ENTREPRENEURIAL SPACE BUSINESS

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Abstract

The outer space environment is rich in opportunities for entrepreneurial business organizations. The experiences of Geostar Corporation are reviewed as a case study in successful space business. Geostar operates spacecraft 35,000 kilometers above the equator to provide a "backbone" for its mobile radio communications systems throughout much of the Western Hemisphere. These systems are projected by the U.S. Department of Commerce to yield over $1 billion in revenues per year by the mid-1990's.

The successful Geostar business formula should be applicable to many entrepreneurial activities in outer space, on the lunar surface and among the asteroids. The key elements of this formula are unique technology which fulfills important human needs, a capital investment of not more than 10-20% of the ultimate funding needed, and a dedicated group of talented people with a "if there's a will, there's a way" attitude.

A New Technology

The Geostar Radiodetermination Satellite System (RDSS) got its beginning from a horrifying mid-air collision between a commercial airliner and a private plane in September 1978 in the sunny blue skies over San Diego, California. The aviation community was shocked by this accident in which 147 people were killed. One person affected by this accident was Dr. Gerald K. O'Neill, a Princeton University physicist known internationally for developing space concepts. During the next several years Dr. O'Neill designed a RDSS system which provided for precise position determination and location and two-way messaging capabilities. The Geostar System consists of three highly technical components--the ground station, the satellite relays and the user terminals. By the end of 1982 a U.S. patent had been issued to Dr. O'Neill covering "...the entire Geostar satellite-based positioning, radiolocation and messaging system, its method of operation and the design of the user transceivers."

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Although this new concept was not accepted by the Federal Aviation Administration, for whom the technology was originally designed to help, it did gain the attention of Colorado businessman, David Wine. Mr. Wine, also a private pilot, envisioned uses for the technology not only in aviation, but in land and marine transportation as well. He recommended that the development of the concept continue through private enterprise. Thus, in 1983 the Geostar Corporation was incorporated to develop and market the Geostar RDSS System.

Since this beginning Geostar has maintained a simple, yet very clear, objective, "...to develop the highest quality radiodetermination satellite (RDSS) technology and to deliver this technology to the widest possible market." During its short life Geostar has developed seven specific functions provided by its radiodetermination satellite service technology. They are:

- -User positioning
- -Navigational guidance
- -Radiolocation(to central dispatch office)
- -Collision warning
- -Message traffic outbound
- -Message traffic inbound
- -Interconnection to data bases and other communication systems.

With these seven functions and the capacity to to handle millions of subscribers, the applications of the Geostar System are limited only by the imagination. Given the prospect for low-cost, handheld user equipment, Geostar can enter many market segments with enormous potential including land transportation, personal communications and navigational markets.

Land Transportation

With the development of the Geostar RDSS System, it is now possible for interstate trucking and railway companies to visually pinpoint all of their mobile units on a computer screen and to track them and to

communicate with them nationwide, in real time, twenty-four hours a day.

The long-haul component of land transportation, encompassing interstate trucking and railway operations, has steadily grown by about 2% since 1977. During this period of growth, it has been increasingly more difficult for dispatchers to know the whereabouts of their vehicles and to communicate with the operators. As a result, these vehicles routinely run empty, which contributes to an annual cost in the US of $2 billion in driver, fuel, and equipment deterioration. A submarket of the long-haul transportation is in special need of positioning and radiolocation services to meet extensive regulatory and safety requirements. This market consists of high-value cargo, hazardous materials and products requiring refrigerated or temperature-protected services. The president of one trucking company which transports military munitions states, "For the first time in my 25 years in this business, I know where my trucks are at." In order to survive in an increasingly competitve industry where the profit margin is often pennies on the dollar, trucking companies have had to develop methods that allow them to deploy their fleets more efficiently and on a more timely basis. The Geostar System allows the companies to improve its productivity, reduce the costs of operation and at the same time offer better service to its customers.

Personal Communications

Personal communications is another market that can utilize the new technology of the Geostar System. At this time the personal communications market is experiencing a tremendous rate of growth, especially in paging and cellular telephone service. The number of paging service subscribers exceeded 6,000,000 in 1987 and is expected to reach 10,000,000 by the early 1990's and the number of cellular phone users now exceeds 1,000,000. The market available to Geostar is with existing personal communications service companies and electronic retailers. Geostar will supply these companies and retailers with innovative products and services to be sold to businesses, professionals, and those interested in new technology products. Geostar believes this market will exist because:

-the Geostar System will provide the first portable two-way nationwide message transfer system;

-the Geostar System will provide navigational guidance in addition to communications;

-the forecasted consumer cost of a user terminal will be within the price range of other personal communication devices; and

-the Geostar System can be used with other personal communication devices and data bases (i.e., for electronic fund transfers and point of sale applications).

Navigation Technology

By offering the combined positioning and communications capability of the Geostar System, the Company will be able to provide service to government agencies, and to maritime and aviation industries.

The interest in the Geostar System by the various government agencies stems from the fact that many of these agencies perform functions in remote areas where standard communication systems are not available. The Geostar System can provide service to the Customs Service for border control purposes, to the Department of Defense for various monitoring and logistic responsibilities and to the Coast Guard for maritime safety and coastal water responsibilities. Providing these services may require dedicated or tailored systems, not to be available for general commercial use, constructed by Geostar specifically for these agencies.

Although systems are currently available which can provide both communication and positioning services to maritime users and offshore industries, the Geostar System can provide value-added service at a lower cost to this market. For example, the Geostar System enables the user to :

-obtain, at any time, his precise geographical position, and have this information relayed to any other location;
-send and receive messages from any other person equipped with a Geostar

transceiver, whether they are nearby or far away and whether they are at sea, in the air or on the ground;

-interconnect through the System computer to a telephone;

-receive, at any time, computer-generated bearing and distance directional guidance from his location to any other location;

-receive, at any time, computer-generated hazard-avoidance warnings on navigational hazards; and

-in the event of an emergency, advise rescue officials of his precise location as well as any special assistance which may be necessary.

It is clearly evident, from tragic, mid-air collisions, that the aviation community has perhaps the greatest need for the Geostar System with its capability to offer both collision avoidance and hazard advisories. Although the FAA has not yet accepted the System as a new air traffic control method, they are looking into the possibility of using the System for the location of downed aircraft. In the business and private community, the Geostar System allows organizations or private owners to communicate and monitor the location of their aircraft from their own operations center or office 24 hours a day.

Geostar System Development

The three components of the Geostar System are estimated to have a cumulative cost of over $300 million. When Geostar first went to an investment banker in hopes of raising the needed capital to construct the system, it learned very quickly that investors were not willing to put their money in a company with a new and unproven technology and an untested market. This was the first of many problems which have dictated Geostar's corporate strategy.

Sierra Tests

In order to prove the feasability of the Geostar System, tests were performed in the fall of 1983 at a Sierra Facility near Lake Tahoe, California. To test its technology, Geostar built low-cost satellite emulators, an experimental ground station consisting of 2 meter antennas and a computer, and a prototype tranceiver unit. The "Sierra" tests were successful in demonstrating the positioning and radiolocation capabilites of the Geostar System. The success of this test stimulated further development of the RDSS service.

Staged Development

Faced with the realization that the implementation of the full Geostar System, using three dedicated satellites, was not initially financially feasible, a plan was developed to deploy the system in stages.

Initial Service

The first stage planned to be operational was a one-way position and message reporting service from a vehicle to a subscriber's headquarters by way of the Geostar Hub. With equity raised based on the success of the "Sierra" tests, Geostar was able to begin the development and construction of the space segment, ground segment and user segment necessary for the first stage. Geostar contracted with GE Astro for the construction of a satellite relay, carrying both primary and back-up RDSS transponders, to be attached to a GTE Spacenet satellite. These transponders would have the ability to receive signals from the user units and relay the signal to the ground segment.

The first phase of the ground segment was the Inbound Hub. The Inbound Hub receives satellite transmissions and converts them into computer readable forms for processing. The Hub was designed in a combination of efforts using radio frequency equipment from Comsat, Hewlett Packard computers and Geostar developed software.

The user equipment was also being developed in stages. The first stage involved the design, testing, production and installation of terminals to work in conjunction with the GE built transponders. Geostar licensed two manufacturers, Sony and Hughes Network Systems, to develop, produce and market user terminals for one-way service. By licensing the two maufacturers Geostar avoided costly expenditures for the research, development and production of user terminals.

With all segments completed for the first stage, Geostar was ready to provide one-way

service upon the launch of the Gstar II satellite on March 28, 1986. After a perfect launch, the satellite reached its geostationary orbit and Geostar was able to successfully send signals using the transponders. Unfortunately, after a few weeks of operation, both the primary and backup transponders failed. Geostar's initial one-way service was now delayed until another satellite carrying additional RDSS transponders could be placed in orbit.

Despite the disappointing failures of the transponders, Geostar was able to raise over $22 million from investors, and also began generating revenues. In September 1986, Geostar entered into a contract with the United States Customs Service to develop and sell to the government miniaturized two-way electronic tag devices. The original contract price of $12.6 million was amended and now totals $13.5 million with future increases anticipated. Revenues received from this contract represented 100% and 96% of total revenues for the years 1986 and 1987, respectively. In 1988, revenues from the contract approximated $8 million or 80% of total revenues. With these funds Geostar continued its development of each segment of the Geostar System for full two-way capabilities.

Argos Services

When the receive relay on Gstar II failed the replacement relay was scheduled to be launched and operational by January 1987. In February of 1987, however, the relay had yet to be launched and even worse, was now scheduled for December 1987 at the earliest. Throughout this period of delay, most of the original one-way customers remained enthusiastic of the benefits they would get from the system. Afraid that this new delay would cause some customers to lose interest in the System, Geostar began to consider other ways to provide them with service.

The answer to Geostar's problem was with Argos, a French science satellite orginally designed to track icebergs and polar bears. Since the satellite was not being used to its full potential, Geostar was able to purchase some of its spare capacity. This satellite would only allow Geostar to track a maximum of 200 units and could only guarantee position determination four times a day. Additionally, the terminals to be used with Argos needed to be modified to use its assigned frequency. With this service, however, Geostar was not only able to keep potential Geostar System customers' interest, but was able to generate a small amount of revenues.

In March of 1988 Geostar's second satellite relay carrying additional RDSS transponders was finally launched into orbit. Again, Geostar was able to successfully send signals using the transponders. After an initial testing period, commercial service began for the one-way service in July of 1988. During the 6 month period of providing commercial one-way service in 1988, Geostar earned over $2.2 million.

Two-way Service

Despite the setbacks discussed above, Geostar was able to keep focused on its goal of providing two-way service. Originally there were plans for a transmit and receive (T/R) relay to be launched which would provide two-way messaging service. However, due to the unexpected delays in the launching of the second satellite relay and based on the earliest launch date available for a T/R relay, it was determined that this two-way relay would not be cost beneficial since the first dedicated satellite, which can provide the same service, was scheduled to be in service only a year later.

At this time Geostar was already researching other possibilities of providing an early version of the complete satellite-based two-way system. Through the efforts of Geostar engineers and Hughes/Kenwood, a system was developed which provided this service. A module, attached to the one-way user terminal, receives transmissions from the Geostar Hub which are relayed from C-band frequency transponders on existing satellites. This Outbound relay, used in conjunction with the existing Inbound relay, completes the two-way service system. In January of 1989 Geostar successfully demonstated, to both the media and customers, the first high capacity nationwide positioning determination and messaging service, including an example of voice transmission using voice synthesis chips.

Dedicated Satellite Service

By developing a reliable two-way product and service and by establishing a potentially large revenue producing market, Geostar has paved

the way for the final phase of its System--Dedicated Satellites.

The first of three dedicated Geostar satellites, contracted for construction by GE-Astro, is scheduled to be placed into orbit from a NASA shuttle mission in late 1991. A large French bank, Credit Lyonnais, is leading the way for raising the $300 million needed to finance the dedicated satellites. It is through a network of alliances (see Figure 1) that Geostar has been able to reach this stage so quickly. Without the total commitment by the Geostar "family" and these alliances and a total belief in the Geostar System, the company could not have accomplished so much so fast .

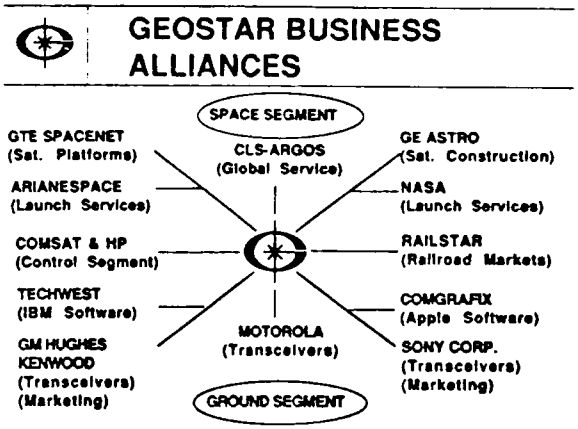

Fig. 1 Geostar Business Alliances

International Development

Geostar has been discussing the potential of a global implementation of RDSS with various entities and countries for several years. The global RDSS system is expected to function by a network of fully compatible systems owned, managed and operated by regional authorities.

The French space agency, Centre National d'Etudes Spaciales (CNES), was the first foreign organization to show interest in RDSS. In 1986 Geostar and CNES signed a Memorandum of Understanding for the establishment of a European organization called Locstar. After two long years, Locstar was finally formed in October of 1988. This organization, which includes 27 government and private interests from throughout Europe, plans to operate a regional RDSS system capable of providing service to Europe, the Middle East, the Mediterranean and Northern Africa.

In addition to the Locstar success, Geostar has signed memoranda of understanding with government agencies from Australia, India, Brazil and China and with the Caribbean Broadcasting Union. In October of 1987 the outlook for the global implementation of RDSS increase substantially when the International Telecommunications Union allocated international frequencies on a global basis for RDSS and adopted the Geostar System as its worldwide standard for RDSS.