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SPACE TECHNOLOGY UTILIZATION IN AN INDUSTRIAL COMPANY - A CASE STUDY

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Mr. Chairman, ladies and gentlemen - In contemplating the theme of this session "Spinoffs From Space," I was reminded of the shoe company who sent two marketing teams to deepest Africa to determine the market potential for shoes. One team reported back, "Forget this market, nobody wears shoes." The other team sent a rush telegram saying, "Get ready to build a factory here, everybody needs shoes." The attitude of the public toward the benefits flowing from the space program appears to be similarly divided.

Those who feel the taxpayer's money is being wasted in the space program seem impatient that a new world has not been discovered; that the dollars spent have not resulted in two chickens in every pot; that these funds could be better spent on our social problems. In my opinion, we have failed to teach these people the science-technology-economic gain-social benefit cycle. The optimistic supporters of the space program, on the other hand, are aware of the bounty produced by this cycle, can point to the multitude of benefits that have already accrued, and visualize the vast potential yet to be realized from only 10 years of effort.

Those in the industrial complex of our country have no cause to complain of a lack of technology flowing from the space program into the private sector. The people in industry who might complain are those who expect automatic flow with neither search nor adaptation on their part. Those who are seeking out and adapting this technology to their use are the ones who are now, and who will continue to be, ahead of their un-informed competitors. Support for these statements is abundant in the experience of the company with which I am associated and I am sure our experience is not unique.

Using a number of examples, I would like to describe to you how the space program has benefited our company and our customers. By extrapolating our experience to the total industrial complex, one can visualize the wealth that has accrued from space program spinoffs.

Ball Brothers Company is a corporation that began operations in 1886 and for many years its main production activity was producing glass jars and fittings for home food preservation. Growing out of this original product through vertical integration it is today a diverse company. It is engaged in the business of glass container manufacture; mechanical rubber goods; non-ferrous metal rolling and forming; injection molded, extruded, blown and decorated plastic parts; television studio electronics equipment and television monitors; ferrite memory core plane assemblies; lithographed and coated metals; and is in several phases of the graphic arts business both in the United States and abroad. In addition, it has a wholly owned subsidiary Ball Brothers Research Corporation which is engaged in the aerospace business. This aerospace company is a prime contractor to the National Aeronautics and Space Administration, and among other things builds the Orbiting Solar Observatory Satellite and sophisticated controls for pointed experiments on rocket flights. It is also a subcontractor to many NASA prime contractors and government agencies in the building of experiments for space flights, such as the majority of experiments to be flown on the Apollo Telescope Mount. Because of the diversity of my company you can see that we have an interest in diverse technologies.

As a contractor to the United States Space Agency we are legally required to report all new developments, techniques, innovations, and discoveries resulting from our contractual work with this agency. To date we have submitted 23 such items to the agency.

It is interesting to note the range of technological fields in which we have reported to date in fulfillment of our obligation. A list would include the formula for a superior optically black flat paint, a reliable pitch control and aspect measuring system, a high efficiency gas jet pump, a remotely programmed timer, a reliable spin control system, a raster control system, an angular acceleration switch, temperature control paints, temperature transducers, a unique nutation damper, a unique instrument for measuring dipole moments called a magnetotropometer, lubrication systems for ultra high vacuum operation, a precision mounting for critical optical elements, and a delta encoder for digital television. When you realize we are one of some twenty-thousand contractors to NASA, all of whom are similarly required to report new techniques, innovations, and discoveries, you can begin to measure the wealth of information available to the industrial community. It becomes self-evident that it would be advantageous to put forth a concerted effort to determine what others have done and how their discoveries fit into your own business.

The Space Act of 1958 also requires that the space agency disseminate information. In fulfilling this duty they have done an excellent job.

NASA, through its technology utilization division, has made it very convenient for industry to examine the innovations and discoveries of others by establishing regional information dissemination centers throughout the country. In our case, ARAC (Aerospace Research Application Center) at Indiana University is used. As you are probably aware, this center, like the others, receives all of the data of a

scientific and technological nature available from the space program as well as information from some other government agencies. Through the use of computers, stored information is easily retrieved. When it was started in the Fall of 1962, ARAC was funded in large measure by NASA. Industries were invited to participate on a fee paying basis. It has become so beneficial that today some 75 business firms are utilizing the center and it has become practically self-sufficient. Without going into detail on the operations of ARAC, let me tell you how we use it.

ARAC personnel have studied our industries, know our fields of interest and capabilities, and have been given intelligence concerning specific problem areas within our company. In conferences with ARAC personnel we have established 40 interest centers. Those technologies which match our interest centers are continually being surveyed by ARAC from the mass of information being made available to them. To illustrate the scope of activity generated by this technique, ARAC has in the last six months alone screened 34,612 abstracts relating to our interest centers. Of these, 8668 were deemed pertinent and sent to us. From these, we selected and ordered 177 complete reports for our use. In addition to these services, numerous other data were obtained in the form of Flash Sheets, Marketing Reports, Computer Information Services, etcetera. The cost for these services, by the way, for the six-month period was $3,829.

Placing such information into the hands of industry is one thing, but utilizing it is quite another. The National Aeronautics and Space Administration has mounted a large effort to make available the technology coming out of the space program, but the utilization and adaptation of the technology are certainly an individual company problem. Recognizing this problem, we decided a diligent pursuit of the knowledge was required. Therefore, we appointed a chemical engineer, who has been with our company in various capacities for a number of years and who knows in an intimate way our product and problem areas, the part-time but high priority task of getting the available information into the hands of the proper individual within our company. He reports to a corporate official and is in effect our "technology utilization manager." This approach, although I am sure it differs from methods used by other companies, has worked well for us. Our premise that we would get no more out of the program than we put into it is valid and the effort we have expended has been repaid many fold.

Examples of how my company has used the technologies developed within our aerospace subsidiary, as well as innovations reported by others, are numerous. The examples related here can be expanded in your minds to reveal the magnitude of opportunity offered industry by the space technology utilization program.

Our design of the Orbiting Solar Observatory Spacecraft required rotating parts such as large bearings and slip rings to operate continuously at 30 rpm in the hard vacuum of space. It soon became apparent that an advance in the state-of-the-art would be required in lubrication technology to avoid the cold welding of metal parts, and the outgassing of existing lubricants which would contaminate the optical components of the instruments within the spacecraft. Many months of research, which by the way is still continuing, resulted in the development of not only a family of lubricants, but also intricate techniques for the application of those lubricants to metal surfaces. These systems have since been proven in over two years of continuous operation in orbit. We have capitalized within our own company on this innovation and today have a sizable operation in the treatment of moving parts requiring exposure to vacuum environment, not only for other aerospace companies, but also for commercial companies whose business involves ground based vacuum systems. We have also learned that some of these lubrication systems are satisfactory for non-vacuum operations, for example in some types of gyroscopes, motors and gears, and an independently manageable business is gradually building up for us in this area.

A similar story can be told about specialized paints which were developed for the same OSO satellites. The development of these paints, which by the way involved a large computer program, was mandatory to achieve passive thermal control of the OSO satellite. This technology is now being used in the Apollo missions. It is also being utilized in the cryogenics industry and in the refrigerated trucking industry.

Digital encoding techniques and temperature sensing innovations which have been reported by our aerospace division have been used by our commercial group in the development, manufacture, and sale of down-hole oil well pressure and temperature gauges which continually monitor these parameters in oil field reservoirs. These instruments which are now a source of income to our company are being used by many oil reservoir engineers in several countries throughout the world.

Our aerospace group in the course of its work has become expert and has reported innovations in the field of digital television. Because we had the skills required for this work in aerospace, our commercial group has been very successful in the development of a number of instruments used in the television broadcast industry including both color and black and white television monitors, special effects generators, distribution amplifiers, and waveform monitors. Growth in this field which is a new industrial endeavor for us, has been exponential and has resulted in the establishment of a division of the research corporation to manufacture and market this equipment.

Under a contract funded by NASA, innovations were made in the development of a nephelometer to detect life on Mars. This is the so-called Wolf Trap experiment named after its inventor Wolf Vishniac. Although this apparatus is yet to be used on Mars, we have adapted it into a unique method for determining the suitability of materials for sustained operation in a vacuum. This work has resulted in a growing business in the material testing field and may well put us into the growing industry of environmental pollution control.

One other example comes simply from doing business in the aerospace field. Because of the high reliability and quality control constraints that are demanded, a company involved in aerospace work finds itself in a position to accept commercial contract work of a highly sophisticated nature. Having these skills has allowed us to become a major supplier to IBM in the assembly, test, and repair of memory core planes for the 360-series computer. We could not possibly have become engaged in this sophisticated commercial venture, employing several hundred people, had we not been indoctrinated in the peculiar requirements of space hardware fabrication.

Innovations from within the aerospace group have broadened our business base. Slant range receivers, temperature sensing payloads, and telemetry transmitters which we are now fabricating and marketing are the start of a product line in environmental instrumentation.

With one more example I will conclude, but not complete, this description of business growth through the adaptation of innovations coming directly from our participation in the space program. Sophisticated space projects involving optics, electronics, and mechanics have led to the development of a cableless underwater television system. In recent tests, acceptable pictures from a depth of 14,000 feet have been received on the surface using the sea water as the only link between the camera at the bottom and the receiver at the surface. We expect this work to lead us into participation in the field of oceanography. Along this same line, and with the oceanographic and environmental scientist in mind as the potential user, a meteor burst communication system is also in the final stages of development.

In the other areas of our business we have taken great advantage of the innovations of others to aid us not only in upgrading and improving our products and processes, but in developing new products which are now a part of our line. For example, resistance welding used in the aerospace field to achieve higher reliability and denser packing of electronic systems is being used as a substitute for soldering by a division of our company making electronic inspection equipment.

In our lithographic operations in which we manufacture presensitized lithographic plates, we have improved our product and saved many dollars through the use of air filtration techniques developed by NASA contractors for clean room operations.

In another area we have used innovations from the aerospace industry to solve a very nasty problem involving the corrosion of zinc platings. The solution of this problem alone was worth all the effort and costs we have put into the ARAC program.

A wealth of information has been made available to us in the technology of adhesives and elastomers which we have found directly applicable in our mechanical rubber goods manufacturing operation.

The integrated circuitry which has evolved from aerospace requirements is now being used in the development of automated glass bottle forming machinery and in the production of an electronic thickness gauge for measuring the wall thickness of glass bottles.

Surface chemistry information available to us from NASA's technology transfer program has resulted in improved lubricating coating systems for glass containers which systems are now being sold to the glass industry worldwide.

It would be a serious omission not to include in any discussion of the spinoff of technology coming from government-sponsored programs, the use of management techniques such as PERT. This has become a valuable management tool within our companies resulting in the savings of many dollars.

We could spend the remainder of the session continuing to give examples of how technology coming from the aerospace industry can be utilized for industrial growth not only by the company creating the innovation but also by using the innovations of others. It should, however, be adequately evident from our case, that those companies who make a determined effort to seek out, analyze, modify, and apply the technology available from the space effort have some serious problems. These are the happy problems of growth and the potential for diversification, limited only by the magnitude of the effort they are willing to expend. Our company has grown and profited from our effort, and the morale of our people has improved, but just as importantly our customers (the public if you wish) have benefited through new and improved products.

Shakespeare in The Tempest says, "What's past is prologue." It is my firm belief that this becomes a truism for any company that is utilizing the spinoff from the space program.