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The little satellite circles like an embarrassing fly over the heads of the free world. "Spray it with DDT," says the man in the street. "It violates our air space," says the diplomat. "This requires an agonizing reappraisal," says the administrator. Committees are called to shift the blame; and reassured by the clanging of crash programs, declassified reports and more meetings the country will settle back to sleep unless we all feel responsible that liberty shall not be lost.

But how can one expect heroic deeds, especially in times of high prosperity, if the true issues are not clarified. And who can speak with real competence? We all see only fractions of the picture. Still, if each one of us inserts his part, we will create a picture of the whole.

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Our laboratory is concerned with modern materials research. In this area, of vital importance to national defense, a revolution has taken place in thinking and research approaches. The administration patterns of American universities and Government services dealing with this field have become as antiquated as Model T Fords. The Russians, not stifled by tradition of the past, are bound to build the Institutes our modern times demand.

This crisis is not solved by spending more money and simply expediting. Ours is a really obsolete machine; and billions are misspent and years are lost in tries to keep it running. But let us explain step by step the situation now existing and the solutions that might provide an answer.

Modern Materials Research

The technical competence of a country is reflected in the way it uses and converts nature's resources. Until recently the approach has been an empirical one: materials were found, their macroscopic properties evaluated, their chemical constituents analyzed, and applications made after proper shaping and processing. Test procedures based on practical experience were the exclusive guide of the engineer.

Suddenly all this is changing. Fundamental science - in decades of quiet studies on electrons, atoms, molecules and their concerted action in gases, liquids and solids - has reached the stage where a more powerful approach becomes possible: "Molecular Engineering," the building of materials to order.

This means that we need not take the metals and plastics, the rubbers and electronic components that industry mass-produces for buildings and household appliances, cars and radios, to construct with them our space ships and missiles, nuclear power plants, computers and the other devices on which our national safety critically depends. We can design materials with prescribed properties for the purpose in hand. We can understand, by observing the molecular phenomena, why materials fail; we can build into the materials the remedies against such failure and get true yardsticks for ultimate performance in the various situations encountered. We can dream up completely new devices, not shackled anymore by presently available materials and empirical performance characteristics.

This development spells the end of the specialization of the past, where scientists and engineers of the various professions were walled up against each other in air-tight subdivisions of schools and departments. The time of synthesis has arrived, in which we begin to think about materials and their applications in unified vision. The fundamental concepts which help develop high-temperature materials for missiles, better semiconductors for transistors or new antibiotics for medicine are the same: the designing of molecular structures with prescribed properties. A true "One World" draws into close alliance all sciences and all engineering, and the promise of this Molecular Science and Engineering approach is tremendous.

In quiet times we could sit back and let this new insight seep through the minds in the span of a generation Unfortunately, today's new technological concepts are weapons. When used only by the opponent, they spell disaster as surely as the phalanx of Alexander the Great doomed the Persians or the advent of cannons broke the power of the knights of the Middle Ages.

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Materials and Defense

Our industry is geared to mass production; it earns its money with the goods our daily life demands. Its products today are not basically different from those used before World War II; and our armament at that period required about the same materials as the civilian economy.

That this was actually a misconception became rudely clear in World War II. Suddenly we had to fight in all climates of the globe, and the failure of materials brought our campaign to a standstill in the South Pacific. The gear was eaten by mites and fungi and rotted in the moist heat of the jungle. Science and technology soon provided resistant materials, but many agonizing months were lost before the supply services responded to the needs of the fighting men. The inertia in continuing the use of materials, even if they prove to be poison for the purpose at hand, is an exasperating Newton's law of economics.

It proved easier to provide needed materials for new weapons like radar, for which no established supply sources existed, but here a different lesson had to be learned. The first available dielectric, capable of insulating and guiding radar waves, was polystyrene; it was already in mass production for the manufacture of synthetic rubber. Who cares for purity of material in rubber tires; but extremely small amounts of impurities may disqualify a radar dielectric by causing absorption of the microwaves. The commercially produced polystyrene proved completely unsuitable for radar purposes. Only the close co-operation between science and industry under the pressure of war provided fast enough the methods for measuring and improving the material and bringing it into production in special plants.

This instance illustrates by implication the crucial difficulty of combining in peace time a strong national defense with the profit motive of free enterprise. Items of the civilian market are the money makers and were good enough for the defense of the past. Today's defense technology has moved out of the sphere of normal life into the realm of unheard-of speeds, temperatures and pressures. Our decisive weapons now are not mass production items on which industry can make a profit. They are ultimate weapons of small numbers which should be built from the right materials and components with extreme precision. Many of the right materials and reliable components are not available today, industry has neither the experience nor the inherent urge to produce them; and there, at present, we are stranded.

To be more specific. Prevention of war today is unfortunately not yet based on human insight and mutual understanding but on the existence of an unbeatable deterrent. A few hydrogen bombs can devastate a country; a few dozen of such bombs, placed as war heads into missiles which can be delivered with certainty, will hold the world in check. Our ultimate defense strength thus relies on extremely small numbers. Why do our missiles misfire so often? Why do we want our missiles mass-produced? Is it because we buy conventional material and components from industry like a householder buys glass and screws from a hardware store? Is it because we think in terms of artillery bombardments of World War II? To prevent the next war, we have not to buy quantity but quality and extreme reliability, and that we can have only through modern materials research.

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Federal Research Laboratories at Universities

The country needs more scientists and engineers of excellent training; only universities can train them but their financial means are insufficient for the task. The country needs modern materials research for defense; only universities can provide the atmosphere of pioneering research where knowledge is sought for knowledge's sake without bias and industrial ties. The universities should create broad interdepartmental laboratories where scientists and engineers work as true allies; they have not yet found the framework to do this. The Armed Services need centers of information in which the latest knowledge for a whole research area is available and facts can be checked unbiased. The Armed Services have pioneering divisions in their research laboratories, which are supposed to work free from immediate tasks for long-range planning; such laboratories can, in general, not flourish, because the research atmosphere cannot be created; they have been depleted of men by industry and are frequently not more than storage rooms for beautiful equipment. The research scientists and engineers of the Armed Services grow stale, just like medical doctors would, if no refresher periods in university laboratories are provided. All these needs can be met if we have enough imagination for a true new venture of co-operation between our Government and the universities.

We need Federal research laboratories at the universities which combine the highest standards of graduate and postdoctorate research on an interdepartmental level with the principal needs of national defense. These laboratories should be devoted to free fundamental and long-range applied research without any hardware aspects. They would train graduate students of the universities, for instance in the broad field of modern materials research, and simultaneously have postgraduate fellows from the Services rotating through on an annual basis. The work would be unclassified in keeping with university tradition and directed by a staff of outstanding scientists and engineers which belongs to the faculty of the university, but is appointed by the laboratory for its needs with faculty approval. There will be no scarcity of excellent senior staff, if we make use of outstanding emeritus professors.

For an excellent junior staff, our country has a great untapped supply. At present our draft system makes no sense from the standpoint of technological warfare. Some are drafted, some are not; most of our good students can finish their studies to their highest potential degree, but the R. O. T. C. students can not. The sensible solution would be to let every student finish his studies with the highest degree for which he can qualify. Then everybody should be drafted for two years for the service of his country. These students should have a chance to apply for service in the Federal research laboratories. Here they would really be worth their salt in working on urgent research problems and come out after two years with an excellent postdoctorate training.

This program makes everybody the winner including industry which would get much better men and competent advice when needed. Our inherent defense strength which rests on outstanding quality of men and weapons would be vastly improved; we would at last have also the information centers we need and not be caught napping again. It will develop that this program is even self-financing by saving defense billions misspent now. Let's try it.

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