Space 30
A Thirty Year Overview of Space Applications and Exploration

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SATELLITES: THE GLOBAL VILLAGE AND TELE-EDUCATION

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Telecommunications is a fast changing field. Morse patented the telegraph in 1844. Marconi showed us how to span the Atlantic in 1901. McLuhan gave us the concept of the "global village" in the 1960's. Telecommunications, in only a few decades, has truly developed into a global and multi-billion dollar industry. The ideas of the early pioneers did not develop out of a vacuum. They were built on the work of numerous other individuals and institutions.

Some Background

Some thirty years ago, when Sputnik I was launched on October 4, 1957, the ideas of authors and artists, dreamers and engineers came to a focal point in a relatively small 83.6 kilogram sphere which had apogee-perigee parameters of 939km-215km. Thirty years later, multi-ton satellites at 35,840km (or geosynchronous orbit) are common. Thirty years from now, what will look small and archaic?

It was only some forty years ago on October 14, 1947, that Chuck Yeager broke the sound barrier in the Bell X-1 known as *Glamorous Glennis.* Yeager built on the work of numerous individuals before him. We humans are cooperative individuals (although there may be political, professional, personal and financial differences between us). We *have to cooperate* as a species in order to survive and advance.

Ten years ago there were only eight communications satellites in operation in Region 2 of the International Telecommunications Union (ITU) in use for North American telecommunications purposes. Today, we have more than 30 satellites in orbit from 45 to 146 degrees West Longitude with a wide variety of transponder utilization, from entertainment to education. The pattern also holds for the rest of the world. An October 1987 report of the Federation of American Scientists points out that there are currently 337 functioning application satellites orbiting the globe. Since that time the number has gone even higher.

To review the entire history of space is not possible here but it should be understood that the "building" began centuries ago. The Polish engineer Kazimir Semenovich remarkably published, in 1650, his *Roketten fur Luft und Wasser* (*Rockets for Air and Water*). In this book, he presented a drawing of a three-stage rocket for the first time in history.

In 1687, Isaac Newton (1642-1727) printed his *Philosophiae Naturalis Principia Mathematica.* At the time he wrote:

> Actioni contrarium semper et aequalem esse reactionem, sive corporum duorum actiones in se mutuo semper esse aequales et in partes contrarias dirigi or Reaction is equal (in power) but opposite (in direction) to the actions of two bodies that are equal (in power) but point in opposite directions.

This law of physics forms the basis for rocketry! Polish, English, German, Chinese, American, Russian, French, Japanese, Canadian and many others were involved in space activities. Space is not for a single nation, but for a species.

Morse and His Precursors

More than 140 years ago, in 1844, the American artist and inventor, Samuel Finley Breese Morse (1791-1872) demonstrated the principles of telegraphy over a forty-mile distance from Baltimore to Washington, D.C. Morse, however, was not alone in his pioneering work, since he borrowed ideas from the American inventor Joseph Henry (1797-1878) who, as early as 1835, invented an electrical relay which was the precursor to Morse's telegraph. Henry, one of the founders of the National Academy of Science of the United States and one of its early presidents, was also the first elected Secretary of the Smithsonian Institution. Morse certainly did not develop his ideas in a vacuum, but borrowed from those around him. Just as certainly he contributed to those who followed him.

Morse and Henry, and also the English physicist and chemist Michael Farraday (1791-1867), the Scottish mathematician and physicist James Clerk Maxwell (1831-1879) and the German physicist Heinrich Rudolf Hertz (1857-1894) with their work on electromagnetism, all contributed to where we are today. As G. L. Franco has described the process:

> Almost all current telecommunications technology can be traced to a few major scientific theories and discoveries of the 19th and 20th Centuries, essentially those of the electron, electromagnetism and quantum mechanics in the 19th; relativistic physics, switching logic and digital communications in the 20th. Virtually all basic innovations emanating from those theories were made during and immediately after World War II.

Marconi and His Work

When the Marchese Guglielmo Marconi (1874-1937) succeeded in transmitting the letter "S" in Morse code across the Atlantic on December 12, 1901, history was made! Building on the work of Morse and Hertz, utilizing his knowledge and skills, Marconi caused the world to "shrink" and today information can be exchanged relatively quickly all over the globe. As the Canadian scholar Marshall McLuhan (1911-1980) pointed out 20 years ago in *War and Peace in the Global Village*:

> It is well to remind ourselves that the computer made possible the satellite, which ended nature in the sense that it has been understood during the past three thousand years.

In 1969, McLuhan continued this theme when he wrote:

> When we put satellites around the planet, Darwinian Nature ended. The earth became an art form subject to the same programming as media networks and their environments. The entire evolutionary process shifted, at the moment of Sputnik, from biology to technology. Evolution became not an involuntary response of organisms to new conditions but a part of the consensus of human consciousness. Such a revolution is enormously greater and more confusing to past attitudes than anything that can confront a mere culture or civilization.
>
> ***The speed of information movement in the global village means that every human action or event involves everybody in the village in the consequences of every event*** (or, perhaps more accurately, everyone can — in theory — be involved in global actions). The new human settlement in terms of the contracted global village has to take into account the new factor of total involvement of each of us in the lives and actions of all. ***In the age of electricity and automation, the globe becomes a community of continuous learning, a single campus in which everybody, irrespective of age, is involved in learning a living*** (*Emphasis Added*).

20th Century Activities Leading up to October 4, 1957

The threads that connect to make the fabric of "satellites in space" clearly come from many sources: electromagnetism, telegraphy, television, rocketry and computers to mention but a few. Satellites allow for the electronic transmission of a wide variety of information, and some of the most important to the public are telephony and television.

Television developed gradually: the first commercial cathode ray tube was introduced in 1897 by the German physicist Karl Ferdinand Bain (1850-1897). His work in radio technology earned Wernher Von Braun the Nobel Prize in physics in 1909, a prize which he shared with Marconi in that year; in 1907, Boris Rosing in Russia made the connection of the cathode ray tube (CRT) to "electric vision;" and, in 1908 in Great Britain, A.A.C. Swinton (1863-1930) had published a brief letter in *Nature* on June 18, 1908, entitled "Distant Electric Vision."

More than 61 years ago, on January 27, 1926, the first public demonstration of television was given by John L. Baird in the United Kingdom. In the United States, on April 7, 1927, the "first publicized test of a television phone conversation" occurred when the Bell System sent live television images of Secretary of Commerce Herbert Hoover by telephone lines from Washington, D.C. to New York City (J. H. Wilson, 1975: 118). Sixty years ago, along other "communications" lines, in May of 1927

Charles Lindbergh "raced" across the Atlantic Ocean in the *Spirit of St. Louis* at a 100 mile per hour clip! Change and progress were proceeding along several avenues simultaneously.

Sixty years ago, Herbert Hoover called for the first international radio conference in Washington, D.C.; on October 4, 1927, Hoover presided over a meeting which included delegates from seventy-six nations (H. Hoover, 1950: 145), a forerunner perhaps of the first World Administrative Radio Conference (WARC) held in 1929.

In October 1945, Arthur C. Clarke proposed the idea of using stationary satellites to broadcast communication signals around the world. In recognition of his pioneering vision of satellite telecommunications, this band of outer space "real estate" is called (at least by a growing number) the "Clarke Belt" (Long & Kearing, 1983: 13). The Clarke Belt was not reached by Sputnik on October 4, 1957. It was thousands of kilometers short, but the space revolution had started. Since that date, things have not been the same!

It should be clear that if one analyzes events as they occurred and not necessarily with literary or historical "hindsight," Sputnik came as no surprise to those individuals who were supposed to be following these things. Willey Ley pointed out in his 1968 publication *Rockets, Missiles, and Men in Space*, that the June 2, 1957 edition of *The New York Times* reported on a *Pravda* article that stated "we have created the rockets and all the instruments and equipment necessary to solve the problem of the artificial earth satellite" (1968: 314); and in June 1957, the United States Air Force also issued a non-classified memorandum stating "that there was every reason to believe that the Russian satellite shot would be made on the hundredth anniversary of the birth of Konstantin E. Tsiolkovsky" (ibid). As William E. Burrows has pointed out in his recent penetrating study *Deep Black: Space Espionage and National Security*:

> Whatever else they were, however, Sputnik and its booster (rocket) were not surprises to (President) Eisenhower and the intelligence specialists who reported to the National Security Council. On July 30, 1957, the Russians had announced that they would launch a satellite during the International Geophysical Year, which had begun on July 1, 1957, and they had continued to make no secret of those plans (1986: 94-95).

Events leading up to the Sputnik launch came from many sources. After 1957, we saw the birth of "true" communications satellites capable of relaying a communications signal from the ground (rather than a pre-recorded signal). In 1958, '59 and '60 came SCORE (one way transmit), COURIER 1B (telex relay) and then the impressive but largely irrelevant ECHO 1, a thirty meter balloon which was inflated after its launching on August 12, 1960. This passive satellite, which had neither the capability to amplify or direct the electromagnetic waves reflected off its metallized surface, eventually succumbed to meteorite action and decayed by May 24, 1968. By the early 1960's we started to see "real" satellites like RELAY, TELSTAR and SYNCOM. Finally, only a short seven years after the launch of Sputnik, we saw a Hughes HS-303 spacecraft, designated "Early Bird," successfully launched on April 6, 1965. This eventually gave us the phrase "live via satellite" between North America and Europe. What was once clearly headline or banner news 30 years ago has become so commonplace that a recent multi-satellite launch by the Soviet Union on September 8, 1987, whereby six satellites (Cosmos 1875-1880) were launched from a single booster, is relegated to the back pages of the newspaper.

It is interesting to note the sheer number of satellites that have been launched into some sort of orbit during the past 30 years. If one glances at the excellent *TRW Space Log* or *The R.A.E. Table of Earth Satellites* (The Royal Aircraft Establishment, Farnborough, Hants, England) for the period 1957 through 1982, there were a total of 2,389 objects launched by more than two dozen nations and organizations (with the USSR with 1,507 launches in this 25 year period). Given that 365.25 days x 25 years = 9,131.25 days, this figure of 2,389 launches means that *on the average* we were launching something into space almost every 4 days (3.82 to be exact) for a 25 year period!

Global Implications of Telecommunications with Educational Emphasis

A 1972 prediction by the Carnegie Commission on Higher Education states that "by the year 2000 over 80 percent of off-campus instruction . . . will use information technology" (C. Feasley, 1983: 1). The 1985 Carnegie Foundation for the Advancement of Teaching report *Corporate Classrooms: The Learning Business* (N. Eurich, 1985) continued to echo this theme on the role of technology in higher education. One need only refer to a recent publication *1986 Compendium on Uses of Television In Engineering Education* (P. Atkinson et. al, 1986) to learn of the usage of television for corporate education needs. Television via satellite has not only been used in this nation and in North America for education purposes, but also around the world.

INTELSAT as well as INTERSPUTNIK are known as providers of various satellite services. Currently consisting of 116 member nations and 175 users, INTELSAT was created on August 20, 1964, when an "Interim Agreement" was signed in Washington, D.C., establishing arrangements for this first global communications satellite system. In keeping with its leadership role and as part of its 20th anniversary celebration, on August 31, 1984, the INTELSAT Board of Governors announced that INTELSAT and the IIC (the International Institute for Communications) would jointly sponsor "Project SHARE" (Satellites for Health and Rural Education) as an 18 month experiment. Because of its popularity it actually was extended to 3 years.

The goals of Project SHARE were extremely positive, but working through the realities of PTTs (Post, Telephony, & Telegraph entities) and the eventual problem of transborder data flow might prove to be an educator's nightmare! Project SHARE clearly demonstrated that the exchange of international education can be a reality if individuals are willing to work at it, but the exchange of educational programming on a regularly scheduled and recurring basis is still difficult among nations.

Educational programming via satellite, however, within the boundaries of a single nation, is clearly a successful venture; witness various satellite-delivered programming in North America, including the work of California State University, Chico, the National Technological University, the National University Teleconference Network, or the Texas-based TI-IN organization. Around the planet, there is Australia's Q-Net telecommunications network for the State of Queensland, the June 1986 decision of the Ministry of Posts and Telecommunications in the People's Republic of China to use two transponders from INTELSAT for domestic educational programming, the PACE and Olympus projects in Europe, and dozens more. China's National TV University was an outgrowth of working with INTELSAT's Project SHARE in 1985, when an estimated 500,000 individuals in the People's Republic of China received educational programming live via satellite through a network of 53 earth stations and 1,000 TV receive only terminals (TVRO) (now expanded to 5,000 TVRO's) (G. Bouck, 1986). Educational programming via satellite clearly does work and it need not be full-motion video. The United States Agency for International Development (AID) projects have successfully demonstrated audio conferencing in Indonesia (W.D. Shaw, 1987). The University of the South Pacific and the University of West Indies have used audio slow-scan effectively.

Prior to utilizing satellites for educational purposes in North America, there were the Ford Foundation projects in the 1950's involved with the National Educational Television and Radio Center in Michigan (later known at NET or National Educational Television), the two-year college degree program known as the Chicago TV College and the Midwest Program on Airborne Television Instruction (MPATI). This last program was perhaps the first precursor to what institutions today are doing with satellite-delivered instruction. In the MPATI program, televised instruction was broadcast from an airplane flying over midwestern states.

Educational television clearly began in California in the late 1960's and early 1970's when terrestrial systems were established. In 1969 Stanford University developed their Instructional Television Fixed Service (ITFS) system known as the "Stanford Instructional Television Network" to serve working professionals in the San Francisco area, and by 1972 the University of Southern California had created their ITFS network to serve professionals in the Los Angeles area. California State University, Chico, and the University of California, Davis, began to share a duplex microwave link for engineering classes in 1975, and by 1976, CSU, Chico, was offering "Instructional Television for Students" in northern California on a terrestrial system.

In the realm of satellites for education, the tempo has kept increasing. In 1981, the term "tele-education" was coined in the book *Global Talk* (J. Pelton, 1981). Next, the National University Teleconference Network (NUTN) was created in 1982 to offer programs via satellite. Next, in January 1984, the National Technological University consortium (NTU), which would utilize satellites for tape-delivery and live instruction from numerous campus satellite uplinks, was incorporated in Colorado; and on September 4, 1984, CSU, Chico, began broadcasting, live via satellite, Computer Science courses leading to the M.S. degree in Computer Science.

The CSU, Chico, Computer Science courses broadcast via satellite across North America follow the ITFS model developed over the past decade: CSU, Chico students take their regularly-scheduled Computer Science courses at the same time industry professionals are taking those courses via satellite; quality control comes through normal academic standards of the university.

In September 1987 CSU, Chico was broadcasting five courses a semester (15 hours a week for a 16 week semester). The program has 9 corporate participants that include Hewlett-Packard, Texas Instruments, General Dynamics, Alcoa Laboratories, Pacific Telesis and MCI. The Computer Science courses are now being received at 20 locations in 11 states: California, Oregon, Washington, Idaho, Nevada, Colorado, Texas, Arkansas, Tennessee, Virginia and Pennsylvania.

Peter Drucker's *Innovation and Entrepreneurship* (1985) has provocative statements for individuals in higher education:

> In an entrepreneurial society individuals face a tremendous challenge, a challenge they need to exploit as an opportunity: the need for continuous learning and relearning (1985: 263). Tele-education via satellite will likely only grow in importance in providing continuous learning and relearning.

Conclusions

Satellite technology is real and it is here to stay! Change is a constant in both telecommunications and in higher education. As we plan for the future let us remember the past and let us also be aware of the present.

Robert H. Goddard, the rocket pioneer, was ridiculed in a 1920 *New York Times* editorial but he continued with his research and, in 1969, *The New York Times* printed the following "correction" to their 1920 editorial:

> On Jan. 13, 1920, 'Topics of the Times,' an editorial-page feature of *The New York Times*, dismissed the notion that a rocket could function in a vacuum and commented on the ideas of Robert H. Goddard as follows:
>
> That Professor Goddard, with his 'chair' in Clark College and the countenancing of the Smithsonian Institution, does not know the reaction of action to reacion, and of the need to have something better than a vacuum against which to react — to say that would be absurd. Of course, he only seems to lack the knowledge ladled out daily in high school.
>
> The 1969 "correction" then when on to say:
>
> Further investigation and experimentation have confirmed the findings of Isaac Newton in the 17th Century and it has now been definitely established that a rocket can function in a vacuum as well as in an atmosphere. **THE TIMES REGRETS THE ERROR** *(Emphasis Added)* (*The New York Times*, July 17, 1969).

Patience, persistence, personality: all of these come together in somewhat unique combinations to provide for change. The personality of the individual, along with the ability of that individual to manage time and resources and the ability to distinguish between that which is urgent *now* and that which is important *later* is important in any endeavor, satellite or non-satellite related. Timing and sequencing are key in doing most everything. The time of national and international tele-education has arrived.