## We Are Doomed to Innovating

R. Hoffman\*

I have been honored with a high award, the Semenov Gold Medal, precisely at the moment at which your country is undergoing democratic changes. The whole world today is concerned about the destruction of the environment, the death of rivers and forests. And I should like to say a few words about the relationship between chemistry, democracy, and ecological problems.

Chemistry is a science of substances and their transformations. It has many practical applications: metallurgy, cosmetics, fermentation and distillation, dyeing, pharmacy, cooking, and the magic blend of ancient chemistry and philosophy known as alchemy. After uniting in its development with physics and astronomy and borrowing the power of quantitative methods, chemistry began to develop into a genuine science, about 200 years ago during the French and American Revolutions. Now the greater part of the gross national product of industrial nations is linked with chemistry, and its share is constantly growing. Directly or indirectly, a nation's wealth depends on its ability to transform the natural. Hundreds of thousands of tons of the chemical world's best-sellers are produced every year. And I can assure you, that they are not produced in such quantities for the sake of entertainment. They are produced, and they are used not for luxury but for daily bread, both literally and metaphorically. Needless to say, the manufacture of chemical products in enormous quantities gives rise to problems and even disasters as evidenced by Bhopal or, closer to your home, the dangerous condition of the Black Sea.

What does chemistry have to do with democracy? Unfortunately, all the freedoms in the world are of little help to starving people in underdeveloped countries. On the other hand, chemistry is constantly showing a specific combination of the low cost of new products and their ever-increasing strength, with new areas and possibilities of use which substantially exceed those of natural materials. Ours is the age of polymers with large synthetic molecules replacing one natural material after another. Nylon is used instead of cotton in fishnets and fiberglass is used instead of wood in ship's hulls (the old fisherman Vasilii Lomonosov would have been happy). Replacement or new use, for instance, polyethylene to wrap food, are always part of democratization, making an ever larger assortment of synthetic materials and products available to ever broader strata and social groups. Pure running water and sewage, a broader gamut of colors, more comfortable housing, the prevention of death in new-born children and women in childbirth are all results of a modern technology which is now available to a far greater number of people than before. And although chemistry still has a long way to go, chemists and chemical engineers do have something to be proud of.

In the 20th century science and technology are changing the world. Science did make itself felt before, but the man-made, the synthetic, and the artificial did not challenge the natural until the present century. So what is it – a time of praise or a time of despair?

The world in which people lived before the appearance of chemistry was not a romantic paradise but a brutal and hostile environment, where men rarely lived to be 40 and women frequently died in childbirth. That natural world was transformed by art and science. Of course not by science alone. We no longer kill newborn female babies, nor do we have slaves, or let the sick just die. And although we still have a long way to go, we have changed all nature. Our life has been improved not only by detergents and synthetic fiber but also by the man-made fabric of social and human support.

I want our colleagues in arts and humanities to realize clearly that the creation of the synthetic, the manmade, and the artificial is not an activity specific to scientists alone. Is there anything natural in these lines from Anna Akhmatova's poem?

As if over a cup I bend over them,

Those endless cherished notes,

They bring a message, dark and tender,

From our youth, steeped in blood.

These lines and thoughts are reminiscent of a catalyst for the more efficient manufacture of some chemical, or what Kandinskii did when he painted, or what Lomonosov did for the Russian language and Russian poetry.

However, we have used our abilities and knowledge not only for creation but also, unfortunately, for destruction, as we exterminated a quarter of the world's biological species and inflicted pain on nature. The problem lies in finding the right balance and achieving optimal interaction with the world around us, without letting our capacity for transformation get out of control.

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There is a concept in the tradition in which I was brought up, the Jewish tradition, consonant with our subject of the natural and the artificial. This concept is "tikkun." Its literal meaning is "restoration," "recovery." It echoes our concept of transformation: the transformation of the world by people.

Friends, we may say that we are doomed to create new things, whether it be chemical molecules, works of art, or democracy in Russia. Nature itself has doomed us to creativity. We may doubt whether our transformations are valuable to man, but there is no doubt as to what our choice should be.