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RUSSIAN SCIENCE AND TECHNOLOGY

Mr Hans Heymann, Jr.

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RUSSIAN SCIENCE AND TECHNOLOGY

4 December 1959

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COLONEL FORBES: General Mundy, Ladies and Gentlemen: Our subject this morning is Russian Science and Technology. We all realize that the road to progress in this field of the Communist Bloc and of the free world will have a profound effect on political and economic orientations of the peoples and nations of the entire world. Of course we also recognize the direct threat to our own military security from Russian progress and technology.

Unfortunately, we have been deluged with a number of opinions on the subject by people with no real background and with no real data on which to base their opinions, so that we have received in the past a rather uncertain picture of just what is going on in this field.

We are really fortunate this morning in having a speaker who is in the serious day-to-day business of evaluating Russian accomplishments across the board. You have his biography, of course. I merely mention that in addition to his own well qualified background in international economics he has available to him, as a member of the Rand Corporation, all of the facilities and all the data which the Rand Corporation and the Government can make available to him. Therefore, his evaluation is a serious analysis based on the best information.

It is a pleasure to introduce for his first appearance on this platform Mr. Hans Heymann, Jr., Senior Staff Member of the Rand Corporation. Mr. Heymann.

MR. HEYMANN: Thank you, Colonel Forbes. General Mundy, Ladies and Gentlemen: I always face the problem in confronting a worthy audience of this sort of living up to my requirement, which is to begin with some sort of humorous anecdote. My difficulty is that I can never find one that is perfectly appropriate to the occasion. So I have adopted a new rule. From now on I will tell nothing but stories that have absolutely nothing to do with the subject that we are about to discuss. So let me try this one on you.

A camel is poised on the banks of the Nile preparing to swim across the river. A little poisonous scorpion crawls up to the camel and says, "Dear camel, I cannot swim. Please give me a ride across." The camel says, "I know your tricks. When we get out into the middle of the river you will sting me and I'll drown." So the scorpion says, "How foolish can you be, dear camel? If I sting you, we both drown." Well, the camel thinks about this for a moment, and he recognizes the logic of the argument, and so he says, "All right. Hop aboard." They get out into the middle of the river and, sure enough, the scorpion lashes out and stings the camel. The camel feels giddy and sick and begins to drown. With his dying breath, the camel says, "Poor scorpion. Why did you do that? Now we must both drown and die." So the scorpion

says to the camel, "Poor camel. Don't you realize this is the Middle East?"

Now that you are thoroughly convinced that this story has nothing to do with Soviet science, let me admit to you that it really does, in a sense. The completely quixotic, irrational, and contradictory character of the Middle East represents the precise antithesis to the society that we are going to be talking about today. There is something quite consistent, quite orderly, quite deliberate, and perhaps even predictable about Soviet behavior and Soviet development. And I want to emphasize this fact, that it is possible for us to make a stab at understanding rationally the nature of Soviet development and the rapid rate of Soviet progress in science and technology. We are not really confronted with a mystery or a contradiction. This thesis has been played too hard and too long. We are confronted with a society whose character and aims can be logically studied and comprehended.

With this preamble, let me pose the question: What can we say about the Soviet scientific effort? Perhaps the easiest way for me to begin is to describe for you briefly two extreme views that we have held at different times in the United States and to try to persuade you that neither of these views is reasonable or proper.

The first of these extreme views is our pre-Sputnik conception of Soviet science as a hopelessly laggard and chronically underdeveloped pigmy. It was a conception nicely compounded of equal parts of

incredulity, complacency, and arrogance. Since we were ignorant of the dynamic elements in Soviet society and unbelieving of the facts of Soviet technological progress that were staring us in the face, we stubbornly clung to the traditional stereotype of "Russian peasant backwardness" and we gloried in the dangerous misconception of an innate Western scientific superiority. Science, we kept telling ourselves, could flourish only in a free society. Totalitarianism and scientific research were fundamentally incompatible; the Lysenko affair that you remember in Soviet biology and the political persecution of the Soviet biological scientists signified the strangling of science in the USSR, and, as far as we were concerned, the supremacy of the West was forever assured.

This first extreme view of Soviet science, this comfortable illusion, was rudely shattered on October 4, 1957, when Sputnik I went into orbit. The succession of Sputniks II and III, Mechta, and the Lunik impact and circumnavigation shots that followed, jarred us out of our complacency and plunged us into an equally deplorable orgy of self-criticism and breast-beating. In characteristic fashion, we took the sudden wide pendulum swing from the extreme of blind arrogance to the opposite extreme of abject humility. Overnight we had become a third-rate scientific power, and Soviet scientists were elevated to the race of supermen, spurred on to unimaginable feats of accomplishment by the generous material and honorific rewards bestowed upon them by their

regime; their huge new synchrotrons, phasatrons, polar expeditions, and rocket flights, and, above all, their single-minded central planning, control, and coordination of all scientific activity obviously assured the ultimate triumph of the USSR in the technological race. The only question that remained was: "How long can our free science hope to survive when it must compete against such effective totalitarian regimentation?" And the easy, popular answers were quickly given: In order to survive, we must build bigger and better bevatrons, launch heavier satellites, reward our scientists with bigger paychecks and prettier ribbons and, above all, impose stricter planning and control from the center. In other words, it would seem that this second extreme view of Soviet science leads us to the illogical conclusion that, in order to fight our enemy, we must forget our own values, adopt his weapons, and lose our identity.

Now I believe that I have carried my two caricatures far enough, perhaps too far, and you may justly accuse me of setting up straw men in order to knock them down. But my real purpose is simply to suggest to you that neither a complacent nor an hysterical view of Soviet accomplishments is likely to produce a sensible U. S. response to the dangerous and complex challenge that confronts us. What is needed, above all, is a sober, balanced, and respectful appraisal of Soviet science, and to achieve this it seems to me most important that we begin by clearing away some particularly sticky cobwebs that have been impairing our

ability to see and to understand.

To be specific, I have in mind our own fuzziness in speaking of "the technological race." What do we mean by the technological race? It's clear enough what Khrushchev means by it. To him it is obviously just like a horse race, in which the American nag, tired and overweight, is still out in front, thanks to its earlier start, but the sturdy and spirited Soviet steed is rapidly closing the gap and is just about to forge ahead to snatch the prize, which is no less than history itself. If Khrushchev had his way, he would turn the entire international arena into a gigantic race track with himself acting as both jockey and judge. Unfortunaaely, he is just about having his way, for we seem to be all too willing to accept his criteria, his ground rules for the contest. It's important, I think, to stop a minute and ask ourselves what are the objectives in the technological race as Khrushchev would define them, and are we, in fact, running on the same track?

As I see it, the enormous scientific and technological effort that the Soviet leaders have mounted and sustained at an ever growing pace is designed by them quite consciously and explicitly to serve three Soviet objectives: (1) rapid economic growth, (2) an imposing military posture, and (3) what I call for want of a better name relentless political aggrandizement. Let's take a quick look at each of these in turn and see how the Soviet scientific effort is tied in to these objectives.

First, rapid economic growth. As you know, the pursuit of national

economic power has been a fundamental aim of the Soviet regime ever since the beginning of the five-year-plan periods more than 30 years ago. The consistent objective has been to create, as rapidly as possible, the industrial base of military power, and this objective has been pursued single-mindedly and with a dogged determination seldom matched in history. By dint of a forced high rate of capital accumulation and a large influx of labor from the countryside into the cities, the Soviet regime has achieved formidably rapid rates of industrial growth, far exceeding those normally attained in the West. Under the latest Seven Year Plan, which began this year, the long-term Soviet economic growth objective is being pursued with even greater intensity than ever before. Employing the typical Soviet horse-race symbolism, the slogan is "to catch up with and outstrip the United States in per capita production by 1970," and, while this propagandistic objective should not be taken too literally, it deserves certainly to be taken seriously.

The important thing for our discussion today, however, is the key role that technology is to play in this gigantic economic effort. For the fact of the matter is that the time-tested mechanism by which the Soviet leaders have in the past achieved their rapid economic gains, namely large injections of new capital and a steady flow of new labor, this mechanism, is not now functioning as well as it once did. Because of the growing Soviet economic maturity, its capital investments are beginning to yield what economists call diminishing returns, and, because

of the population deficit caused by World War II, the economy is currently pinched by an inadequate labor supply. This means that future economic growth must now depend to a much greater extent on improvements in the productivity of labor and capital--that is the output per unit of labor and capital--and this means that all eyes in the Soviet Union are focused on technological innovation, mechanization, automation. Some of you may have had an opportunity to visit the recent Soviet exhibition at the Coliseum in New York, the exhibition of science and technology. If you did have an opportunity to visit it, I am sure you were as surprised as I was to find on display a bewildering array of very advanced automatic control equipment and sophisticated aids to industrial productivity. For the most part these are still experimental models, to be sure, but they testify to the broad-based industrial R&D effort that is now being conducted with the utmost urgency in the USSR, aimed at harnessing the nation's scientific talents to the problems of production.

The second Soviet objective that I mentioned is the creation of an imposing military posture. This need not necessarily mean that the Russians must acquire an absolute and decisive superiority in the quality and quantity of their weapons and forces. But it does mean, at the very minimum, a well designed policy of selective demonstration of key military capabilities that will sufficiently impress and intimidate any potential rival. This policy of selective demonstration is of tremendous importance in Soviet national strategy. The Soviet leaders can pursue such a policy

only because of their ability to maintain an almost impenetrable blanket of secrecy and concealment over much of their defense decisions, an achievement which is probably unparalleled in the annals of military history. It creates a fundamental imbalance in the military requirements of the U. S. versus those of the USSR, imposing on us a much heavier burden of munitions production, and enabling them to devote a larger share of their resources to the arena of research and development, to which much of the contest for military superiority has now shifted.

I am merely stating what I am sure is already well known to you, namely, that the largest share and, in terms of quality, no doubt the most precious share of the Soviet scientific effort is devoted to national defense. Just how large this share may be cannot be accurately determined, but some recent evidence suggests the likelihood that at least two-thirds, and perhaps as much as three-quarters, of the generous current budgetary allocations to "science" are directly associated with their national security program.

Let me say just a few words about the third objective that science and technology must support in the USSR. For want of a better term I have called this political aggrandizement, and it has nothing to do with territorial expansion, aggression, or subversion. It is rather the determined effort by the Soviet leaders to improve the political appeal and the influence of their society throughout the world, the desire to utilize

of science so vigorously propounded by the USSR. In the West, we expect the pace of scientific development to result more or less fortuitously from the uncontrolled or loosely directed activities of private enterprise and universities responding to individual preferences or market forces. The Soviet Union, on the other hand, has made the forced growth of science and technology a dominant and direct objective of national policy, and its results have been little short of phenomenal.

The question we must ask ourselves now is: "How have these results been achieved, and do they hold any lessons for us?"

In trying to put the success of the Soviet scientific effort into perspective, several factors seem to me to be relevant:

First, the fact that the Soviet Union was doubly blessed with a scientific inheritance from the past and a technological legacy from abroad. The Soviet regime was fortunate, in 1917, to be able to build upon a very powerful scientific tradition, the rich inheritance of Russian intellectualism of the nineteenth century. Such scientific giants as Mendeleev in chemistry and Pavlov in physiology had won worldwide renown for Russian science long before the Soviet state came into existence. Similarly, in the field of technology, its rate of progress was greatly accelerated by the fact that Soviet technology was far behind. Having entered the industrial revolution much later than the Western world, it was able to take over bodily large chunks of modern technology from the more advanced industrialized West. The Soviet Union, quite

every device at their disposal, both at home and abroad, to enhance the ability of the Soviet image to inspire and persuade; in other words, to employ their resources so as to build up their national prestige and to back up their foreign policy.

How nicely science can be used to serve this objective is well known to the Soviet leaders. Their uncanny ability to squeeze out the last drop of political capital from a scientific achievement has been convincingly demonstrated time and again. It is particularly interesting to see how cunningly the Soviet leaders are applying science and technology in their foreign economic policy, particularly in their foreign aid program, where the aim is to evoke the right kind of image of the Soviet Union in less developed countries. In the developing countries of Asia and Africa, Soviet aid places great stress on modern scientific symbols. A nuclear research lab is set up in Cairo, a fully automatic telephone exchange in Damascus, a technological institute in Rangoon--these tokens of advanced technology are intended to convey an image of Soviet progressiveness in human discovery and inventiveness in the application of science to peaceful progress.

So much for the three objectives which, I believe, pretty accurately characterize Khrushchev's conception of what the technological race is all about. I have described these objectives in some detail here because I want to draw a sharp contrast between the easygoing national attitudes toward science that we embrace in the West, and the tough-minded philosophy

sensibly and efficiently, has elevated the practice of copying and adapting to a fine art. We sometimes tend to ridicule this Soviet practice. For example, we poke fun at the Soviet automobile industry for slavishly copying our Cadillac tailfins on their own automobiles; instead, we should congratulate them for having the good sense not to waste any of their own precious design resources on such trivia.

Second, and even more important, is the very special place accorded to science in Soviet ideology, the conscious reverence with which it is nationally cherished and felicitated. It has been said, with some justification, that "Soviet rule has bestowed upon science all the authority of which it has deprived religion." This quasi-religious worship of science stems, of course, from the Marxist faith in science as the instrument that will transform nature and that will create the abundant society necessary for the ultimate attainment of communism. The regime's intimate concern with science has meant, on the one hand, an irresistible urge to interfere politically with scientific theories, to impose ideological constraints on the freedom of scientific inquiry; and, on the other hand, it has meant the elevation of the scientist to the highest ranks of the professional elite and the award to that profession of the ultimate in social honor and prestige. For the Soviet scientist, therefore, his government's loving embrace has been a bit of a mixed blessing. Ideological and political pressures exist side by side with the highest rewards and esteem that the society can bestow. But we

must remember that political pressures and interference are present everywhere in Soviet society, and, in fact, relatively speaking, science, and particularly physical science, is probably the freest area of activity in all the land. As one observer puts it: "If the Soviet scientist lives in an ideological cage, the cage is a gilded one and within it there is more freedom and luxury than almost anywhere else in Russia." What counts is the relative position of the scientist compared with other professions, and here it is clear that the social conditions under which Soviet scientists are trained, work, live, and interact are such as to be able to attract and recruit into their ranks the very best talents in the nation. Of all the professions, it is the most desirable.

A third factor that may help us to understand the success of Soviet science is the close working relationship that exists between the political leadership and the scientific community. This is made possible, first of all, by the high degree of scientific literacy and engineering sophistication that is to be found among the Soviet political leaders. An engineering or technological education is as common among Soviet government and party officials as a law school diploma is prevalent among U. S. political figures. This fact makes for a natural affinity and an intimate, informal relationship between government and science; it also makes for a keen personal interest in, and understanding of, scientific matters on the part of the top leaders.

A good illustration of this was given to us when Nixon went to the

Soviet Union. While the Presidential jet, the 707--or the official version of it, which is the EC-135A--was parked at Venukevo airport Nixon invited Khrushchev and his entourage to inspect this beautiful airplane. In the course of this inspection of the airplane Khrushchev launched into a highly erudite and sophisticated discussion of the relative merits of the turbo-prop power plant versus a turbo-jet power plant and how ultimately the turbo fan will displace both. I don't believe that you can think of a single Western leader who could even have understood that discussion, never mind participate in it.

Above all, this engineering sophistication and understanding and sympathy makes the Soviet leaders willing to listen to and to be guided by scientific advice and to delegate to the scientists the highest responsibility for the conduct of scientific affairs. It is often said that Soviet science is an "organized science," and this is certainly true, with a vengeance. But the saving virtue is that it is organized by the scientists themselves and not by political hacks. The principal instrument of organization is the Soviet Academy of Sciences, whose members comprise the leading scientists of the nation. Its Presidium acts as a kind of science general staff for the Soviet government. It determines overall scientific policy, tries to discover what subjects it would be important to study, and decides how resources for science are to be allocated. Its recommendations to the Soviet government are vigorously supported and generously funded.

This delegation of authority, moreover, is not confined solely to the top level of the scientific hierarchy. It is also practiced at the more mundane engineering levels in high priority scientific projects and particularly in military weapon development. Unlike our own involved bureaucratic process of committees, counterchecks, approvals, and concurrences along a seemingly endless chain of command, the Soviet development practice prefers to vest unequivocal authority in a single senior designer who becomes the undisputed technical manager of the project, with a great deal of flexibility and decision-making power. The Soviet leadership has evidently persuaded itself that, at least in the key projects, it can and must trust its leading designers to make the right technological decisions unhampered by bureaucratic red tape. And, of course, these leading designers are very special people. Artem Mikoyan, for example, the co-designer of the famous MIG series of fighter aircraft, and brother of Anastas, the First Deputy Premier of the USSR, is not only a Lieutenant General of the Army but also a professor of engineering mathematics at Moscow University, the head of one of the most important aircraft design collectives, and the manager of several aircraft production plants. His rewards are immense and he earns them the hard way.

But men of such talent are not plentiful in any society, and it would be quite wrong to assume that the entire Soviet R&D effort is characterized by such enlightened practices, by such willingness to decentralize

authority. On the contrary, the scarcity of first-rate talent, the limited size of Soviet scientific resources, and the vast number of projects that have to be undertaken have made it necessary for the Soviet government to make a most painful choice between those projects which are absolutely indispensable and those which are only highly desirable. The indispensable projects that are of key military or political significance are accorded the highest priority, are generously endowed, and are given unstinting support. All other projects of a more routine nature--and these include, of course, the bulk of the nation's scientific activities--are only minimally supported; at best, they are allowed to share in the general encouragement given to all Soviet science, and at worst they are allowed to languish in isolation and neglect.

And this brings me to my fourth and final point, namely, the great unevenness of performance and results in Soviet science. The government's policy of differentiating systematically between high- and low-priority activities has divided Soviet science into two worlds:

(1) The elite world of Soviet scientists engaged in research and development of central importance to the state. This includes not only the key military developments, such as ballistic missiles, and the political prestige developments, such as space flight, but it includes also some of the most promising fundamental investigations, such as high-energy neutron bombardment and controlled thermonuclear reactions. The significant R&D successes of recent years have been achieved almost

entirely in selected areas such as these, and predominantly in the field of technology--not in the field of science. The technological successes have been attained by a relatively small community of very high caliber research scientists and engineers, organized into high priority projects and teams, lavishly equipped and staffed, carefully nurtured, given a great deal of authority, and, above all, allowed the freedom to make mistakes. The R&D management policies, the modes of decision-making, and the development philosophy applied in this part of the world reveal a high degree of Soviet sophistication about the nature of the R&D process and the measures that are required to achieve short lead times. The successes chalked up by the Soviet Union in these priority areas speak for themselves.

(2) But side by side with this elite world, there exists another and a quite unspectacular world of Soviet science, namely, the mass of routine scientific activity that has grown, like Topsy, into a maze of institutions, agencies, and projects numbering in the thousands, most of them poorly staffed, inadequately equipped, and miserably run. Far from being organizational geniuses, in this sphere the Russians are just as baffled as we are by the formidable problems of planning and coordination that confront them. This part of the Soviet world includes not only much of the huge technological development and design effort of Soviet industry but also a good part of the basic or fundamental research carried on in the less notable corners of the Academy of

Sciences. The performance of this part of the Soviet world can hardly be called distinguished. It suffers chronically from overcentralization, organizational rigidity, diffusion of effort, lack of communication, and the most extreme forms of wasteful duplication. This, then, is the price that the Soviet government pays for its decision to concentrate on those problems that it considers to be of the greatest national significance. The concentration of effort on a part means the neglect of the whole.

How serious is this neglect, and are the Soviets paying too high a price for their priority concentration? I think it can be argued that, given severely limited resources, it made good sense for the regime to be highly discriminating in its science promotion policy. Certainly, the successes they have achieved in the choice areas suggest that they have an enviable ability to select and to predict the subjects and problems that would have the greatest payoff. But we must remember that it is largely a problem of prediction and, moreover, prediction about one of the most uncertain and unpredictable of human activities, R&D. In part, at least, their past success in predicting correctly must be attributed to the fact that they were coming up from behind. Having fairly complete knowledge of the more advanced state of the art in the West, it was not too difficult for them to pick out the most promising trends. But now that the Soviets are rapidly pulling abreast, the uncertainties are becoming much greater, the interesting important alternatives much more numerous, and the problem of prediction much

more risky and agonizing. There is much evidence that the Soviet leaders are currently deeply worried about this, and a major effort is being made to raise the general level of scientific activity. The rate of Soviet improvement is impressive indeed, and they are bending every effort to mobilize the best scientific minds of the country for the difficult task of selecting, in every field, the most promising directions for scientific endeavor. But it is going to be a tough job, and they have a long way to go.

My time has run out, and you will note that I have cleverly avoided answering the central question, namely: "What are the implications for the U. S.?" I have avoided answering it because I feel that there are no easy and obvious prescriptions for us that flow directly from a contemplation of Soviet reality. On the contrary, I have tried to suggest that Soviet science exists in a political and social atmosphere that is totally different from our own, that it serves concrete national objectives that are, on the whole, alien to us, and that its success cannot be understood purely in terms of the much publicized superficial gimmicks of central planning, lavish rewards, and ingenious organizational techniques.

By this I do not mean to imply that we can afford to ignore the Soviet challenge, that we can be complacent about the state of our own science. On the contrary, there are some very searching questions that we must ask ourselves. But my point is that we must ask these questions in the

context of our own social setting, our own values. What are our national objectives and ideals in science? Should our primary reason for underwriting research be purely a utilitarian one to provide new facts and ideas to be used by industry and by the Nation, or is there also a case to be made for investing in science and the arts for their own sakes, because they are part of the good life? Are we doing enough for truly basic research, that rarest and most precious of personal creative activity, that is concerned with ideas, hopefully and critically directed toward understanding, or are we being completely taken over by our mania for large, organized teams, enormous expeditions, and costly instrumentation? Do we, as a nation, exhibit a sufficient love of knowledge, a respect for the mind, the kind of appreciation of science that will sustain the emotional commitment necessary to its flourishing, or do we still suffer from the anti-intellectualism of the frontier?

These are the kinds of tough questions we must ask ourselves. I am afraid that no amount of hypnotic contemplation of Soviet successes will give us the answers.

Thank you.

COLONEL FORBES: Gentlemen, Mr. Heymann is ready, willing, and eager.

QUESTION: Talking about the specific race track that we seem to have joined up with the Soviets on in response to this Lunik-Sputnik problem, we have done two things: Suddenly we have gotten on the track with about a half-billion dollars this year. Secondly, we split that effort off from where the greatest technology existed in this country, from the military. To me that is something of a contradiction. Would you comment on that, please, on whether it is good or bad, let's say?

MR. HAYMANN: Well, on the specific issue of whether one can make better progress in a joint military-civil approach to space flight or space exploration, or whether a separation of the two is better, I really don't have such very strong feelings. I am just not a great believer in the magic of organization as solving any fundamental problem. The fact of the matter is, of course, that you have an immense empire of interlocking directorships in the U. S. space program. Anyone who has looked as this beautiful maze that was printed--it was actually called "Space Maze" and it was printed in one of our aviation journals--will recognize that organizationally a democracy of our type is just never going to make any progress in cutting through red tape. This is sort of a handicap or limitation with which I must be burdened. It means greater inefficiency compared to, say, a totalitarian system in which directives can be made clear cut and where there is a nice, direct line

of command and orders are executed. They also have difficulties, because a mistake made by a totalitarian regime generally tends to be a whopper. Mistakes made by numerous little agencies in a democratic organization tend to cancel themselves out. So it isn't all disadvantage. But the point I am trying to stress is that what really counts here is that we've got to make up our minds what are our objectives, our own objectives. How is space exploration related, consciously and precisely, to our national objectives, to our national interests? The only way you can answer the question as to how much you want to do in this particular contest is to say that certain space development projects are necessary for future military security. This is the notion of a moon station, which could be of immense value in a military context in the 1980's--or something of this sort.

Similarly, you have to ask yourselves: What is in our interest more generally as a nation, as the kind of nation we would like to develop, the kind of order we would like to develop at home, the kind of impression we want to create of ourselves abroad, which has great political significance? From this point of view, maybe the argument on the peaceful side should be that peaceful space exploration is not nearly so advantageous for the U. S. as, say, discovering a cure for cancer, or solving the problem of heart disease, or various other purely civil solutions to basic scientific problems that would benefit the world immensely--the notion of growing food or developing new sources of food production in

arid areas. Things of this kind would really have a revolutionary impact on the world. Sometimes one wonders whether we are not being carried away by an excessive concern with what the Russians are doing and therefore gearing our problem to this competition.

My argument simply is: Let's look at our own interests and then ask: How should we encourage our scientific resources in those directions?

QUESTION: Sir, a remark attributed to Dr. Teller is that in 10 years the scientific leadership of the world will rest with Russia, regardless of what we do right now. Would you comment on that, sir?

MR. HEYMANN: Yes, I'll be glad to. I have very strong views on these predictions of the inevitability of certain developments. Humanity just doesn't operate that way. We can say that there are certain trends in evidence in the two countries. We know, for example, that the Soviet government is bending every effort toward the most rapid possible acceleration of science and technology, expanding these efforts, however, very much with a concentration on applications to life, as they call it. In other words, the emphasis is on applied research. It is true that they are encouraging basic research to some extent, particularly in certain areas that they have magically picked out as being capable of achieving important results; but, by and large, their emphasis, just like our emphasis, tends to be more on applied research than our true scientists would argue is desirable in terms of maximum growth. It is also true that the Russians are educating and training

huge quantities of scientists and engineers, particularly engineers. But the question is: Do they really need that many engineers? Is this based on any reasonable estimate of how you can use these engineers most efficiently? There have been time after time evidences of the misplanning in the Soviet Union of scientific talents. They have, for example, graduated something like 60 geologists--a planning decision made three years earlier. At the time these geologists were graduated there was need in the economy for 3 of them. That meant that 57 had to be retreaded to some other use. It was a total waste of talent.

So there is this question. I just don't believe that you can make a confident prediction of the inevitable superiority of Soviet science, or even that there is a strong likelihood that this will happen. It is true that they are developing very energetically; the gains that they are making on a large number of fronts now are impressive. There's no question about it. But we are still very far ahead in the quality and the breadth and the scope of our resources. We are spread over many, many areas of the scientific world which the Soviet Union has deliberately neglected and ignored. I believe it is entirely likely that 10 years from now the Soviet Union may lead in the field, say, of cosmic ray research, and it may lead is perhaps a half-dozen other fields, and that these may be very important in terms of some aspects of national power. But to say that they will have captured the scientific lead across the board seems to me to be a highly questionable prediction. It is a matter of opinion.

QUESTION: Doctor, there has been a great concentration in the country on the relative merits of Soviet science versus our own, say. You used one example, the Sputnik type of thing. Now, I think that we knew how to do it also. Could you tell us why we didn't do it and why we don't do other things that we already know how to do? And how does this affect this race?

MR. HEYMANN: We you know, this is a highly controversial matter. There are a number of different opinions. I don't want to give you the impression that I have any magic answers to this very complex relationship. I would like to suggest one sort of primary explanation which has always struck me as being a reasonable one, as to why we are behind in these two significant areas of the ICBM and the space rockets. That one major reason is that several years back we were ahead of the Russians in discovering that you could package nuclear weapons into very light-weight envelopes, and what then appeared to be an almost impossible requirement for a very high-thrust rocket engine to boost the vehicle into the outer atmosphere suddenly turned into a more modest and reasonable requirement, because the payload requirement had been reduced. So we gave up, or we ignored, or we neglected the development of the high-thrust rocket engine, because we found that for the military application that we had in mind it wasn't going to be necessary.

The Russians were apparently behind us in this development of the miniaturization of the warhead, and they therefore believed from the

first that what they needed was the ability to lift very large payloads. So they concentrated. Even before we became aware of the value of the ballistic missile as against the airborne vehicle, they concentrated on high-thrust rocket motors and had a broad development program under way. This is now the foundation, acquired over a number of years, of a very important superiority that they have, namely, the availability of this large engine.

What does this engine permit them to do? Forst of all, it permits them to lift payloads with much greater simplicity. There are fewer clusters; there are fewer multiple disengagers, and so on, that you have to worry about. Secondly, and this is something that is often overlooked, it permits them to throw into their payload a redundancy in guidance. That is, if you want reliability in guidance, you can do it in one of two ways--have extremely reliable components of a single black box, which, of course, are expensive and difficult to develop, or you can put 2 or 3 units in in parallel. If one of them happens to fail another one will take over. This is a huge advantage to the Russians in providing the guidance. They don't have to calculate and argue and worry about that last half-ounce of payload, because they do have the large rocket engine.

That is part of the answer; it is only one part, the technical part. I don't want to give you the impression that there aren't many other answers as well. For example, there is the mere fact that we made a

huge blooper in not recognizing the importance of space and in not encouraging it nationally. Many people were aware of this deficiency and argued in favor of it, but, at the government levels, where the decisions had to be made, it was not received gracefully.

QUESTION: Sir, it has impressed me, especially in regard to research, that one of our biggest problems is the dissemination of information, particularly about foreign research. Conversely it has impressed me that our Russian friends have a very good knowledge, right down to the laboratory level, of research going on in our country. There seems to be a bigger difference in this area than perhaps in any of the others. Would you care to comment on this?

MR. HEYMANN: This is another one of these favorite whipping boys that I don't go along with completely. I am quite familiar with the Soviet devotion to translation and dissemination of foreign technical information. It is a large effort; it is an effort that was undertaken by the Russians for the very simple reason that they recognized that, being behind, it was vitally important for them to copy from the more advanced West. They are not only translating U. S.; they are translating all of Western European technology; they are translating an awful lot of stuff that appears out of nowhere and that is of very little value.

One of the great disadvantages of this mechanism is that it is rather undiscriminating. It is such an enormous mass effort of translation which inundates you that there is little time left to do anything else but read

foreign translations. There just is not quite the same need in this country or there hasn't been in the past, for translating Soviet scientific literature and technological literature, because we were generally ahead. There wasn't the interest, and there weren't the number of people in this country who had the time to devote to observing, some of from a point of view of interest, what somebody else was doing.

I must say that even today I am not as convinced as some people are that we are going to solve our problems by translating huge quantities of Soviet scientific output and just making them available. This stuff is to a large extent available already, and to those who are really interested it could have been made available in larger quantities without undertaking a huge effort. I do believe that it is more important now to read Soviet technical literature than it has been in the past, but much of this can be done through a rather modest intelligence effort. I would hate to see our scientists waste their time in morbid fascination with Soviet science instead of concentrating on the main part of the job.

The real issue here is: How do we signalize the relatively few areas of real importance, of original contribution, that do exist? How do we select these? This is an administrative problem, because, good scientists, who are the only ones, of course, capable of selecting, generally don't want to be bothered with this kind of crubby work. They want to do their own. So, whom do you get? You get third-rate engineers who can't get a job elsewhere, and what do they do? They miss the

important indicators. So it is a problem.

The solution is not for everyone to learn Russian. This is a very time-consuming and difficult job, and you spend all of your time reading Soviet literature. I'm not sure this is the best use of our time. I have no answer to the problem.

QUESTION: Sir, we are pretty well convinced, I think, that Russia is striving a little faster than we are to develop an engineering stockpile of men and perhaps scientists. In our country we spend a large percentage of our engineers on things like electric trains for children, electric can openers, stereophonic hi-fi, and even hoola hoops. I am curious because, in another lecture, a speaker gave us the impression that maybe Khrushchev and company really do not want to open up to their people the goods, the nice things, for popular living that can come from this engineering. So now my question is: What is Khrushchev going to do with all this engineering talent if he challenges it into being very brainy and then won't turn it loose to build things for people?

MR. HEYMANN: Well, you know, Khrushchev is only a man; he is a bright guy; he is not omnipotent. There are some things that, even though he'd like them to be one way, just turn out to be otherwise. It is quite true that he would like nothing better than to keep his nation concentrated on priority activities, on certain areas that he feels are going to pay off handsomely for the national interest, but he doesn't really control human desires and human interests, particularly in the

field of science, where people have to be motivated, where they have to go where their instincts lead them. That's one aspect of it. The other is the growing preoccupation in the Soviet Union with consumer goods, with the things that make life worth living. This preoccupation can't be controlled by a party, no matter how ideological and how energetic it is. That is, there the people want to enjoy the greater fruits of life, and one of the painful experiences for Khrushchev on his visit here has been a renewed impression of the insatiability of human wants. I mean, he took a look at our super-markets and he saw that huge row of shelves filled with different brands of dog food, and he tore his hair. This is the sort of thing that he would least want to have happen in his country. And yet there is a limit to how he can control it. Human desires are going to overtake him.

This is not going to happen suddenly. This is a long-range development over many years. I am just sure that these evolutionary changes are going to occur if we are just a little patient and keep our powder dry, and keep being energetic on our side, because we are going too far over in the other direction. This is one of our problems. You know I have emphasized the Soviet side here. If I started talking about the U. S. side we'd recognize very soon, and I think most of you do already, that there isn't anything really remarkable about Soviet successes. What is remarkable is that we can be so incredibly inefficient and fail on so many fronts. But I don't want to beat that theme, because I know

you've heard it many times.

QUESTION: Sir, my question is in the area of labor. You observed that there would be a shortage of labor in the Soviet Union. What about the area of skilled labor and technicians, and these persons who have sub-professional training and who are so essential to the accomplishment of professional work? What is their status?

MR. HEYMANN: That's an interesting question. They are very important, you see, because, from the point of view of labor shortages it is important not to think of this as a big chunk of the population, namely, the labor force, being equally affected by the shortages. As a matter of fact, in the unskilled classes the Russians have labor coming out of their ears. All you have to do is walk through the streets of Moscow and see the thousands and thousands of women with twig brooms sweeping the streets, or walk around a Soviet railroad station and see 40 people walking around with little trays, selling food, able-bodied people. They are unskilled, and the retreading of these people for a semi-skilled profession is a problem. It takes time and it takes resources.

So, the issue is: What about this important category of people who represent the backbone of your technicians, your technical effort? These are being trained energetically, but they are really the category of people where the greatest problem lies, because of the tremendous rate of technological change; you must constantly reeducate people to the new technologies that emerge--things like computer technology, which is a dreadfully

backward area in the Soviet Union. It takes hundreds of thousands of experts, of rather highly skilled people. And there isn't this pool of mechanical talent in the Soviet Union. Even a tractor driver has to go through a complex training program of a year and a half to learn his job, whereas in the U. S. every 8-year old kid on the farm gets to learn how to drive a tractor and handle it.

So this is really the critical area in the Soviet labor force. What the Russians are trying to do about it is to revise, interestingly enough, the wage scale, the salary structure, so that these people would be motivated to produce efficiently, motivated to improve their qualifications, motivated to stay on the job, and so on. This is a very tough thing to do in the Soviet economy, because the wage structure is already so complicated, so beset with graduated premia and bonuses, that in order to revise it sensibly you really have to eradicate it and start from scratch. The revision has been going on for three years, and there still isn't much sign of a solution.

I'm afraid that's a long answer to a short question.

QUESTION: Sir, you mentioned this great mass of red tape to Russian science. I begin to think that maybe this is the kind that is helping their military forces. Do you have any indication of how problems get from the military to science and how developments get back from science to the military? Do they have an organization, or is it a hodge-podge?

MR. HEYMANN: I think your last phrase is the right one--hodge-podge. Again, organizationally the techniques are not at all impressive. I spent a lot of time, you know, trying to pin down this question of how these decisions are made, to whom they are passed on, where there is a policy decision, and how it is passed back, and so on. All I find in the Soviet discussions of this problem is kind of a helpless paralysis. The same basic solutions that are talked about here as being somehow magical are proposed there, and they are violently argued about. The magic word always is coordination. What does this mean? It means that, instead of having just two agencies, you set up a third one to coordinate, and then you find, because you have parallel empires in Soviet science--you know, you have the Academy, you have the Ministry of Education, and you have the Industrial Research empire, and then you have your coordination team for each of these empires; then you need a master coordination team for the three empires; and so on--you multiply coordination. I have counted no less than 167 coordination organizations, with that word in the title, in the Soviet science effort.

So there are no magic solutions for this broad, huge empire that exists. But, as I tried to point out in my talk, in the priority areas, in the military, in the categories that count most, in the scientific prestige efforts that are of political importance, in those they do develop the kinds of solutions that we in the U. S. have found very successful when we've used them. Unfortunately, we don't use them often enough.

Such a solution is to make one man responsible and to give him the position of a production czar for R&D, and to have a first-rate team under that man, to give him full authority, to give him the opportunity to make mistakes if he wants to make mistakes; to leave him alone; not to stifle competition; perhaps to set up parallel developments, so that the two will regenerate each other. Things of this sort are done in the Soviet Union, too, and they have proved remarkably successful.

Some of our own failings in this regard are that really now we tend to argue that any competition in R&D is wasteful competition, and we tend to cut it out, whereas competition is the spice of life, it's the generative instinct. We go in now much more for centralization and central planning, and it is not the solution. The important thing is the technically competent, skillful project leader, who must be given authority and adequate support and must not be hamstrung by this terrible bureaucratic machinery of concurrences and approvals and committees.

On this you get just endless examples of how our progress is delayed by the inability to make decisions, and, most important, by the unclarity of the amount of financial support. The budget problem dominates everything today, as you know. It is certainly true in the scientific field. A group of scientists comes up with a proposal that they were asked to come up with. They were told, "Here is an area of great potential importance. Please look at it and come up with recommendations as to

what the Government should do about it." They come up with a recommendation and maybe there are three suggested alternative budget levels, one at $100 million, one at $50 million, and one at $75 million. They spend six months at this and come up with these recommendations, and then the thing gets thrashed around in the agencies, the Budget Bureau, and so on, and it comes back--"Sorry, we have only $5 million for this." This is not based on the merits of the issue. It's based purely on a financial consideration. Then it goes back to the scientists and they have to start all over again with a new constraint--$5 million.

What can you do? You waste time and you waste resources, and you never get anywhere. This is our big problem today.

QUESTION: Do we have sufficient knowledge of the slave-labor problem, in order for us to evaluate its effect on the economic and technological growth of Russia?

MR. HEYMANN: Well, we don't have sufficient knowledge of anything, unfortunately. We don't have sufficient knowledge of the forced-labor situation. We do have enough knowledge, I think, to say that we might as well forget about this issue as being of any relevance to the Soviet progress or to the Soviet threat to us or to the ability of the regime to enthuse its people. This has become a very minor issue. Under Stalin it was a major issue. Under Khrushchev it is quite clear to him that it is inefficient to use human beings in bondage as a labor force. From the point of view both of economic efficiency and of national morale, this

system has been slowly but surely dismantled. What remains now of the labor colony is really, to our best knowledge, a quite minor feature of the Soviet system, whereas one time it was very serious.

QUESTION: To go back to the previous question, I wonder if you'd like to comment on Soviet use of operations research techniques to bridge the gap between the military and science.

MR. HEYMANN: As far as the economy as a whole is concerned, the Soviet Union has not been terribly interested in operations research. They have not used it much. They have not gotten to this degree of sophistication. I think it is important to recognize that they are still at an earlier stage of economic development, and, therefore, the kind of industrial problemsthey have had were overwhelmingly concerned with production at almost any cost. The notion of the mass approach, the main-force sort of idea, and the notion of efficiency of production, that is, maximizing output per unit of input, which is at the core of operations research, is a quite recent one. It dates maybe over the last three years. Well, because of this lack of interest in the past, they really have not, either among their economists or among their engineers, developed the specialized interests and educational backgrounds that go into operations research activities. They are now becoming interested.

There is a laboratory in Leningrad that is specialized on the problems of applications of linear programming techniques at the level of the plant

and at the level of the project. These are the obvious applications that make sense for the Soviet Union. There is also an interest among Soviet economists, broad economists, in applying input-output techniques--that is the Leontieff Linear Programming Model--to the problems of planning, of national planning. It is still a fairly simple and rudimentary interest. They are experimenting with some pilot tables. They have a 47x47 table that is now being compiled, and they are planning one much larger than that, but they are not getting the support from the government that they would like to have.

Interestingly here there is a party resistance against using intelligent approaches to planning. The party has always thought of itself as being the manipulator of decisions. Political decisions, which are, of course, economic decisions, too, always rested in the hands of the party. They don't like automatic mechanisms. This is why they have resisted the price system. They don't want to have a perfectly logical market mechanism that allocates resources. This is their job, you know. It is up to the intelligent human being to decide the fate of the world. You don't devise automatic control mechanisms to do this for you.

So you have an anti-intellectualism in the Communist Party, in a sense, which has retarded the development of the application of these techniques. But more and more they are being forced into the acceptance of the need for efficiency , and of course the scientists, the mathematicians, and the economists are enthusiastic--the younger ones--about

using these new techniques. The older ones, particularly the older economists, are scared to death of this taking over, because, you know, they haven't had linear algebra, or anything like that. They don't even know what you are talking about. But you have the same resistance in this country. I know.

QUESTION: Sir, you referred to the advantage that the Russians enjoy with their advanced rocket engine. Could you comment on Dr. York's evaluation of the whole ICBM, and say whether or not you share his views?

MR. HEYMANN: Could you remind me what Dr. York said? I have read so many official statements lately I am not sure.

STUDENT: He commented that he felt that as far as general weapons are concerned, we are still ahead--the guiding system, the propulsion, and the whole weapon.

MR. HEYMANN: Well, you know these official statements are always based on a very careful reading of intelligence evidence that is available at very high levels. I think it just would be out of order for me to comment on that statement in those terms. I really don't have any superior knowledge of our relative standings here. I can refer back to my statement that the greatest single advantage the Russians have is their ability to conceal from us the real facts of their current status and dispositions in the military field. The evidence on this just is not unequivocal. It is not so clear that anyone can get up and say, "This is the case and we

can be confident that this is the case." The range of possibility of Soviet current military capabilities in these fields is rather wide, stretching from a very comforting low capability to an extremely dangerous high capability. From the U. S. planners' point of view it would be reckless and criminal to assume that only the lower range of these estimates is the right one. I think it is a matter of the utmost urgency for the U. S. to recognize that the uncertainty of the information is such that it permits quite clearly of the probability of the high estimate being correct; and we ought to base our emergency planning on that and not on the low estimate. But this gets us into a very large subject of the whole notion of intelligence estimates.

QUESTION: Sir, would you address yourself to give us an evaluation of what has been imported in the way of science and technology from the satellites and from their international intelligence system as opposed to their own self-generation?

MR. HEYMANN: I am afraid I couldn't list these things, because the things that have been imported from the West in one form or another are legion. The influence that Western science, Western technology, and Western design have had on the development of Soviet science is immense, especially in the field of technology, of course. In the field of science they have their own talents which have contributed, especially in mathematics and some branches of physics. You know you really couldn't list these.

As far as Eastern Europe is concerned, this has been a quite minor element in their total capabilities. They have benefited, of course, from their satellites, right after the war, first of all, in the removal of plants in certain areas which were taken as reparations. This was very valuable. They have benefited from certain technical assistance received from the Eastern European countries. One of the Czech construction engineers that I met a couple years ago said to me, "Oh, we have a fine exchange with the Russians. They come to us to learn from us, and we go to them to teach them." So it has been very much one-sided.

I think the trend now is slightly to shift, because, again, the satellites have been forced to concentrate on certain activities that are really redundant, that parallel Soviet activities. Others they have had to neglect. So the Russians can now give them some assistance.

The areas in which the Russians have the most to learn from us now, curiously enough, are areas where they are making a vigorous effort to import from us or to obtain our help. If you ask me, we are being perhaps a little too helpful in some cases. For example, if you look at Soviet medical science, you find that the outstanding areas of neglect are heart disease, cancer, virology, biochemicals, and so on. Lo and behold, I noticed the other day that the exchange that was worked out between our Bethesda Public Health Center, or whatever it is called, and the Soviet Academy of Medical Sciences covered, most importantly,

these fields, in which we were going to have a noble exchange with the Russians. I am wondering how aware we are of the sort of one-sidedness of some of these exchanges. The Russians would like nothing better than to import chemical process equipment from us. For many years they have ignored chemistry as an industry, and particularly petrochemicals and biochemicals. In those areas we are tremendously ahead of them. And I think it is important to be aware that when we do have exchanges with them they always want to push for the advantage and we really don't have an awful lot to learn from them that we can ask for in return. This imbalance is a difficult one for us to deal with, because we do want to encourage exchanges for other reasons, not for technological reasons but for sociological reasons--the importance of the contact between ourselves and the Soviet Union. But we must not be misled in our enthusiasm to have contact to simply give away something for nothing.

QUESTION: Sir, a related question: I believe you mentioned that you feel that the Soviets are probably not doing as much basic research as they should. We have also heard that we are not doing nearly enough. But it seems to us that everything we do is immediately given to the Russians in the form of publications of whatever sort. Do you feel that we, in turn, are getting any fair proportion of the results of what basic research the Russians are doing?

MR. HEYMANN: I think we are getting not only a fair proportion

but an overwhelming proportion of all the basic research the Russians are doing--the basic research. There are, of course, important areas of applied research that they conceal from us as we conceal from them, in the classified areas.

Now, how do you handle this problem of trying to hold on to your inherent advantage here? It's a very difficult one. On the one hand, in trying to keep them from obtaining access to our scientific information, we inevitably hurt ourselves. The minute you classify something, the minute you prevent something from being published, you retard scientific progress in your own country by a certain proportion, a certain degree. You cannot communicate in the scientific field by way of classified internal circulation of data. / You just can't do it. The scientists won't play along with this. They'd all have to be cleared, you know, and you'd have a mess. The Russians have found this out. They have found out how much it has hurt them, outside of the specific classified areas, and they have eased up on this, too. They have found it necessary to publish and to circulate.

You have a choice among evils. You gain the efficiency advantage of publishing and communicating freely in your own country, and you lose the advantage of withholding from the enemy. I don't know what the magic answer is. My own prejudices, being sort of scientifically inclined, are on the side of relaxation of controls and of taking the cost that goes with it. I am not completely relaxed about this, because there

are many areas in which I think we are being completely foolish in unnecessarily publicizing things that we do and decisions that we make. There is a distinction that must be made between communication necessary for science progress and communication that serves only the interests of the sensation-seeking press. These are two very different things. There is a journal in the aviation field--I don't want to name it but it is an outstanding one--which insists on showing intimate pictures of our ICBM production lines and things of this sort. Some of them have been cleared, foolishly, for publication; others have not been cleared and have been obtained through other channels, irregular channels. It is not necessary for us to publicize these things to that extent. Even more serious, it isn't necessary for us to publicize wildly every political decision that we take in this country. We don't seem to have any sense of proportion as to what we spread all over the front pages and what we keep quietly to ourselves.

The most effective kind of action that the U. S. can take is the kind of action that is not publicized but that is simply done. This is what impresses the Russians. The Russians don't believe our official statements, even if they are true. You know, we say, "Such and such has just gone into production at the following rates, and it will come into operation on such and such a date." They call this "des informatsia." "Des informatsia" means deliberately planted misinformation, and they are constantly accusing us of this, because they cannot believe that any

nation could be so stupid that it would really publish the facts.

Well, there are two sides to this question, as there are to every one.

COLONEL FORBES: Mr. Heymann, we are certainly grateful for the completeness of your contribution to the College. On behalf of the Commandant, the faculty, and the entire student body, thank you very much.

MR. HEYMANN: Thank you.