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Science, Technology, and Education

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Science, technology, and education are at once the three great achievements, the three great problems, and the three great opportunities of modern civilization.

They are really not three independent entities, of course; technology grows out of science, and both are unthinkable without education.

One can, however, push the interdependence of these three problem children too far. For example, one of the greatest popular fallacies ever perpetrated by the American people on themselves is the one that the Russians got ahead of us in space because they had smarter, or more, or better educated scientists and engineers than we had. "Therefore," it is said, "their educational system must be better than ours; hence they'll soon surpass us in all fields and we will soon become a second-rate power."

Here, indeed, is a lovely mixture of "sequiturs" and "non sequiturs." It is true that, if our educational system were markedly inferior to theirs, we would be in serious trouble. We would become a second-class power. But it is also true that the Russians' big rockets were not made in the Russian schools – nor does their bigness prove the corresponding smartness of their engineers.

In fact, we know now that for military purposes the smart engineer will design the smallest and simplest rocket – not the biggest – for a given military purpose. Our Minute Man rocket is better than the Atlas precisely because it does the same military mission with smaller weight, smaller thrust, and less cost. *Its* designers are the *smartest* rocket engineers on earth. But have you ever heard anybody stand up and *say* so? No – because we can't yet separate the biggest from the best. We think, somehow, they must be identical.

What really happened in the rocket field was that the American scientists and engineers, considering the problem of delivering a thermonuclear bomb of the size available at the time, concluded that a 300,000- to 400,000-pound-thrust rocket could do the job. So they designed, developed, and built such a rocket. If they had been smarter, would they have built a bigger one? Not at all. If they had been really smart, they would have multistaged it more efficiently, and thus made the first stage smaller.

And the Russians?

They, apparently, were considering a different military problem: either they had a large warhead, wanted to send it farther, or else had some other problem posed to them. They apparently decided they needed a bigger rocket – say 800,000 pounds. So that's what they built. They were smart, too, of course. But they were also lucky. For then along came the space problem – a problem not really considered very important in the United States ten years ago – and the big Russian boosters were a natural for that job.

Were we dumb *not* to start space work back in 1953, say? I don't know. Looking back, it would have been nice if someone had convinced Congress that going into space was important and worth spending a billion dollars or so on a larger rocket to make it possible. If the decision had then been made, the rocket could certainly have been built – as the Russians proved. But the lack of such a decision was *not* attributable to a shortage of scientists and engineers. If anything, it was a shortage of psychologists, or propaganda experts.

More specifically, it was the shortage of a few men who had vision, knowledge, persistence, and persuasiveness to sell to the President, the Congress, and the American people a concept which, in 1953, would have sounded utterly insane – sending a five-ton capsule into space.

Somebody sold that idea to someone in Russia – or else the Russian engineers weren't smart enough to develop a *light* hydrogen bomb, so they had to solve the

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military problem by brute strength and awkwardness. I suspect that is what they did, and that the space venture came as an extra dividend – an unearned run, as they say in baseball.

At the same time, one must concede that the Russians capitalized on this unearned run in a big way, and poured an enormous and well-directed effort into making it pay huge dividends to the glory of the Soviet State.

I say all this to emphasize the point that, to judge a whole educational system, the whole scientific and technical strength of a nation, and even the whole worth of a political system, on the basis of one technical achievement – like a big rocket – is to grossly misunderstand the essential interrelations which exist between education, science, technology, and true national strength.

But what do we mean by true national strength?

I think there is only one sensible meaning to this term; namely, the strength and the ability to use our talents and resources to meet the national goals which we ourselves set.

If this be the definition, then it is obvious that different nations will have different goals and, hence, will give different meanings to the term "national strength." Hence, various nations will develop their talents and resources in different directions.

National goals

In the Soviet State, the national goals are clearly to enhance the power and prestige of the state itself in order to promote the spread of Communism throughout the world. The desires, needs, and aspirations of individual people are secondary to the needs of the state.

In the free world, the priority of goals is reversed. The aspirations of individual people come first; the enhancement of the power and prestige of the state is secondary.

This does not mean that a free people will willfully neglect the essential needs of the state. Quite the contrary. We believe deeply that free peoples can build a basically stronger society than those who live under a dictator. But the purpose of the state will be to protect freedom – not to destroy it; it will be not to impose domination of the state either over its own people or the peoples of other countries.

Now, understanding this contrast between the national goals of a free nation and of a dictatorship is essential to the formulation of our national policies relating to the development and use of our talents and our resources. If we allow ourselves to be led into a mad race to follow and to copy every achievement, every practice, and every policy of the Soviet Union, in the belief that this is the only way to match their strength, then we will, in the process, destroy our own national character; we shall abandon our own national goals; and we might as well organize a Communist state here and now and be done with it.

Obviously we are going to do no such thing. But we would do well to be alert to this danger, else we may drift too far down this road only to find that it is too late to retrace our steps.

All of this has a direct bearing on the subject of science, technology and education. For these three interrelated activities are essential features of our national strength – just as they are essential features of the strength of the Soviet Union. But because of the differences in goals of the two countries, the ways in which we develop our activities in these areas will be vastly different – or at least they should be.

We have heard much since the launching of Sputnik I about the excellence of the Russian educational system and the decadence of our own. But before we begin copying the Russian system we would do well to inquire about the purposes of the two systems.

Educational goals

As I see it, the purpose of the Soviet educational system is two-fold:

1. To indoctrinate its people in the glories of Communism and to shield them from insidious truths about the operation of other social and political systems.

2. To select young people of particular types of talents and to train them in areas which the state believes are essential to its goals and purposes.

I believe the Russians have developed a system which matches these purposes pretty well. Clearly, from time to time, they themselves find defects in the system and change it to meet new needs. But, clearly also, the system has produced those types of scientists, engineers, technicians, and political leaders which they desired. And it has produced men and women well trained in these specialties, and, apparently, has produced them in adequate numbers.

The goal of *our* educational system is quite different; namely, to offer to all our young people the opportunity to develop their own talents and abilities in such ways as will lead them into the types of careers and the kinds of lives which they believe will be most fruitful, most satisfying, and most useful. Thus, we offer not only opportunities to those whose talents lie in scientific and technical fields, but also to those who wish to become bankers, lawyers, political and social scientists, businessmen, housewives – or just good citizens.

How well does our educational system match these goals and these objectives?

No one would maintain that the match is perfect, that our system is ideal and could not be improved. On the contrary, we have far to go to build a system adequate to our needs and our ideals. But the important thing is that, as we change things, we do not abandon our goals but seek only better ways to achieve them.

Wherein have we failed?

We hear much about how we have sacrificed intellectual quality in our pursuit of the goal of developing the "whole child." We did, in fact, up until a few years ago, swing pretty far in this direction. We tended in many cases to put extracurricular recreational and social activities ahead of the classroom, both in our thinking and in our school expenditures – and even in the training of our teachers. Often, too much classroom time was devoted to frills and trivia that were only remotely related to sound intellectual development. Many educationists insisted that methodology was far more important than substance – and many teachers were graduated from college, loaded with methods courses, and with only the slightest understanding of the subjects they expected to teach.

We are now reversing this trend – too slowly perhaps – but we have started. We now realize that while every child, every school, every locality, every school level offers different problems, the goal of intellectual opportunity should be the same for all; that all peripheral activities should lead us closer to and not further from that goal.

We have also tended, in past years, both in our schools and in college, to neglect the highly gifted student. Our nation sorely needs the trained talents of such students. But, even here, we must always keep in mind that our basic purpose is not to train talented men to serve the state – but to give the individual student the opportunity to reach the highest levels to which his own talents and ambition can take him. It is the tenet of a free sociey that when that is done to the maximum extent the nation, too, will be stronger and will prosper.

Science and technology in a free society

This theme of individual opportunity carries over into the realms of science and technology. Shall we educate scientists and engineers primarily to make bigger rockets to enhance the prestige of the nation? Or shall we educate them in order that they may seek and apply new knowledge in any field they select? If we are truly devoted to the ideals of a free society, the answer is self-evident.

We must also ask how, in a free society, we shall set up and organize our scientific enterprises. Shall we do as the Russians have very recently done, and place all science under the rigid control of a powerful agency of the state – an agency which will allocate all funds, determine what scientific projects shall and shall not be pursued, and at what level, and with how many people?

Or shall we continue the policy which has always been followed in America of saying that scientific discovery is the product of the free unfettered minds of individual people, that it shall be the policy of the citizens and their government to encourage the investment of private funds, state funds, corporate funds, and even government funds, in such a way as to provide the best scientists of the nation the opportunities to pursue their investigations into the unknown in whatever directions they believe are most fruitful?

If our goal is to provide the biggest rockets to impress the Hottentots with the glories of our political system, then we should pursue the Soviet plan. But if we believe in free inquiry, and if we believe that the advancement of knowledge on a broad front will, in the long run, do the most to advance the welfare of people everywhere, then we should continue our present policy.

Science in Russia

The Russians have admittedly assigned their best scientists and engineers to work on rocket and space technology. Their achievements in this field have been brilliant. But they have paid a heavy price in the neglecting of research in many key areas of basic science. Not all basic research has been stopped, of course, but the scale, breadth, and depth of their scientific work is grossly inferior to ours – or to that of the British. Count the awards of Nobel prizes in physics, chemistry, and medicine: 61 American scientists have received Nobel awards, and only five Russians.

Witness also the fanfare with which the Russians hurriedly built a 10-billion-electron-volt nuclear accelerator, at very great cost, in order to advertise, for a time, that they had the most powerful nuclear machine in the world. The machine was indeed built – but it has never worked properly and is now almost inactive.

Both the United States and CERN (the cooperative European laboratory in Switzerland, now directed by an American physicist) have in successful operation far more powerful and productive machines. The Russians have not advertised this situation in their international propaganda and, unfortunately, neither have we. We did not build our machine just to beat the Russians; we did it because we believe in the advance of scientific knowledge.

I contend that we should *believe* in freedom and should be proud of the achievements of a free society; that we are justified in using and promoting that freedom because, in the long run (and in the short run too), a free society will contribute most to human welfare throughout the world.

Similar observations apply in discussing the organization and promotion of technology – of applied science. In technology, however, the problem is a little different. Science, as I have said, proceeds most effectively through the method of free inquiry – through projects evolved, pursued, and stimulated by men with ideas. Technology proceeds this way also – in part.

For example, inventive groups throughout the coun-

try have developed a myriad of new consumer products, so we have more television sets and refrigerators and automobiles and new food products – and more Metrecal – than all the rest of the world put together. But we have better industrial processes, more advanced communication techniques, and better public health and medical care than the rest of the world, too. These are the products of free technology.

But there are other areas in which technology must be mobilized, directed, and supported by the government – military weapons, space technology, nuclear energy, certain areas of public health, for example. Here again we have not done too badly. I don't believe for a minute that we are behind the Russians in over-all military strength – or even in the specific field of missiles. (As I said before, the biggest rocket booster does not necessarily mean the best military weapon.) Only in space technology have we lagged, for reasons I have already given.

And here I come to one serious defect and criticism of our democratic society – the decision-making process in our government is slow, inefficient, and lacking in courage and imagination. We did not foresee the huge prestige value of space exploration – and, once we did realize it, we were slow in making decisions as to which of many competing lines of endeavor we should pursue and which to abandon.

In both military and space development we have tended to put a small effort on many things, instead of concentrating large efforts on a few essential things. We have trouble in setting priorities among our various national objectives, and, once having set them, we lag in making the essential technical, fiscal, and political decisions to implement our program vigorously. This may all result in making more varied advances on a broad front – but we forego the opportunity of making quick breakthroughs in certain critical areas.

Three choices

What do we do about this? We have three choices: (1) we may say that things are good enough as they are and do nothing; (2) we can abandon our democratic process and put decision-making in the hands of a dictator or a small group of commissars; or (3) we may retain our democratic government, but improve its decision-making processes.

Obviously we shall try to do the latter. But it is not going to be easy. And, since I am not a political scientist, I am not competent to invent a solution. Nevertheless, it is a problem to which I hope the government will devote a serious, extensive, intelligent, and sustained effort in coming years.

We have some terribly important decisions impending just now; not only decisions in politics, international affairs, and national defense. We also face decisions in science, technology, and education.

In education, for example, we as a nation face a major task: how shall we, as rapidly as possible and on an extensive scale, improve the intellectual excellence in our educational system? First, we must recognize that intellectual excellence is our goal – that (according to the National Education Association) – the "central purpose of education, at all levels, is to develop the rational powers of men." There are many things to do to instill this ideal and to achieve it. Can we, at both local and national levels, bring ourselves to make the necessary decisions to give intellectual excellence the primary place in our school programs? We could devote untold billions of dollars a year into doing more of the same things we are now doing. We could also, for a much lower sum, improve the quality of what we do – improve curricular materials and learning aids; challenge students at all levels to really use their full capacities; make the education of teachers a more substantive, more meaningful, and more challenging process.

Problems and decisions in science

In science, too, we face problems and decisions. Shall we see to it that free inquiry by free minds continues to be fostered in all fields, and that such inquiry shall command all the financial support it needs – for its own sake? Or shall we let free scientific research be solely the by-product of the difficulties we encounter in the technological fields of industrial production, space technology, or national defense?

But it is in technology that the decision-making machinery of our Federal Government faces its sharpest challenge. Where do the real technical problems lie in the field of national defense? Do we have the courage to concentrate on them and stop the diffusion of our efforts in pursuing a host of marginal or obsolete areas – or by pursuing exotic notions which have the aura of glamor, but little substance of military effectiveness?

In our space program, shall we concentrate effort on pursuing space explorations which have a sound technical base and a useful scientific goal, or shall we let our space program be confined to trying to lift bigger packages into space than the Russians do? Are we interested in space gymnastics or space science? I don't mean that space science won't require big things too. But we must make some decisions on what our goals should be.

These are all problems which may seem remote to the graduating classes of 1961. But many of you will be immersed in these and similar questions very soon; all of you, as citizens, will be immersed in them eventually. They are not problems that are either superficial or temporary; they go to the heart of the problem of the future of a democratic society. How we handle them will be your business for many more years than it will be mine. They are problems that are interesting, exciting, challenging – and terribly, terribly important.