ENGINEERING AND SCIENCE
February 1960, Volume XXIII, No. 5

The Importance of Space

What are the *real* goals of space exploration?

by L. A. DuBridge

The Space Age is well over two years old now. But, like a two-year-old baby, it hasn't really begun to make much sense as yet. Fond relatives exclaim that it is the greatest baby ever born. But sharp critics argue that it is not worth so much attention — and that scientists would do well to stay home from their space ventures and try to cure cancer and other diseases. Still other people, noting that the American space baby is neither as old nor as hefty as the Russian infant, are impatient that in spite of all the vitamins and minerals we are feeding the child it persists in remaining both smaller and younger than the Russian prodigy.

It is undeniably true that the Russians have exploited their infant prodigy to the fullest. They are such proud and boastful parents that they have succeeded in giving all the rest of the world a severe inferiority complex. And there appear to be those who believe — or who fear that everyone else believes — that the remarkable vigor of the Russian space baby proves that its parents are the greatest people in the world and have now surpassed all the rest of the world in all matters scientific, military, technological, educational, and possibly even political.

In short — what a lot of commotion the arrival of the Space Age has caused!

Now there is good reason for excitement, of course. Since the beginning of history, man has dreamed of flying to the stars — always fearing, however, that the dream was an impossible one. Actually, flying to the *stars* still is impossible for us; but journeying to the moon and the planets is not. Indeed, manmade packages have already flown to the moon and beyond. Venus and Mars are perfectly feasible targets for "near-miss" trajectories in the near future. It is now a fact that men have learned to launch sizable vehicles with sufficient speed and accuracy to attain satellite orbits around the earth, and even to escape the earth's gravitational field altogether. This is surely one of the greatest human accomplishments of all time.

It is such a magnificent human achievement that it is distressing to see how so many small-minded men have flown into a jealous rage over the fact that the Russians accomplished the feat a few weeks before the Americans did. After 100,000 years or so of human history, why was that last 16 weeks so important? Future historians, I am sure, will have a hard time explaining why that 16 weeks had such an extraordinary effect on world politics.

One reason that the Russian successes have been so exasperating to Americans is that we know we could have been first if we had wanted to. The scientific knowledge and the technical know-how in the United States and Russia were essentially equivalent. No great new secrets of nature were discovered or great new inventions made by the Russians. Their earlier successes were the result of a technological accident combined with a political decision.

The technological accident was that the United States Atomic Energy Commission was able to develop an extremely powerful thermonuclear warhead of rather small weight. To carry this warhead to any conceivable enemy target requires a rocket whose thrust is about 150,000-200,000 pounds. So, such a rocket was developed — now known as the Atlas. And, in fact, to be sure of success, a second development of a somewhat different model, but with similar performance, was undertaken — the Titan. These rockets, plus the associated guidance and launching equipment, are now becoming operational — and have had spectacular success in meeting the military requirements originally set forth.

Now, the "accident" came about through the fact that the Russians apparently did *not* achieve a lightweight thermonuclear warhead, and hence decided that their missile must have a thrust of 300,000 pounds or more. So they developed such a rocket – in great secrecy, of course.

Hence, in 1957, Russia emerged with the first 350,000-pound rocket and we produced the first Atlas, with one-half that thrust. Each nation achieved what it set out to achieve: an operational intercontinental ballistic missile adequate for its needs.

But now came the political decision. The scientists of both nations considered it desirable to launch earth satellites in conjunction with the International Geophysical Year program. The United States decided that, since IGY was a peaceful international effort, it would not use military equipment in the program, but would develop a smaller rocket for the space-launching task. It was called Project Vanguard, and full information about it was released to the public.

The Russians released *no* public information but *in secret* decided to use their large military rocket as a booster for a space vehicle. They apparently put an enormous effort on this project in order to beat the well-advertised Vanguard dates. They succeeded dramatically, of course, and thus exhibited the advantages of very-large-thrust rockets for space expeditions. At that time we did not have any firm military requirement for a rocket larger than the Atlas (nor do we today for ICBM weapons). Hence, no large rockets were even on the drawing board. Hence, we still have none, and won't have for a year or two.

So it came to pass that a technical accident and a secret political decision combined to produce an enormous psychological victory – and brought the entire world to begin to think about the importance of space – and shocked the entire world into an awareness that Russia was no longer a nation populated solely by illiterate peasants. It should not have taken Sputnik to teach us this; there was plenty of other evidence.

Obviously, a substantial part of the initial shock came about because of the possible military implications of the Russian Sputnik. Because the U.S.S.R. launched a bigger space vehicle earlier than we could, it was immediately concluded that military supremacy had now passed to the Communists – and the term "missile gap" or "missile lag" entered the English language.

We have already seen that our Atlas or Titan missiles will carry our best thermonuclear warhead to any possible target – and these missiles are now becoming operational. A missile of twice the thrust would not do that job any better. We don't have to carry larger loads any farther to achieve any foreseeable military mission. Clearly, the fact that the Russians are using a larger rocket to achieve their purposes is of no military consequence to us whatsoever. No military superiority resides in a thrust larger than necessary for our purposes. If "missile lag" means *they* have larger-thrust missiles than *we need,* then the missile lag is not of consequence at all, and we should quit worrying about it and quit using the term!

Does missile lag mean they have more intercontinental missiles than we do? That, of course, would be more serious. However, we must all be confused by the conflicting information being released on how many missiles they have or will have in the near future. And no analysis has been released to the public on whether they would need three times as many weapons to knock *us* out as we would need to knock *them* out. So we don't know – at least, I don't know – whether there is really any numbers lag or not. Let me add, however, that, since we don't know, we would do well to put forth all efforts to increase our number of operational Atlas and Titan and Thor and Polaris and other military missiles as rapidly as possible, until our needs have been met.

Furthermore, until then, we should divert as few as possible of these priceless military weapons to nonmilitary space ventures. I prefer the solid comfort of a good military weapon in our arsenal to the passing psychological satisfaction of launching a bigger vehicle to carry cosmic-ray counters into space. As a scientist, I can assure you that I am *very much* interested in carrying cosmic-ray and many other scientific instruments into space as soon as possible. But scientific experiments can wait if military security is at stake. We should abandon the illusion that launching big space vehicles automatically assures military supremacy.

However, even if we can be skeptical about the existence of a missile lag, we cannot deny the existence of a "space lag." Even if huge booster rockets do not necessarily make any more effective ICBM's, they do undeniably enable one to launch larger space vehicles and to send them farther into space. In this the Russians have acquired a substantial lead which we envy.

We might envy the Soviets their space lead for three reasons: (1) military; (2) scientific; or (3) psychological (or political or prestige). Let us deal with each in turn.

I. MILITARY VALUE

Does it give the Soviet Union a military advantage (at present or in the foreseeable future) to be able to launch larger space vehicles than we can, or launch them farther into space?

There are going to be strenuous arguments on that question for years to come, for no one actually knows whether – or to what extent – there will be important military uses of space vehicles.

The values to military forces of communication networks employing satellites are obvious – and should

be vigorously developed. The attractiveness of using space satellites for military reconnaissance is also obvious, provided practical methods for achieving this difficult task can be developed. This, too, should be vigorously pursued. But improved communication and reconnaissance, of themselves, do not give overwhelming military advantage to either side. We are not going to surrender suddenly to the Russians because they can talk to each other better than we can – or even because they can see us better than we can see them. They can do that now!

The question is: What new weapon systems does space provide, or what new methods of using present weapons does it promise?

It is on these questions that our ignorance is so great that only speculations can be made. But speculations are being made very vigorously!

For example, does a space vehicle promise to be vastly superior to an ICBM when it comes to placing weapons accurately and surely on distant targets?

My own opinion is that at present no techniques are known by which this superiority can be attained. An ICBM can be made so accurate, so reliable, and (when suitable launching sites are available) so relatively impregnable that space vehicles have a very long way to go to equal them, much less surpass them. Space satellites in orbit are not especially invulnerable; there are a number of methods of observing and destroying them. While they are in orbit, they are extremely difficult to control – i.e., to change orbit. They tend to stay in the same orbit forever, and one must wait patiently for the earth to turn underneath them for a given target to come into position. Finally, the ejection of a weapon from a space satellite with the proper speed and direction and timing to hit a given target accurately is an enormously difficult task for which no present technology is anywhere near adequate or satisfactory. New and better technologies may someday come, and a development effort is certainly necessary. But we need not get hysterical about space-satellite weapons yet.

What about those who say it is of great importance for us to capture the moon as a military base? Here is the ultimate in the "high ground" the military man always seeks!

A long and very learned-looking article in *The Air University Quarterly Review* last summer set forth the arguments why the moon should be "sovereign U.S. territory" – our 51st state presumably. If it was our territory, we could tell the Russians to stay away, and it would then be a "tremendously hard" missile base. No one can quarrel with that. All we have to do is figure out a way to keep the Russians off, or, even more important, keep them from getting there first!

But even if the moon is shared with other nations, the article says, our missile bases would still be hard to see (from the earth, that is) and hard to destroy with nuclear weapons, especially if the bases were underground. Again, no one can deny that. But bases in Iowa or Texas or Maine or Alaska would be hard to see and destroy, too – if they were underground. And these places are much closer to Moscow than the moon is. Viewed from the moon, Moscow is on a spinning ball, about 240,000 miles away and moving (relative to the moon, or the moon relative to it) at about 2,000 miles per hour. There is nothing scientifically impossible about developing guidance and computing equipment able to do the job. But I'll predict we can hit Moscow more often and more cheaply from Iowa – for the rest of *this* century, at least.

The clinching argument for a missile base on the moon appears to be that the acceleration of gravity is only 1/6 as great there as on the earth, and hence the velocity of escape is only 1.5 miles per second instead of 7 miles per second. Splendid! But just how does the missile get to the moon in the first place? And what about the crew, the equipment, the fuel, the food, water, oxygen, the bulldozers that will operate in a vacuum, etc., etc. They have to be lifted from the earth – and then landed very gently on the moon before the missile can be shot off. It will take many times as much fuel to get to Moscow via the moon as to go directly.

Finally, the article suggests that, in order to obtain good observation of the earth, so we can see what the Soviets are doing and can guide our missiles to the target, we should erect a 200-inch telescope on the moon! I hope I can return from the grave the day that the Palomar telescope of the moon is dedicated. It will be a great day for the science of astronomy. But the task of putting a 200-inch mirror on a rocket and delivering it safely to the moon strikes me as being one which presents certain difficulties. I breathed a sigh of relief the day our 200-inch mirror safely completed the 130-mile journey from Pasadena to Palomar Mountain.

I have great confidence in the skill of American engineers, you understand. I just think some of these things may take a little time. Say 100 or 200 years.

Please forgive me if I express certain doubts as to whether lethal military operations in – or from – space are an immediate probability. But again I emphasize that further research and development is justified. New ideas and new inventions may change the picture. I just don't like to bet billions of dollars on discoveries not yet made.

If military security is not obviously or immediately the most essential reason for conducting space exploration and development, what then about the scientific values?

II. SCIENTIFIC VALUE

Here is where I would like to give a complete lecture on the scientific value of space research. To explore the earth, the moon, Venus, Mars, and the great mysteries of interplanetary space presents problems

which will challenge men's ingenuity and add to their knowledge for generations, for centuries, to come. If setting up a missile base on the moon appears to be a bit chimerical for the present, it is by no means farfetched to plan soon on sending scientific instruments there in order to make many, many measurements and observations. Instrumented flights to Venus and Mars are also in sight. Someday, too, we will wish to make measurements beyond the capacity of automatic instruments, and then we may want to send trained scientists and engineers along to supplement the instruments and make them much more effective.

I, for one, believe it is worth a billion dollars a year to develop these scientific projects. A great opportunity for the extension of man's knowledge has come to our generation. I hope we can exploit it fully.

Neverthless, when the congressman or the average citizen asks about space projects and about the Russians being "ahead of us," he does not ask whether the U.S.S.R. has obtained more scientific information in space than the U.S. The answer would be "no." The U.S. is ahead in the scientific field. But the citizen knows that the heaviest Soviet space vehicle weighed 3,245 pounds, and the heaviest U.S. vehicle only 1700 pounds. Q.E.D. – the Russians are ahead of us. No one asks what was *in* the Russian vehicle, or whether the U.S. vehicle might have obtained more or better information. Actually, the Soviets have done some fine experiments, but the U.S. has achieved more knowledge. That doesn't count, apparently. The Soviet payload *weighed* twice as much as ours.

III. PSYCHOLOGICAL VALUE

Clearly, then, the "space race" or the "space lag" is based not on military or scientific values, but only on poundage. "The bigger, the better," is a good old American adage – and that is the one we are applying today. Pound for pound, shot for shot, we must catch up with and surpass the Russians. Our good old competitive spirit has been aroused. We must have the biggest cars, the tallest buildings, the largest cities, the fastest runners, the highest jumpers, and the biggest rockets.

Well, I agree! I think we should too; especially rockets – for the whole world is interested in space, and I hate to see us out-classed. But let's be honest about it. It is just a game – a big and serious game, no doubt, but a contest for psychological prestige. I am not going to get hysterical if it takes us a couple of years to get the bigger rockets and bigger space vehicles. We all want to improve the U.S. psychological and political stature in the world. It is probably worth one or two billion dollars a year to achieve this – especially if the rockets are designed to perform valuable scientific explorations too. What is called for is clearly an energetic, well-planned, intensive effort aimed at clearly worthwhile goals and not just stunts.

IV. THE FUTURE

If we do this, what goals can we expect to achieve in the next 50 years – by the year 2010?

First, we shall see many sizable satellites circling the earth taking weather and other observations; serving as communication relays; collecting data on solar radiation, cosmic rays, magnetic storms, and many other phenomena still not yet discovered. I hope, too, that an astronomical telescope in an earth satellite will have come into being. This is not an easy project, but astronomy would move ahead by leaps and bounds once observations could be made above the atmosphere.

Instrumented and manned landings on the moon will have been made by 2010 A.D., and much data on lunar conditions and structure will have been accumulated. I cannot predict what will be discovered (if I could, we would not have to go!) but my guess is that the moon's surface will be found far too unfriendly for continuous human habitation, and any notion of an earth colony on the moon will still – in 2010 A.D. – seem to lie far in the future. The lack of water and oxygen will be the two critical deficiencies, I suspect. Hauling drinking water up from the earth would be a bit expensive. And, though some say that water will be found in the moon's rocks, we have no information on this question.

But even if lunar conditions do not make a self-sustaining moon colony a feasible enterprise, there will be many scientific expeditions achieved, and much information will be gathered.

In a recent TV panel discussion, a well-known English economist predicted that someday the world's excess population would be shipped out into space to live. *To live!* Since, in a few years, excess population will be piling up at the rate of 30,000,000 per year (100,000 per day) it appears that we had better start preparing for quite a passenger business into space. If we could start colonizing the moon, it would take only 20 years (at 30,000,000 per year, plus their *own* babies) before the moon would be as densely populated as the earth. Then Mars? Well, Mars could bear the traffic for 50 years or so. It has only one-quarter the area of the earth, but it is all land. Shall we then go to Venus? Maybe, but then we are through!

Possibly other stars have planets, but the nearest of them would take a thousand years or more to get to, in order to find out. And how do we know that the 20th generation born on that flight will remember to come back and tell us about it? I suggest we try to solve our population problems on earth, and not depend on space.

But the exploration of space offers so many important opportunities and possibilities that it will pay us to pursue an energetic program of space research. It will take some time, at best. It will take quite a lot of money. But the dividends – even the financial dividends – may eventually be very great.