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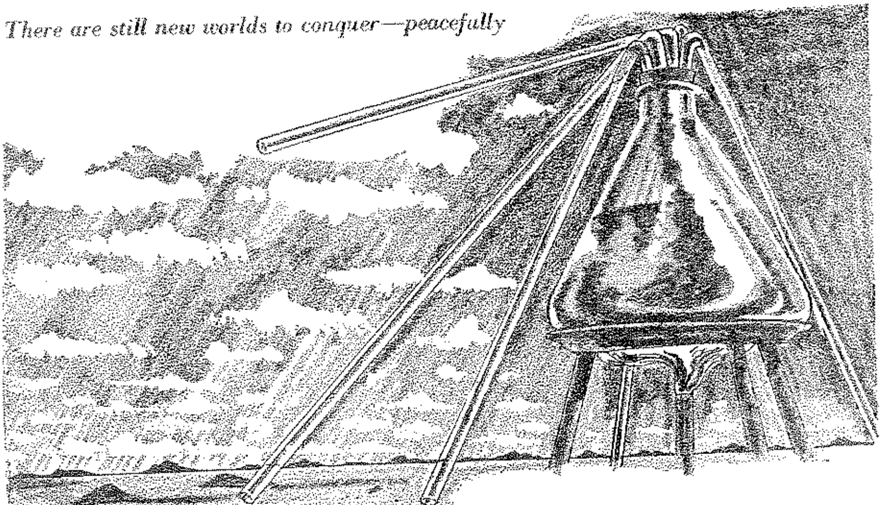
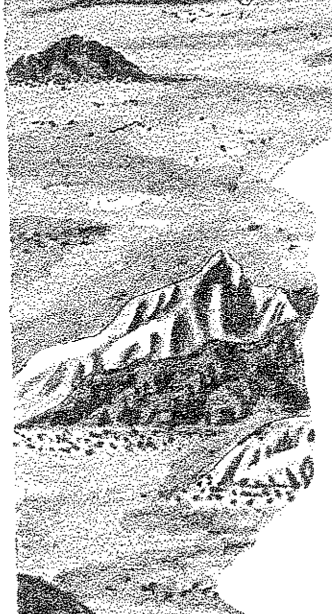
There are still new worlds to conquer—peacefully





SCIENCE
Our New Frontier

John J. Miller

THE STORY of mankind is essentially the story of national frontiers. With the expansion of a nation's boundaries, there has usually been a gain in individual stature and in national power. With the retraction or shrinkage of boundaries, there has been national collapse.

What has been true of Asiatic and European history applies as well to our own. Hardly had the Thirteen Colonies been organized before the pressure of events forced our pioneering ancestors outside the colonial borders. William Penn, by staking out all of Pennsylvania, drove settlers unwilling to pay his price for locations further west to take more land from the Indians. The Northwest Territory, the Louisiana Purchase, the settling of the far northwest—all were the result of the necessity for extending our frontiers. Significantly enough, our last geographical frontier was Alaska, which was not an integral part of our own land area.

During this long period of geographical expansion there was little or no unemployment, for whenever business stagnation threatened, the frontiers could be extended, opening up new opportunities. With the cessation of geographical expansion, the nation faced two alternatives—it had either to acquire additional foreign territory or suffer periodic industrial slumps, economic upheavals, and national retrogression.

Fortunately, at this point in our history, science came to the rescue. During World War I science enabled us to round out our industrial economy—to make fuller use of raw materials abundantly available. World War II forced us into much more intensive development of all the physical sciences, with the result that we greatly expanded our manufacturing capacity, improved many industrial processes, and increased the mechanization of our farms.

BUT MAKING two blades of grass grow where one grew before is not the entire answer to our present economic problem. We can and must multiply the yields, but, equally important, we must multiply the *variety* and the *values* of the commodities which we can produce and manufacture advantageously. We must perfect thousands of new processes and create thousands of new products—both agricultural and industrial—if there is to be an abundance of good things for all our people.

This is the job that science is equipped to do. It can function not only in preventing stagnation in the older arts and established businesses, but also in creating multiple new frontiers in whatever direction human needs may arise.

For example, one acre of farm land ordinarily produces about twenty bushels of soybeans—worth approximately $40—and it would require an agricultural miracle to increase this yield by any great amount. Through the application of industrial science, the acre's soybeans can be transformed into enough proteins, oil, lecithin and other by-products to create an acreage value of $600.

Thus it becomes evident that whereas one square mile of agricultural land ordinarily produces crop values of a few hundred dollars, this same area, when put to production of raw materials for chemurgic use, can yield values running into thousands of dollars. Or, stating it another way, one square mile of land in chemurgic production creates as much wealth as hundreds of square miles put to ordinary farm uses. The present need is, therefore, not for new geographical frontiers but for the broader application of science in bettering the utilization of the crops produced within present boundaries.

Another illustration is the conversion of coal, water, and a certain organic salt into nylon hose. A ton of these raw materials, valued at a few dollars, is transformed by science into hundreds of pairs of hosiery salable at many hundreds of dollars. Through the application of new techniques, mine-run coal is processed in half an hour's time into hundreds of different chemical substances, worth nearly a thousand times the original value of the coal.

We hear a great deal about the exhaustion of our iron deposits and consequent business stagnation in the "iron range" territory. These gloomy prophecies take into consideration only our *rich* iron mines. What about the hundreds of millions of tons of iron ore reserves which can be worked advantageously by a slight change in our mining techniques? One of the chief handicaps in our efforts to utilize these lower grade ores has been the lack of cheap hydrogen gas, an efficient agent for separating iron from its oxide ores. Now, with the perfection of the revolutionary "sponge iron" process and the development of a method of producing hydrogen from our abundant lignite deposits, the recovery of iron from low grade ores is entirely feasible. These discoveries mean low cost iron and steel for industries and consumers in many parts of the nation.

Then there's magnesium—a metal that is being extracted from the sea at the rate of many millions of pounds annually. Instead of importing it at $5 a pound, as we did before World War I, we are now producing magnesium from limitless coastline waters at 22 cents a pound. But this recovery of magnesium and of other metals from the briny deep—representing annual values of billions of dollars—may be considered as only one sector of our vast science frontier.

BUT in terra firma we have other elements that have long awaited exploitation. For instance, silicon and oxygen, the constituents of sand, make up three-quarters of the earth's crust. Silicon is probably the most abundant of all the world's metals—but what have we been doing with it? Outside of the manufacture of some glass and a little carborundum, practically nothing.

Now the *silanes* and *silicones* are coming into the limelight. The silanes are compounds of silicon and hydrogen, having a chemical structure similar to that of methane (fire damp), the principal ingredient of illuminating gas. Yet some of the silanes can be chilled to 70 degrees below zero without freezing or heated to 400 degrees (red hot) without burning. The possible practical uses of these compounds and their derivatives stagger the imagination. We know now that they serve admirably as heating agents and as hydraulic (or pressure) substances. The silicones are silanes with oxygen added, and their derivatives are valuable rubber substitutes as well as excellent electrical insulators. As covering for wiring, the silicones are unequaled for certain household applications.

As for fuels, there need be little worry about our dwindling petroleum supplies. When our farm areas are allowed to produce power alcohol, and as long as our paper mill wastes are available for conversion to alcohol, there can be no lack of motor fuel. Besides, we have our forest wastes—sawdust, bark, tree trimmings, branches—

running into billions of tons a year. These are excellent sources of alcohol and the price of alcohol so produced can be competitive with our mineral fuel.

Another important fuel is methane, the gas found in coal mines and abundant in the gas wastes of gas and oil wells. The billions of cubic feet of methane which are going to waste daily could readily be condensed or compressed for engine use. Other sources are fermenting garbage and sewage. Both can be utilized as economical sources of methane gas for operating stationary engines, or for transformation into numerous valuable chemical substances. Surely the better use of our basic fuel materials is a vital technical frontier.

The term chemurgy, simply defined, means the transformation of agricultural products into industrial commodities. In extent this frontier is practically boundless. Already we have established our own synthetic rubber factories, and we can produce rubber for about ten cents a pound—which means successful competition with the imported natural substance. For about 90 per cent of the more than 30,000 products now made of rubber, the synthetics are as good as or better than natural rubber. Our natural rubber needs, too, can be met by domestic production—from the Russian dandelion, Russian sunflower, American milkweed and the prolific goldenrod—at about the same cost as for imported rubber. Surely from the millions of acres on which goldenrod grows wild there are opportunities for rubber production which can mean much to a nation intelligent enough to utilize such a new frontier.

In the commercial preparation of vitamins we are overlooking perhaps the most abundant and available source—ordinary farm and garden weeds. From weeds we can extract carotene (vitamin A) and most of the other best known vitamins. The weeds growing in a few square miles of waste land in the Chicago area could supply practically all the supplementary vitamin needs of the city's population.

The sunflower is another long-neglected chemurgic opportunity. From its stalk valuable fibers, as well as a pithy cork substitute, are obtainable. The petals of the flower yield medicinal substances; the head provides pentosans, a rich source of furfural; and the seeds furnish an edible oil similar in properties to olive oil. The residual meal resulting from the extraction of the oil, when refined, gives an excellent cake and pastry flour. And sunflowers, if encouraged, will grow wild on lands which are now entirely unproductive.

The plastics open up another science frontier. Until recently we thought that plastics had to be made of pure chemicals, for example, phenol plus formaldehyde. Now we know that plastics for many purposes—such as household appliances—can be made from impure plastic-producing raw materials. Ordinary corncobs and corn stalks are excellent plastics sources, as is also the lignin from our paper mills, which is wasted to the extent of millions of tons annually.

Forest waste also is a valuable raw material for plastics, and the resins which are obtainable in practically unlimited quantities from tree stumps, wood wastes, crop wastes, likewise serve as plastics ingredients. We have done well in the refinement of plastic articles but we are only beginning to utilize the available waste materials for a greatly increased variety of plastic commodities.

THIS IS something of the picture of science as a basic factor in the production of wealth and in the improvement of the living standards of mankind. There are, however, several deterring influences which militate against the fullest utilization of this illimitable frontier. One is the monopolization of our natural resources—forests, mineral deposits, water sites and land—a monopoly which severely handicaps our industrial science program. Another is patent abuses, which result in the suppression of new processes and the discouragement of businesses dependent upon old methods. Then there is the lack of "know how." This is the factor, strange to say, that has kept many feasible processes from benefiting the public.

Comparatively few of our industrialists and engineers have the "know how" for using and expanding the technical methods essential to large-scale industry. Here is where our schools are partly at fault. If, instead of teaching merely the principles of science, our schools would carry on to the point of practical application in all the physical sciences, the "know how" could be spread to thousands of areas. Such a program, in combination with the encouragement of industrial science which state governments could give, would decentralize industry and make it possible for many thousands of technically inclined individuals to be in business for themselves—and thus to serve their country most effectively.

But the responsibility is not solely upon school boards, nor state and federal authorities. The people themselves must realize that science is basic and vital in our national economy. They must appreciate, for instance, the relationship between further advances in science and such practical and diverse things as the cost of electricity, the safety of an automobile, and everyone's opportunity for employment. If we want an abundance of the good things of this world—as well as such essentials as food, clothing and shelter—we shall have to give much more attention to science. Given free rein, science can create an ever-expanding frontier!

» An era like this ought to open our eyes until we see things we never saw before. This whole catastrophe goes back to the refusal of vision, to wrong ways of looking at life. What if out of this wartime experience we could come with our eyes open?

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