

SPACE IN THE 1970'S: INVESTMENT AND RETURN

Founder's Day presents all of us with an opportunity to do some serious soul searching about ourselves and our historical context--the sort of reflections that most of us find an abundance of time to postpone as we busy ourselves with the concerns of the day.

We can, if we choose, rejoice over the long and successful history of this fine institution. We have much to be proud of, and each year our record is embellished with new achievements.

But rather than praise our 107 years of accomplishment, for my part, I'd like to focus attention on the state of mind that makes such successes--indeed, the very existence of V.P.I. --possible.

Many things combine to make a successful school--outstanding teachers, dedicated administrators, bright students, generous and loyal alumni--but without a single element, all these would never come to be.

The founding of an institution of higher education depends on a very special human quality, a quality that was essential to the beginnings of civilization--and a quality no less necessary to our own age.

Thus, in the spirit that lives on Founder's Day, we may find a key that opens not only the door to our past, but also unlocks the formidable gate that threatens to bar us from a peaceful and prosperous future.

Most of our lives are not spent facing the momentous questions of our age. The myriad of small problems that beset us leaves little time

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to foresee and develop magnificent solutions to the far greater difficulties that determine the course of most of our lives. Nevertheless, great decisions sometimes are made, by default, if not by wise people and wise leaders.

The great milestones of history stand out prominently against the background of ordinary events. Was there an economic crisis in the days when Magellan circled the world? Did morality seem to be declining as Leibnitz developed the calculus? Were there threats of wars and blockades when the Wright brothers flew along the beaches at Kitty Hawk?

One would probably be safe in saying that temporary crises have been the background for life throughout human history. But against that background there has been progress--partly technological, partly in human relations.

Progress--the sometimes unsteady advance toward a world in which war, famine, poverty, and illness may be ultimately abolished--depends on a quality typified by the Founders of this school. A quality we must all draw upon in the coming years.

Important historical events are those that affect many people over a long period of time. The founding of Virginia ^{TECH} Polytech was such an event.

Establishing such an institution requires a firm decision to pursue long-term benefits though such a decision may require postponement of

some apparent gains that are desirable but temporary. Our resources are limited, so when a portion is committed to the future--there is always an outcry that some present needs must be curtailed or denied.

Universities, research programs, scientific and technological exploration--all require a commitment that at the time seems difficult to make. There can be no question of that. The best of such essential programs cannot propose to find quick solutions to immediate and pressing problems faced by every age. Research and education can bring real and lasting benefits--but the best of such things take time.

The dollars spent on research and on education produce no instant supply of food for the hungry, they manufacture no clothing for the ragged, they do not heal the sick. But in the long run they may give these and many more benefits that far outstrip the initial expenditures.

So the founders of V. P. I. and those who committed funds to the exploration of space had a common resolve. Conscious of the needs of their own time, they nevertheless firmly committed a portion of their resources to assure that their society would not merely survive the years to come but would thrive. And that we would succeed, not through brute force, but by the far greater power of our own minds.

The decision to postpone some immediate short-term benefits is essential to the development of man's potential--and is one of the keys to civilization itself. Though the effort required of modern nations to commit

resources to such programs is great, it cannot match the sacrifices of primitive man when he temporarily set aside his crude weapons to begin cultivating crops thousands of years ago. This was the first commitment to mankind's future.

When man turned to agriculture, he made possible a system that freed a small portion of his society from the work for survival against the elements. From such careful husbandry, all future civilizations took root.

Man's early society was led by persons of great vision: religious men who developed written records, kings and queens who reached deep into their treasuries to chart the known world and explore the frontiers, scientists and educators who combined to study life and to teach others with what they had learned.

Our own time is in some ways little different from those centuries past. Our research programs, our explorations, our educational system are much more complex--but our goals are much the same.

But now, we--as citizens--bear far greater responsibility for the success of the human venture. In a democratic society, we must choose for ourselves the course of progress--and we, too, must commit ourselves to the necessary sacrifices.

Our physical needs have changed little over the centuries, though both our expectations and our ability to fulfill those expectations have grown immensely.

Because of our rising expectations, the improvements brought about by the miracles of technology--from the wheel to the computer--really have not changed the nature of our spiritual conflict. The Four Horsemen of the Apocalypse--War, Conquest, Famine and Death--still ride with us. Here in the United States in 1974, three other threatening horsemen called Economy, Energy and Environment are galloping close by.

Against such a background, each of us must face a struggle much like that faced by the founders of this college. We must agree to set aside a portion of our resources for the future--for essential programs of education, research and development, and exploration--both here on earth and in space. Today is yesterday's tomorrow--and once again, the yardstick of history is catching up with us.

We--all of us--are the founders of our own future. Millions of Americans and citizens of other nations are the founders of the space age. Most of us have a strong commitment to the future, and a willingness to sacrifice for a better tomorrow for all the world's people.

To say this is not to say that we would ignore, or even neglect, the problems of our own time. It is to express confidence that we are able to solve these problems--and to observe that the record of our investment in the future may offer us a guide to solving the new crises which affect us today.

If we have learned anything from our record in space and from technological research in general, it is that no physical barrier is insurmountable. The journey to the Moon, which many thought to be no more than a wild fantasy a few decades ago, has now passed through the impossible to the accomplished fact.

Many of our current problems are technological, and like the impossible journey to the Moon, the searches for new energy sources, for new transportation systems, for better medical care and housing, for a cleaner environment--all can be accomplished by men willing to invest their labor to attain goals that now lie many years in the future.

Dr. Robert H. Goddard, the Father of U. S. rocketry, put it very well, I think, when he said, "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."

The short history of the space age teaches us the same lesson that is enshrined here in this school. Through the work and investment of one age, a better world is provided for the next. If we could teach but one lesson, learn but one rule, this message might guide our planning for the future.

For the great paradox is that our current problems are not problems of today, but the result of yesterday's action and inaction. They cannot be solved instantly as they come to the surface. We cannot, as common sense seems to dictate, wait until some giant has us in his grasp before

we devise a means of escape.

Fifteen years ago, when the space program was taking its first improbable steps, our nation looked beyond the many problems that faced it--and the problems of those years were as serious as those we face today--looked beyond current needs to take actions necessary to forge the future.

Our nation agreed to set aside an increasing portion of its resources to expand our horizons--both physical and mental.

We are the beneficiaries of that investment--an investment by our democracy, not by a single king or queen, and an investment that continues to pay rewards.

The costs of the journey beyond Earth were great, just as the expense of Columbus' journey to the new world was great. But the benefits already returned to us are even greater.

It will come as no surprise to scientists studying the Earth, the Moon, the Sun, and the Planets, that the first fifteen years in space were of great benefit. They have advanced their sciences immeasurably.

But for the average taxpayer, the men and women who made their investment in the 1960's, new scientific knowledge must be analyzed for its usefulness to all mankind and for its cash value to those who have agreed to support it.

There can be little argument that an investment in the future is important, but the taxpayer has a right to decide whether more immediate returns on our investment have justified the expenditure.

In the case of the extensive research and development programs undertaken for the exploration of space, detecting an immediate hard and cold profit to our complex economy is no easy matter.

We are all familiar with at least a few of the valuable technological breakthroughs made possible by space investment: fuel cell development, cryogenics, new fireproof materials of several sorts. And most of us have heard about the practical by-products of space invention now in use: improved blood analyzers, medical monitoring systems, hospital clean-room techniques, electronic controls for the paralyzed, money identifiers for the blind.

But the final evaluation of the economic return must be made by the economists and other trained specialists, and such evaluations are difficult.

Though it hasn't had much publicity, such an investigation has been done. The report of the Midwest Research Institute on the value of dollars invested in space is a clear piece of evidence that each of us, as taxpayers, should take into consideration as we plan for our future.

The Midwest Research Institute found that the return from investments in the sort of basic technological research and development

undertaken by the space agency amounts to some 33 percent per year. I hardly need to point out that such a return exceeds the typical yield from investments in stocks, bonds, and real estate.

Have the dollars spent so far been thrown away? A look at such economic analysis assures us that the opposite is true--they have been better invested than most of us could imagine, much less hope for. The remarkable 33 percent return each year is not immediately visible to most people, because the dollars spent in space go to many companies, large and small, all over the nation. They buy inventions--an estimated 30,000 of them by the conclusion of the Apollo program--that serve us in uncountable ways--but inventions that do not have "product of space research" stamped on them when we see them in action.

The wide geographic distribution of our economic benefits helps to assure us that the improvements in the standard of living will benefit many people from many places and from many walks of life. The total return, which continues to expand through the economy for an average of 18 years, amounts to 700 percent--seven dollars for every dollar of tax money spent.

The billions spent putting men on the Moon and establishing our competence in space are indeed very large sums--but the profits, measured in the tens of billions, are the legacy of the 1960's to our decade--and today's budgets will provide similar benefits in the 1980's.

How about our country's Balance of Trade?

Aviation Week Magazine points out that in the vital area of Balance of Trade, aerospace exports reached a record \$5.1 billion last year. This enabled the United States to achieve a favorable net balance of \$1.7 billion rather than a deficit of \$3.4 billion.

This decade has been described by some as a period of transition for the space program. We have reached the Moon successfully, now we are turning our attention to the Earth and to the immediate benefits that space promises to all of us. The groundwork laid in the 60's makes possible a wide range of practical applications now. We have evolved from a decade of exploration to a decade of exploitation.

With the Earth Resources Technology Satellite launched nearly two years ago, man first began to learn about parts of Earth both too close to be seen clearly, and too inaccessible to be studied thoroughly.

In the past year, the remarkable findings based on the electronic images sent down from this Earth scanning satellite have set the stage for dramatic advances in monitoring pollution, measuring agricultural production, mapping surface features, and detecting essential natural resources. The satellite's sensors may provide essential data for detecting water for potential farmland, scarce minerals, and potential deposits of oil and natural gas. Success in all these areas has been reported by scientific investigators.

The strong technological base established in the 1960's has made applications programs like ERTS-1 both successful and inexpensive. The findings of this first test vehicle will be expanded by its twin, to be placed in orbit during the coming year.

How much did ERTS-1 cost us? The total--for satellite, program operations, and scientific investigations--was less than 50 cents for the average American. Given its potential for aiding us in the coming years, who would not support a program that costs less than a gallon of gasoline, less than a half-pound of ground beef, less than eight ounces of copper?

The recently completed Skylab program proved without a doubt man's usefulness in space not only as an observer, but also as a scientist, engineer and repairman. Skylab produced a wealth of data about Spaceship Earth as well as what may be a quantum jump in the field of solar astronomy. The benefits of Skylab have already begun to surface in a greatly advanced understanding of ocean currents and marine life, and in successful applications of space photography to mapping, regional planning, geology, and other needs. The analysis of data from these three record-setting flights will occupy scientists throughout the world for many years--a continuing return on our investment in space and a clear indication of the potential for space laboratories in the coming years.

Virtually no one questions the value of our weather satellites or the superb international communications network made possible by space

applications. This year, two Synchronous Meteorological Satellites will be launched--the first weather satellites capable of keeping constant watch over the same portion of the Earth, viewing the movements of weather systems both day and night.

This year, too, we will launch a new and improved Applications Technology Satellite, the sixth and last in the program. Though this is an experimental communications satellite, it will be used from the beginning for important applications--as a vital link in a program that will bring improved educational television first to remote areas of the United States--in the Rocky Mountains, in Appalachia, and in Alaska--and later to 2500 villages in India.

Keep in mind that a 1,000 pound satellite circling the Earth from several hundred miles up can do a job in communications that on the ground requires some 200,000 tons of copper cable laid beneath the oceans. A three-minute phone call from Blacksburg to London today costs about \$5.40, whereas just three years ago it would have cost about \$9.00.

The tremendous success of space applications can best be judged by the enthusiasm with which industry, other government agencies, and foreign governments are taking advantage of the special talents we have developed over the years.

This year, for the first time in the history of the National Aeronautics and Space Administration, we will launch more spacecraft for other

organizations than for NASA itself. Included in the fifteen launches for others are domestic and international communications satellites, and cooperative scientific flights with Germany, Italy, Great Britain, and the Netherlands.

During the past year, men have set an admirable record in space as both the United States and the Soviet Union launched crews into orbit about the Earth. In a little more than a year, we with the Soviet Union will make the first manned international space flight--the culmination of the Apollo-Soyuz Test Project.

Apart from the international cooperation fostered by this project, both nations are reaping substantial benefits from exchanges of scientific knowledge in many areas. The Apollo-Soyuz project may come to symbolize the new flavor of space exploration--a task to be undertaken not by Americans or Russians or Europeans, but by the people of Earth.

The investment of the 1970's that will pay, perhaps, the greatest return to future generations, is--as the early Apollo program was--a complex research and development project. We have already made excellent progress in space applications, but the Space Shuttle--now under development--will make possible even greater advances--and at even lower cost.

The development of the Shuttle, now well underway, will pay countless dividends to the 1980's. With an estimated annual cost equal to about

five dollars for each American, the Space Shuttle will be a modest investment in the future; but like previous programs, it will promise substantial rewards--again, in the tens of billions over the coming years.

For those of us who dream of a future in which man journeys first to the planets and then to the stars, the Shuttle seems but a stepping stone. With such a transportation system, we can--if we should choose--build permanent space stations and launch planetary vehicles and eventually starships from an orbit far above the Earth.

But in terms of immediate applications to life here on Earth, the Shuttle will be unmatched in its capabilities. With it we may launch a variety of scientific devices to study Earth phenomena. We may carry teams of international specialists, too--a program made possible not by our tax dollars alone, but by the cooperation of Europeans who will build a Spacelab module to fly in the Shuttle's multi-purpose hold. Through the European Space Agency, hundreds of millions of dollars will be spent in a program that unites many nations for the benefit of all.

Who can say what rewards our investment this year will bring to the Earth? As our resolve reawakens, we can commit ourselves again to the extensive research and development programs necessary for the advancement of all mankind.

Perhaps the Space Shuttle will carry tons of equipment into orbit to collect solar energy to supply our Earth in the coming decades--the decision

to invest or to refrain from investing in such a program is a decision that must be made by all Americans. Such decisions will determine the course of our future, not merely our success as a nation, but perhaps our ultimate survival as a species.

Our record, looking back over several generations, is a proud one. We have, indeed, sacrificed a portion of our resources so that man might live better in the years to come. We continue that tradition, established through the centuries and honored today in these ceremonies, to the best of our abilities.

In science, in engineering, in space research and exploration, we have made our ^{small}~~tiny~~ mark on tomorrow. In our sacrifices and through our wise investments, we have worked to set man's course to peace, to prosperity, and if life prevails, to the stars.

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