5GHz AERONAUTICAL	15 MHz	1543.5 to 1558.5		1645 to 1660 MHz
7 and 8 GHz MILITARY	500 MHz (50 MHz exclusive)	7.250 to 7.750 GHz		7.90 to 8.40 GHz
1.5 GHz MARITIME	7.5 MHz	1535 to 1542.5 MHz		1635 to 1644 MHz

Transportation and Communication

The role of communications and high speed transportation in promoting cross-culturalization on a large scale is the central theme of this conference.[20] In this section, we shall examine several areas in the transportation field which are being significantly impacted by communication advances.

Air transport today represents a paradigm of what our global civilization is all about. For most people, the resources put at their disposal (for a small fraction of their annual incomes) are quite astonishing. Consider that

the fare for a transcontinental trip could be about the equivalent of $200 and all the trained technologists on the ground (airport controllers, maintenance and ground crews, remote beacons, weather stations, etc.) as well as those in the air are concerned with getting this paying passenger to his/her destination in comfort and safety and more or less on time. Then, of course, there is the entire sweep of historical development (Newton, Bernoulli, Wright brothers) leading to the pressurized cocoon with its precious human cargo hurtling at high speed through the stratosphere. by 1995, several new aircraft will be making their debut (such as the Boeing 777). In addition to the usual initial navigation systems (INS), instrument landing systems (ILS) and the global positioning systems (GPS), there will be an increase by orders of magnitude in the information and data to be made available and communicated. "The airplane has become another communications node in the corporate data network."[21] The flow of information is considered in two parts: in-flight and at the gate (Project Gatelink). Voice communications in-flight which today are upgraded versions of World War II technology (VHF and HF) will be in the future via geosynchronous satellites. Both low and high speed data will be also transmitted via these high price tag media ($300-400 million for each satellite placed in orbit).

When the aircraft is parked at the gate, data transfer between aircraft and terminal today takes place over a slow

radio link at 2400 bps (ACARS) or by having a messenger carry tape recordings between airplane and terminal. With one megabyte of stored data typically to be sent, it takes upwards of ten minutes for transmission. In the future the amount of information will increase by a factor of 1,000 or more to the gigabyte level. This data will be generated by improvements in on-board maintenance systems, electronic library system leading to a paperless cockpit, and cabin management such as LCD displays, credit card readers, light weight telephone handsets, individual keyboards for passengers in support of a host of planned amenities. A new method with significantly improved bandwidth has been selected. Using both fiber optic connections and broad infra-red beams, the Boeing 777 airplane and terminal will be communicating at the FDDI rates of 125 Mbps. The problem for retrofit for current aircraft is still under study.

Another area where optical communications and transportation intersect is the IHVS (Intelligent Vehicle/Highway Systems).[22, 23] In the U.S.A. alone it is estimated that Americans spend 1.6 billion hours in traffic jams and waste an estimated three billion gallons of oil annually. There are three obvious solutions:

1. improvement of mass transportation alternatives;
2. increase road use efficiency; and,
3. keep people at home with their terminals (telecommuting).

9. Critical Connections, op.cit., pp. 7-10.

10. Ravi, op. cit.

11. Roussel, Anne-Marie, "International Networking Profile: Southeast Asia Telecom" in Data Communications (May 1992), p. 92.

12. Ibid.

13. Critical Connections, op.cit., pp. 190-191.

14. Kierstead, Fred, "Global Education in America: Its Failures and Futures," Abstract:

15. Altschull,J. Herbert, "The Origins of Journalism Education: A Cross-National Perspective," Abstract:

16. Patel, Virat "Broadband Communications" in Telecommunications (March 1992), p. 73.

17. de Sola Pool, Ithiel Technologies of Freedom (Cambridge, MA: The Belknap Press of Harvard University, 1986), p. 226.

18. Spilker, James J., Jr. Digital Communications by Satellite (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1977), p. 156.

19. "Healing by Wire", Time, May 18, 1992, p. 58.

20. Draft letter from S. Fred Singer and Frederick Seitz on Committee V dated April 27, 1992.

21. "The Aircraft Becomes a Node," Avionics Engineering Memo (Tulsa, OK: American Airlines, M&E Center) Nov. 2, 1989.

22. D'Agostino, Salvatore A., "Machine Vision and Intelligent Highways" in Photonics Spectra (April 1992), p. 109.

23. "Dynamic route Guidance and Interactive Transport Management with ALI-SCOUT" in IEEE Transactions on Vehicular Technology 40:1 (Feb. 1991) p. 45.