Science in the Art College

E. Dobing
Sunderland Polytechnic

35

Students taking a Foundation Course in Art colleges are encouraged to broaden their educational experience as far as possible. From a practical and even a purely cultural standpoint, a knowledge of science seems invaluable or even essential. But the problem remains of what science to introduce – and at what level? One solution is to talk about the history of science or the philosophy but theses young people are not interested in placing a study which they barely comprehend in a perspective which they do not appreciate. They are more interested in the direct experience of scientific activity. Once they realise that they need not think of themselves as "artists" or as 'scientists" but as individuals who can participate in one activity as readily as in the other, then the organiser of such a course starts with a basis of goodwill and enthusiasm.

But what of the obvious disadvantage, their lack of scientific or even mathematical knowledge? This situation is not confined to Art students. Any interdisciplinary approach must consider the base on which it is to build. This problem can be overcome by rejecting the idea of building a firm foundation of mathematics and the principles of measurement and adopting a phenomenon – based approach. Start with the object, the material, the process or the observation and look very closely. Use a magnifying glass or a microscope or ultrasonics or x-ray diffraction. It is not necessary to comprehend wave particle duality to see the effects of the ultra-small in an electron microscope.

This description of a course which has been run by the Materials Science department at Sunderland Polytechnic for several years, illustrates the pleasures and pitfalls of this approach.

At the very first meeting, the students go into the laboratory and melt aluminium in an induction furnace. They can see exactly what is happening and in a few minutes they are pouring molten metal into sand and metal moulds and watching the results. The effects of surface tension, shrinkage and cooling rate are immediately obvious. The small castings are cut vertically and the exposed faces are polished and etched. The effects or differential cooling rates and casting defects are immediately apparent but it is the grain structure itself which is used as a starting point for the discussion of crystal structure.

Many students are aware of the regular crystalline structure of common materials like sugar and salt but very few appreciate the variety of materials which are crystalline or the relationship between crystallinity and the regular arrangement of atoms. An examination of as many different crystals as possible leads to comparison and classification and very often to excursions into geology.

At this point, students sometimes feel that the subject is expanding too quickly and they welcome the idea that atoms are arranged in patterns and that this arrangement decided she shapes they have been seeing. Polystyrene balls built into three dimensional solids with minimum restraints are most effective although more sophisticated models of unit cells are used if they are warranted by student interest. The idea of close packing is emphasised and the significance of interlocking close-packed planes on mechanical behaviour is particularly strongly stressed. Indeed, this is just the first of many occasions when a distaste for the "great man" view of history can be indulged by pointing out the effect of mechanical working on face-centred cubic copper and the effect of Bronze Age Greeks on the history of art.

The students now have a model of the material world and are confident enough both to see snags and to want some direct experimental test. The startling confirmation of crystal structure produced by Friedrich and Knipping with x-ray diffraction is easily reproduced. Thin slices of pure silicon and other materials, very accurately oriented, are readily available and the use of polaroid film enables very short exposure times of a few minutes to be used. Quite complicated layer line pictures can be obtained by using drawn polypropylene. The surprising symmetry of these patterns convinces even the most sceptical and the way is now open to relate structure and properties.Testing materials to destruction on the miniature rack of the Hounsfield tensometer provides evidence that the ideal model will not suffice and the idea of dislocations must be introducted. Here, bubble rafts and an overhead projector with a perspex tray and ball bearings provide dynamic illustrations.

The difference between the mechanical behaviour of metals and polymeric materials and the variation between polymers is immediately apparent. An explanation is sought on the level of atomic arrangement. The idea of directed valency bonds is acceptable without recourse to any discussion of hybridised orbitals and the unique position of the carbon atom is readily appreciated. Building up random structures from model carbon atoms invariably produces a diamond molecule, long chain, branching and network structures. Educational psychologists may like to know that Art students produce more long chain structures than engineers who tend to co-operate in the production of giant diamond molecules.

A collection of plastic objects reveals wide differences in properties. The connection between screw-driver handles and cross-linking is striking and similarly the relationship between flexibility and a spaghetti-like mass of long chain molecules. The more complicated load versus extension curves are explained as far as possible in terms of spring and dashpot models. Many polymers can be made in the laboratory and simple processing at relatively low temperatures produces test specimens and totally useless pin trays.

The importance of temperature to the behaviour of polymers leads to a consideration of glassy materials and the possibility of a level of organisation above the atomic or molecular. Microscopic examination indicates the presence of phases in metallic alloys and the construction of a binary phase diagram for the lead-tin system from cooling curves is an instructive co-operative exercise.

In forty to sixty hours, it has proved possible to convince the students of two propositions: first that just as engineering can be looked upon as the study of the relationship between the behaviour and properties of materials, these properties are dependent on underlying structure and second, that it is possible to obtain a working model of the material world without laying down a pyramid of mathematics and the intervening physical sciences.

Making Modern Danish Furniture
by Rolf Schutze, published by
Van Nostrand Reinhold, £1.60.

37