

## 38. Alan L. Mackay

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*Computer graphics / Flexi-crystallography / Generalised  
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“X-ray crystal structure analysis can now be seen as a special kind of microscopy which is being extended to the recognition and examination of many kinds of ordered structure more general than crystals and which leads to their synthesis or construction by various methods. Electron microscopy and many other techniques now combine to give a coherent science of structure at the scale range of Ångströms to microns, atoms to assemblies visible to the eye, which should continue to be called “crystallography” although it overlaps with nanotechnology, molecular biology and solid state physics. Most generally, “a crystal is a structure the description of which is much smaller than the structure itself” and this view leads to the consideration of structures as carriers of information and on to wider concerns with growth, form, morphogenesis and life itself.”

However, the malaise of crystallography, the fragmentation of a harmonious research community, is really a manifestation of the wider crisis of science itself. The traditional ethic of science is changing. Science is now largely not done for the general good but for money and power. Nowadays science, on which technology stands, represents military, economic and social power and, especially since the recognition in the 1960s of the “scientific and technological revolution”, science has become subject to all the strains of such participation. Taking land and mineral resources into private ownership was the feature of the “enclosures” of the 18th–19th centuries. During industrialisation, the means of production became privately owned. In our own period the emphasis is now on the private ownership of “intellectual property”, including aspects of the genomes of human beings and many other organisms. Intellectual property includes many of the results of scientific research. With the collapse of the Soviet Union the major alternative system of managing the ownership of land, the means of production and intellectual property has disappeared and we are left with the “market economy”, so-called globalisation, which in practice means the pressure to make all national economies conform to the practices of the present US economy in which “multi-national” corporations, outside popularly elected systems, exert power comparable to the power of nation states.

The consequences of this for traditional science have been severe. The ownership of intellectual property is overwhelmingly concentrated in the USA so that develop-

ing countries find it impossible to develop independent manufactures. In the USA there are some 900,000 lawyers who live by determining ownership and other "rights". (In Japan, with different traditions, there are only 18,000). At the same time science has passed from Small Science to Big Science and front line research facilities are increasingly out of reach, so that a brain drain is encouraged, where the poor countries subsidise the rich by exporting their most talented people. The scientific structure of the former Soviet Union in particular has been cannibalised, productive projects and people being taken over by other countries. Previously, countries such as Japan and S. Korea moved through industrialisation to modern technology by frank copying from more advanced countries. This is now much more severely inhibited by strong economic sanctions. As with wealth generally, the difference between rich and poor, scientifically as well as economically, has become much accentuated.

Individual scientists, especially in the biomolecular field, are now tied directly to commercial enterprises so that the free exchange of information is inhibited. Large sectors of science have been militarised with even more severe restrictions on communication. At the same time, business management techniques have been applied to scientific research. People are pressurised: "Dr Pythagoras, it is a long time since you produced a theorem". As J. D. Bernal liked to point out, society is still in debt to science for electromagnetic induction, antibiotics and very many free gifts to society, which, if even a small royalty had been exacted, would have paid for all subsequent science and scientists. The recruitment of scientists has been inhibited by the greater salaries earned by people in the financial, management and advertising sectors.

Emerging from the war of 1939–1945, the International Union of Crystallography was outstanding in its internationalism and its support for scientific research, the free dissemination its results and for help in enabling scientists in developing countries to work effectively in their own countries. Since the prevailing mode of property ownership is being forced on the old traditions of science, where a scientist acquired intellectual ownership of a discovery by giving it away, consideration might be given to the assignment of intellectual property, in the form of molecular structures, genome sequences, processes and techniques, copyrights, etc. to the International Union of Crystallography, insofar as it is necessary to prevent them from falling into private ownership.

George Soros has done individually more than anyone to address these issues. Perhaps the International Union of Crystallography could take the lead and collectively look into such problems which are of growing concern to all scientists.