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Soviet and U.S. Professional and Technical Manpower

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It is particularly fitting, I believe, that at this time we look back at the profound perceptions expressed in the philosophies of Francis Bacon, while at the same time we consider the meaning for us of the educational developments in an alien but challenging society such as that of the U.S.S.R.

Bacon asserted that it had not yet, in his time, been recognized that the true aim of all science is "to endow the condition and life of man with new powers or works" (*1*) or "to extend more widely the limits of the power and greatness of man" (*2*, p. 116). Bacon, however, does not take the position that these are the sole purposes of research. Truth for the sake of truth is by no means excluded. Indeed, by pursuing truth for the sake of the power with which it endows mankind, one also arrives at true knowledge, since without knowledge there is no power. Whether one seeks truth first and utility second, or vice versa, are, in fact, the same, since "works themselves are of greater value as pledges of truth than as contributing to the comforts of life" (*2*, p. 124). Bacon must be credited with emphasizing the fact that knowledge should proceed in the consciousness that the growth of knowledge is the way to increased power over man's environment. The Soviet perversion of this philosophy is that power, and power alone, is the justification for both education and the pursuit of science. It is a dangerous perversion, because it is true that knowledge is power. The danger lies in the fact that, in the U.S.S.R., the search for knowledge by the state is greatly supported for power purposes alone. Education there is the instrumentality for the pursuit of science.

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Soviets and the Baconian Concepts

The Soviets have thus stepped well beyond the position of Bacon and have added to his concepts the additional factor of a science and an educational system directed to the support of a superpowered state.

The first shock of this information has, to some extent, worn away. This does not mean that the significance of the developments in Soviet education has been discounted, or that the validity of the information has been questioned. It has, however, been possible to take a more mature look at the program of the U.S.S.R. in education and to examine somewhat more dispassionately its meaning for us and for the world. While the evidence from the U.S.S.R. has been clearly pointed to the need to examine critically our own system of education, it is becoming possible to reevaluate our own program primarily in the light of our own needs and desires, our own resources and capabilities, our own social institutions, and our own educational philosophy rather than under the effects of a sort of hysteria which appeared to exist for a time in the minds of some.

Although this is a boon and an advance, it should by no means blind us to the significance of those aspects of the Soviet system which differentiate it so sharply from its own past, from the traditional systems of Europe, and from ours, and which do lend it significance in the context of a world in fundamental conflict.

Purpose of Soviet Education

The characteristic of Soviet education which stands out above all others is that it is conceived, consciously and totally, as an instrumentality of the state. This is indeed something new under the sun, except that the possibility of this rather stark and barefaced policy is certainly inherent in Bacon's philosophy, although he, I am sure, would have been horrified at such a distortion of his ideas. Certainly, never before has the relationship between the training required by a modern industrial state and the economic, political, and military power aspired to by that state been so clearly envisioned. Never before has it been so clearly stated or so clearly enunciated as national policy. The implementation of that policy has been consistently energetic, and the continued support by the state, manifest.

The effect of this great interest by the state is apparent in a number of respects. Even as far down in the system as the early grades, the curriculum reflects a heavy emphasis on the technical branches. This emphasis is actually increasing. A statement made recently in Hamburg, Germany, by A. Shibanov, chief of polytechnic instruction of the Academy of Pedagogic Sciences of the U.S.S.R., describes the plan of the Soviet State for increasing this emphasis. By 1960, he stated, secondary-school instruction up to age 17 would be obligatory. Science and mathematics and "scientific foundations of production" will then account for 55 percent of the curriculum up to the end of secondary instruction, he said. The percentage is now about 40 percent in the first 10 years of Soviet schools.

Already, in 1956, about 90 percent of those who finish the first seven grades go on either to secondary school or to one of the many *tekhnikums,* which provide a substantial degree of technical or semiprofessional training. This is an increase from about 70 percent 3 years ago. These *tekhnikums* are themselves an important indication of the practical slant of Soviet education. Training in them is intended

to provide numbers of persons well qualified to assist the fully trained professional specialist in the many fields for which the higher educational institutions provide personnel. In the fall of 1956, 480,000 persons were admitted to the entrance year of these institutions.

In the fall of 1956 there were enrolled about 1.2 million full-time students in higher educational institutions and about 700,000 additional extension students; and in the *tekhnikums,* about 1.6 million regular students and about 300,000 extension students. This adds up to a total of almost 3 million past-secondary-school students.

Qualitative Considerations

Sheer numbers, however, do not adequately reflect the nature or the intensity of the Soviet effort. In any human enterprise in which many are engaged, the intensity of the effort is dependent only partially on numbers. More important than numbers is the quality of the participants, their motivation, the competitive drive which powers them, and the satisfactions which can come to them as a result of their effort.

It is attention to these aspects which sets the Soviet program aside as something new. In other lands these factors have largely been determined as the outcome of the evaluation of social and educational attitudes among the people of these countries. They have never been consciously manipulated by central authority. In the U.S.S.R. these matters have been quite consciously contrived.

Rewards for persons who are productive in the fields of science and technology are relatively among the best available in that social and economic structure. Salaries are relatively high. Scientists and engineers are glorified in the press and over the radio as distinguished "servants of the people." They enjoy a relatively large measure of freedom, perhaps primarily because their work scarcely involves controversial philosophic concepts, but nevertheless they are freer to pursue their activities unmolested. Those who are successful teachers enjoy even more prestige and advantage. It is indeed strange to read complaints in the Soviet press that teachers earn more than industrial scientists. It is also strange to read of competition among grade-school and high-school youth in mathematics and physics, with honors and acclaim redounding to the winners, much as we recognize our football heroes.

This manipulated atmosphere of obeisance to accomplishment in intellectual matters is, in large measure, responsible for the intensity of the Soviet educational effort. The other factor in creating a highly competitive situation in the schools is the system of successive screenings which occurs at the various levels of Soviet education. Indeed, many are called but few are chosen may be the pattern, at least in the higher reaches of their system.

The progressive thinning out of the flow of students through the schools is perhaps, to some degree, due to economic circumstances, but this is not the major factor. All tuition fees, from elementary school through the university, are abolished. As of October 1956, grants-in-aid are available, not only on the basis of scholarship, but also on the basis of need.

Article 121 of the constitution of the U.S.S.R. has recently been revised by the Supreme Soviet to read: "All citizens of the U.S.S.R. have the right to education. This right is insured by universal compulsory seven-year schooling, by extensive developments of secondary education, by the fact that all forms of education, both secondary and higher, are free of charge, by a system of state stipends for students who have distinguished themselves in higher schools. . . ."

The process of successive culling results in the fact that about a quarter of those who enter the first grade emerge as graduates from the tenth grade, the remainder veering off to enter labor schools, schools for skilled or semiskilled, and higher technical schools such as *tekhnikums,* or to enter employment. The major selection, however, is made at the university level, where rigid entrance criteria are exercised. In the 1956 academic year, selections for the first year of university work were actually reduced over 1955. In October 1956 only 223,000 regular students were admitted, as compared with 285,000 a year before. The drop is rather clearly due to heightened selection standards.

The net result of this complex system of conspicuous rewards and unsentimental rigidity in screening at various levels is to contribute to a high degree of competitive intensity of effort through the length and breadth of the educational system. I am reminded of an incident related by an American who found himself working with a Russian in a recent international scientific conference. He told how the Russian had found it necessary to return to his home while his daughter underwent her entrance examinations for the university—not to help her, which he could not do, but to give her moral support during a very critical period of her life.

Incentives to Education in Science

Perhaps to these characteristics should be added the various special features which tend to make the basic scientific categories, such as physics, mathematics, and engineering, the more attractive fields, with the result that the abler part of the flow of students is polarized toward these disciplines. This is achieved by military service exemptions for persons in these preferred categories, by differential rewards, and by the relative absence of political interference.

Finally, it is worth stressing that one of the motivations behind the state interest in specialized education, aside from the clear conception of the role that technology plays internally in the development of industrial and military might, is the usefulness of technology as a political weapon of conquest in the uncommitted nations. Especially in very recent years the growing emphasis on export of specialists for political reasons is apparent. Offers of technical assistance to many nations have been a common item of international news.

While the American reaction to the outlines of the Soviet educational effort has matured over the past few months, and while it is generally recognized that there should be no desire on our part either to emulate the Soviet program in any respect or, indeed, to attempt to match it point by point, it would be unwarranted to deny that it does present a challenge. It does call for some reevaluation of our own educational program to determine whether, in fact, our system does meet our own needs in a tumultuous world in which the role of the product of specialized training is becoming ever more crucial.

New Role for Science and Invention

Surely if Bacon were alive today he would find it necessary to extend his thinking to apply it to the modern world, particularly the Western world in its present position vis-à-vis the new, belligerent civilization which confronts it. To the goal of knowledge for the sake of power over nature and the environment, which he envisioned, one must now add that science and education, in the service of the community, must take also a large share of responsibility for the defense of the Western world. They must also provide the leaven for the expansion of the economies of our nation.

The prescience of one great intellect perceived, as long as three centuries ago, that the role of science and invention and of technologic education must be not only to search for truth but also to direct the fruits of science in the interests of the community and mankind. It could hardly have envisioned the extent to which these elements are now the major pillars of our social, economic, military, and other activities. As one contemplates the services of modern technology in the

interests of the community and the state, the catalog is indeed a long and a growing one. But not only is it already an extensive catalog; it is destined, as surely as one may predict anything in a changing world, to be greater and even greater.

One can now, from the vantage point of the mid-20th century, look back upon that era of 100 years ago to appreciate the enormous changes that have occurred. It is since that time that our great technologic civilization has taken form. It is since that time that perhaps 98 percent of what we call modern technology has been established. It is in that short century that essentially all of the industries that are now our colossi have come into being, such as those in chemicals, pharmaceuticals, petroleum, communications, transportation, and the like.

In each case the services which these industries render have been built into the warp and woof of our existence so that they represent not only the luxuries and comforts of our lives but the very basis of present-day life, community organization, economic support, and economic and military security. Consequently, the services to the community, and that state which Bacon envisaged, now go far beyond anything he foresaw. Technology must ever meet the needs of this voracious demand of our day for technologic services. It must press on to achieve new levels of accomplishment in harnessing the phenomena of nature to our purpose. And our technical institutes must furnish the ever-increasing flow of personnel of advanced training needed to carry out these increasing functions of technology. Such institutes are going to be particularly preoccupied with the problem of meeting, on the one side, the requirements of a growing surge of youth into the halls of learning and, even more importantly, with helping to meet the insistent cry for more and better graduates from the technologic branches.

Manpower Requirements in the U.S.

Within the recent past, newspapers have carried the earnest plea of such persons as Admiral Rickover, of the Navy's atomic submarine effort, and of Lawrence Hafstad, of General Motors Company, for greatly accelerated training of specialists in the technical branches. Rickover proposes drastic revisions of our school systems to meet our coming needs. Hafstad calls attention to the recent official estimate of the Atomic Energy Commission that, in the next few years, nuclear research and engineering alone will need another 40,000 scientists and engineers.

The growth of employment in the United States has been a plainly overt phenomenon with its own remarkable acceleration. Within this employment total the trend has been toward the technologic industries. But within the technologic industries, again, the trend has been toward ever-increasing percentages of persons with ever higher training.

The rate of this increase in the demand for personnel with advanced training has been a very difficult thing to measure in our society, and, in fact, even the methodology of such study is not available—tried, tested, and reliable. But evidences are by no means absent, nevertheless, of the growth of our personnel demands.

One has only to note the growth of the engineering profession over the past two decades to appreciate what has happened. The 700,000 engineers, more or less (which now is about our supply), are not only the products of our university and technical institute courses but also represent a substantial effort on the part of employers to upgrade any available talent by on-the-job training and other intensive efforts. And yet the demands outstrip the supply.

Specific industries have reviewed their histories and have examined their historic trends with the thought of projecting into the future the firm trends of the past. The evidence, they have decided, leads to predicted levels of activity which would have seemed quite unbelievable a quarter-century ago but which, today, are actually unfolding at indicated rates.

The recent road programs of the Federal Government, the recently announced multi-billion-dollar expansion program of the communications industry, huge research laboratories recently dedicated, all present their evidences that our technology is expanding at a rate as great as during the past half-century, that it is becoming substantially more technologic and, hence, accelerated in its demands for highly trained personnel, and that the extent of training for the personnel required is constantly rising. The prediction seems eminently justified that our schools are unlikely to be able to satisfy the accelerating demand, insofar as one can foresee the future, even though one takes into account the increasing number of youths entering the college age group during the next decade. Our industry has more than doubled its demands every decade. In spite of the formidable increases in enrollment due in another decade, the increase in number of youths of college age causing that increase is not so large as to double present levels.

Educational Challenge

Thus, as one contemplates the rapidly increasing role of technology in the services of the state and of the community, the challenge to our system of education, both from without our country, in the light of other systems of education, and from within, in the light of our own needs, is a grave and serious one.

I have been speaking primarily of technologic personnel. It would be out of balance, however, to fail to point out that the same increases in demands which occur in the technologic fields also occur in a large part of other disciplines. Public administration, economics, psychology, and many other fields show the same surge forward of demand because of the same increase in complexity in our society. Problems of organization, of personal human relationships, service functions, and a host of other problem areas all show accelerating demands. It is important to bear this in mind, for we unconsciously tend to serve only one, not all, of our needs, and it is clear that we cannot expect to solve our manpower problems in one area at the expense of another. Education has moved into the position of a major factor in our economic well-being, a major bulwark in our national defense, and a key factor in our friendly relations abroad. As its importance is more fully recognized, its proper functioning becomes more significant.

I do not intend, here, to undertake any exhaustive reevaluation of our educational system, nor am I competent to do so. However, I think a few comments may be in order, stemming from the foregoing considerations.

Perhaps one of the major questions which we should ask ourselves is the extent to which the needs of the state and the community shall be a conscious factor in the development of our educational system and in the channeling of our youth into the various specialized areas of instruction. The very thought of this strikes us as alien. Our educational system has, from the beginning, been heavily influenced by our emphasis on the dignity and freedom of the individual. Thus, we have emphasized opportunity, but in terms of the opportunity of the individual to reach his own self-determined goals, with the happy confidence that, if each person develops himself according to his own desires, the sum total of all these desires and of all these developments will be a population whose capabilities add up to the best possible sum.

There are increasingly many who are beginning to question whether we should not reevaluate this position entirely. I am sure that no one would ever wish to see a situation arise in our country where people were told what to study, or would even want to have them subjected to heavy influences that would tend to channel personnel into areas of specialization according to some master plan. Our pas-

sion for self-determination and for freedom of thought and action will always be too great for that. However, to state that we who are charged with educational responsibilities do not also have responsibilities for the extent to which the products of the educational system of our country serve its greatest needs is an untenable position. The end-result of the educational system in its product, at all levels, is by no means solely determined by the individual choices of the students at the various levels. These choices themselves depend on a wide variety of circumstances and policies which are laid down as a guide and, in many cases, as a completely limiting factor in the exercise of choice by the individual students. The very latitude of choice which remains is a matter of policy which is determined in one way or another at each level in the educational system.

Role of Secondary Schools

One of these policy questions which, in the opinion of many, is in grave need of review is the purpose and role of our own secondary school. The growth of this great institution in the past four decades has been a monumental fact in the development of American life. It has served a great social purpose in creating a more homogeneous and literate public. It has also, however, by the sheer magnitude of its task, been driven into certain patterns which warrant scrutiny.

In most high schools a majority of the students have been terminal students, as distinct from those intending to go on to higher education. This has led to a preoccupation with these terminal students, and with their needs, that has often tended to ignore the more able students and those who should be building toward advanced training. Sometimes this has occurred because a school simply has not been able to serve both groups adequately with its limited resources. Sometimes it has happened because of the attitudes and interests of its faculty. Sometimes it has happened because of a doubtful philosophy of secondary education—that democracy requires that all people be cast in the same mold. The result has been a very real question whether our high schools are not of doubtful efficiency for the better students.

It has been of much interest in this connection to observe the results of an experiment by the Fund for the Advancement of Education. A few years ago they entered into relationships with a number of higher education institutions whereby second-year high-school students, carefully selected, were admitted to college on a par with high-school graduates. After a few years it has now been possible to evaluate progress of these young people in comparison with that of their classmates of matched intellectual ability. These students, on an average 2 years younger than their fellows and presumably handicapped by having had only 2 years of high school, out-performed their classmates. Their grades were definitely higher. If this is a fair experiment, it seems to indicate at least a doubtful contribution by the high schools in their last 2 years.

I am convinced that if we are going to solve our educational problems of the kind earlier discussed in this article, it can be done only by regaining lost ground in the secondary schools. There is no inherent reason why American secondary-school students cannot perform at least as well as students of comparable age abroad. It is no uncommon experience in Europe, for example, to find a youth of 13 or 14 who has a good grasp of one or two foreign languages and of mathematics, through the calculus, and who has made substantial progress in the sciences, history, and literature. And yet a statement such as this is met in our country with incredulity. Certainly American youth can meet these challenges as well as those of any other country, and enjoy the doing of it, if our schools can, in fact, be geared to challenge the full ability of each student in a program worthy of his intelligence.

Need for a Balanced Curriculum

It should perhaps be emphasized that this is by no means a plea for more science and mathematics at the expense of a well-rounded curriculum. It is much more appropriate that a student round out his education at the high-school level than at the college level, where the inexorable demands of specialization are beginning to preempt time and capture interest. It is a plea for a curriculum and for standards at the secondary-school level which are worthy of the caliber of the young people who later must be our leaders in the professions and in all of the many specialties which our society demands. There is no unkindness we can do our youth or our society greater than to establish the thought that the above-average youth should be content with an average accomplishment.

It is my conviction that in the strengthening of the secondary-school curriculum lies our only hope of meeting the numerical demands of the future for specialists. If a well-rounded curriculum is available for the student, with substantial mathematical and scientific courses, as well as other disciplines, and if these courses are taught so as to give him a feeling of accomplishment, of competence, and of interest, he is more than likely to follow his interest into advanced work. The greatest deterrents to the pursuit of advanced training in any of the intellectual disciplines are shaky and inadequate preparation, weak motivation, lack of aroused intellectual interest, and slovenly mental habits.

Role of Higher Education

What, then, of higher education in the sciences and engineering? Should more persons enter these fields of study to meet the growing shortages which have arisen to plague us? The answer to this question might appear obvious, and yet many thoughtful persons have seriously questioned whether added emphasis on science and technology at the college level and added efforts to channel more students into these fields may not tend toward a mechanistic society and away from ancient traditions and values. This is a question none of us would wish to treat lightly, I am sure.

Nevertheless, the question, it seems to me, lacks realism. The rate of increase of our requirements for personnel of advanced training has been a phenomenon growing directly out of the complex of social and economic trends that form the fabric of our civilization today. The health and the strength, the vigor and the growth, of our economy rest on satisfying the ever-growing demand for people of special skills and knowledge. To remain a vigorous and vibrant civilization, we must have the annual influx of young, well-trained minds. This is a necessity and not merely a philosophic desideratum. If the lessons of the past can at all be extrapolated into the future, they seem to me to indicate that the extent to which we can increase our supply of persons in the special areas of science and engineering will determine our future well-being and strength.

One of the fallacies in the arguments of those who question the wisdom of increasing the numbers of persons trained in the sciences is the thought that scientists and engineers are necessarily narrow in their training and unaware of their political, economic, and intellectual environment. I would agree at once that a curriculum in the sciences can be too narrow. There are those who graduate with a limited background of general information and no interest in widening their horizon. But this is equally true in other fields, such as economics, education, linguistics, or political science. Narrow specialization carries the same penalties, both for the individual and for society, whether it be in the one field or another. The answer to the question of whether our nation does or does not become more materialistic lies not so much in the professional training of our specialists or in the numbers of persons in

one field or another as it does in the integrity and character of the rest of the curriculum, if indeed the school system as a whole is the determining factor in these matters. We tend to forget, sometimes, that perhaps the most important factors in shaping our attitudes and our ways of thinking are the homes, the churches, and the mass media of communication.

Time for Reevaluation

While these things, I believe, are true, they do not minimize the importance of a reexamination of all our curricula. We need more persons trained in the technologic specialties, but not at the expense of other areas of training necessary to our society as it becomes ever more complex. We need more specialists in the nonsciences in a great variety of fields having to do with human relations, with human organization, and with those fields through which the values and the experience of the past are brought to bear on the present. We must train these people so that the breadth of their understanding makes it safe to entrust the future to them.

I am persuaded that this can be done only by some rather searching reevaluations of the curriculum in all fields. It is important, I believe, that the leadership in all branches of the curriculum inquire into what the fundamental goals of its field really are and determine whether courses, as now designed, really contribute toward that goal. Perhaps in the field of physics, which was my own field of professional concentration, the force of this admonition has begun to be recognized by many. Physics as now taught in 90 percent of the schools and colleges, at least, differs little from the way it was taught a quarter-century ago. And yet physics has developed more and changed more in the past quarter-century than in the preceding 300 years, back to the time of Newton. There is at present a rather fundamental attack on this problem of reevaluation in physics, centering around Jerrold Zacharias of Massachusetts Institute of Technology, and already several hundred thousand dollars have been committed for the project. A similar profound reevaluation and regrouping is under way in mathematics.

The aim here is by no means to create easier or more entertaining courses. On the contrary, it should be to create courses which are inherently so meaningful and challenging that they reach out and absorb the interests of competent students.

Thus there is a reevaluation under way in at least some of the scientific subjects which, it is hoped, could relate these subjects more clearly to the contemporary scene and could much more efficiently present to nonscience students the contributions of science to modern life and thought.

But similar reevaluations are surely in order in other fields. One of the purposes of education is to bring to the student a knowledge and appreciation of the intellectual heritage which is his and of the human experiences which have relevance for the modern world. If this be the essence of humanism and the function of the humanities, then it must be admitted that not all of the courses given in the name of the humanities serve this end as well as they might. This fact has more frequently been noted, of late, by humanists themselves. Too many of the courses classified under the heading of "the humanities" are, in fact, primarily introductory courses, preparatory to complete specialization in the subject matter rather than a sensitive synthesis of human values and human experiences growing out of the agelong history of humanity's struggles with its problems.

B. C. Keeney, president of Brown University, himself a humanist and a medievalist, expressed this need for reevaluation of the humanities pointedly in speaking to the medievalists a year ago when he said (*3*): "The real purpose, however, of undergraduate study of the humanities is to acquaint students with the role and scope of the emotions, and to lead them to make judgments of value and of ethics. Yet I have heard a distinguished member of the Medieval Academy of America, speaking of his course in art in general education, say that he left all judgments of value to the humanists. They are mathematicians, logicians, semanticists, or historians of the scientific rather than the humane persuasions. What scientific historian will make a judgment of value in one of his courses. . . .? Fundamentally, it is the wistful imitation of the scientists by humanists that has robbed the humanities of their humanity and has made them the jejune and learned nonsense that they now are."

He went on to say that "the humanities must be learned (for they can not be taught) as human and humane things in life, not as masses of assorted data and as skeletons without flesh."

If, indeed, this type of reevaluation occurs it will surely be recognized that science itself is one of the great areas of humanism, since certainly it represents one of the great contributions of the human intellect over the centuries.

In closing, let me state again that in the modern age we must be increasingly aware of the imperative role of science and invention, of technology and technologic education, in the service of the community and the state. We must be aware that the welfare and security of our society depend on technology, and that correspondingly increasing numbers of specialists in their fields are necessary. This is going to require some fundamental reconsiderations of practices and some reevaluation of concepts in both lower and higher levels of education. Particularly we must inquire into the very nature and materials of the educational process to see whether the imperative requirements of our age are being met in a world which leaves less and less room for complacency and for misdirection.

I have always had great respect for American youth, growing out of a lifetime spent in education. There is one great comfort I think we can take: if we who shape education do our part, the youth of the land will do theirs to meet the challenge of the present and the future.

References

1. F. Bacon, *Filum Labyrinthe.*
2. ———, *Novum Organum.*
3. B. C. Keeney, "A dead horse flogged again," *Speculum* 30, No. 4 (Oct. 1955).