The Natural Philosophy of Paintings

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IN his inaugural lecture in 1936 as Tait professor of natural philosophy in the University of Edinburgh, Prof. Max Born referred to an essential difference between science and art. Mathematical and physical theories deserve well if they meet the intellectual needs of their period, whereas the creations of great artists are for all time. It might appear from this that mankind is obliged to reckon with continuous change in his scientific concepts, and can hope to find rest unto his soul only in the static nature of art. However this may be, it is no purpose of the present article to insist upon such a distinction, but on the contrary, rather to inquire into the conditions which exist (or may exist) tending to bring the worker in the 'exact sciences into contact with the world of art and its problems.

One such opening is obvious enough—the task of applied physics and chemistry in assisting the curator in the conservation of paintings, both by a knowledge of materials as such and by devising methods of improving the environment in which objects of supreme value are housed. Progress along these directions is not difficult to trace. There are laboratories specially equipped for such studies at the Fogg Art Museum in the United States, at the Louvre in Paris, the National Museum in Lisbon, and three in London—at the British Museum, the Courtauld Institute (Norman Wilkinson Foundation) and the National Gallery. Much has been learnt at all these places; but it is clear that basic questions relating to the behaviour of paintings in certain circumstances remain unanswered, and that a fair amount of the data so far collected is little more than empirical.

In Great Britain, co-operation with specialist institutions under the Department of Scientific and Industrial Research has proved both interesting and effective. The experiments needed are so many-sided that no one laboratory could expect to cope with more than a fraction of them.

There is another way in which physics and chemistry may help. This is in the prosecution of systematic studies relating to the technique of the old masters: the search for forgeries and their possible establishment are notoriously difficult tasks, but if and when such results are possible, it is not infrequently as a by-product of the careful investigation of painters' methods in general. There is much to be said for the regular use of X-ray analysis to assist the student of art history

in his researches, and as a check upon the conclusions which he may reach on stylistic grounds. It is no part of scientific method to attempt to do what only 'an eye for a picture' can, in the end, accomplish; nevertheless, investigators will not refuse objective evidence when it can be forthcoming. Fortunately, favourable cases do arise.

Yet another possibility can be visualized, difficult as it is. In much the same way as physics and philosophy are to some extent conterminous, so a detailed study of art history leads naturally to the necessity of exploring the mind of the artist, and consequently the outlook of his time. Thus art history and psychology tend to share common ground. Doubtless, a large number of pictures were commissioned and executed according to rigid conditions prevailing in the ideas of the period, yet here and there examples appear which seem to indicate that the work in question was brought into being in the subconscious mind of the artist and is thus a document of the deepest significance. It is a far cry to the day when anything of this nature might conceivably be demonstrable experimentally; what is important at the moment is the infiltration of scientific method into the attempt to effect a closer synthesis between our appreciation of works of art as they are, and the mental and cultural background which produced them. A work of art is an organized whole, possessing shape as well as tone; above all, it is no mere accident, and in its fashioning the artist may be presumed to have given of his best. These conditions approximate to the law of *prägnanz* in the psychology of Gestalt. It may be here that, in the last resort, a natural philosophy of paintings may be found.

The immediate problem is the application of scientific principles to paintings in the matter of conservation, restoration, environment and in the systematic study of technique. A major consideration is that of safety. No risks can be entertained for a moment, and therefore much may have to be learnt upon models, or by the artificial reproduction of conditions. The essential characteristic of a painting—mural or panel—is its stratified structure. In order, there are (a) the support or carrier, for example, plaster or wood, (b) the ground, (c) the paint film, (d) the surface or varnish film. According to the varying methods of different schools, modifications of this sequence

may arise; but it represents the normal state of affairs, and the one with which the scientific investigator usually has to deal. Clearly, of the four, the paint film is of the greatest interest to the beholder, for it is in fact 'the picture', as generally understood.

From this arrangement the scope of physical and chemical investigations can be gauged. First comes the need for accurate knowledge of the physico-chemical properties of plaster and wood. Secondly, the ground is perhaps composed of 'gesso', a water paint containing lime as its main constituent, and often the seat of an involved system of cracks, which may influence the layer above. Thirdly, the paint film is a most complicated phase, comprising pigment plus binding medium. Fourthly, the varnish film is not an exact chemical entity, and its properties change considerably with time. All these layers react to some extent upon one another, more especially with regard to relative flexibility. Chemical reactions in the paint film sometimes generate fissures akin to geological phenomena on a minute scale.

In general, the paint film may be constructed in a variety of ways. The pigments may be embedded in a previously prepared surface, or they may be powdered with a suitable medium (as in ordinary oil painting), or again they may be applied to a dry surface and afterwards fixed by some kind of spraying.

As in other branches of science, physical methods may be preferable to chemical ones in that no sampling or removal of minute fragments of material is required. When, however, it is necessary to know for certain the composition of a pigment, then it has long been the custom to detach a microscopic amount from some inconspicuous part of a picture (under the rabbet of the frame for example) and to subject it to chemical or spectroscopic analysis. In very favourable cases, observation with a polarizing microscope will give a clue to the nature of a pigment *in situ*, by reference to crystallographic properties, colour and index of refraction. An extremely illuminating method—when conditions allow—is to use a micro-borer, and so to obtain, in the form of a minute cylinder, samples of all the different strata. Microscopical examination of the core, at a magnification of about one hundred diameters, reveals the constituents clearly.

The possibilities of X-ray work are considerable, and at several institutions systematic use is being made of them. The whole process, so far as pictures are concerned, depends for its success upon the particular pigments and technique in question. It is by no means of universal application. Exceedingly thin films of paint, such as

those sometimes used by the Venetians, are frequently too transparent to offer any appreciable resistance, except perhaps to the very softest radiation. However, areas containing much lead or mercury, in the neighbourhood of compounds like the lakes, composed of elements of low atomic weight, make excellent subjects, and a wealth of detail is often revealed. Sometimes the experienced eye can perceive the presence of an outline under the visible paint layer: X-ray photographs supply the objective proof. The uses to which such photographs can be put are several. If it is proposed to remove over-paint, the extent of the original picture left can be determined before any action is taken. Again, a previous version of a composition may be discovered or, as has happened lately, the work of two artists can be distinguished.

It remains now to discuss some external factors which influence the condition of paintings, and to which it is possible to apply scientific methods. For many years there has been an increasing movement for the abolition of the glasses from pictures in the national collections. From the students' point of view such a course would have everything to recommend it. In practice, however, difficulties are encountered. Experiments have shown that the surface of a canvas, if unglazed, is usually cooler than the air of the gallery, and consequently condensation of moisture sets in, forming a thin wet film over the varnish. Dust and smoke particles settle on this film, and create in time a dull, dirty layer, easily removable in some cases, but by no means in all without risk to the varnish. The cure, theoretically, is a complete air-conditioning and filtering plant. Observations in the National Gallery have demonstrated that for every pound of carbonaceous material per million cubic yards of atmosphere in the immediate neighbourhood of the gallery, 0.7 lb. is present within the building. This is an average figure for the interior as a whole, and seems to represent a fairly constant quantity. In any event, there is a strong argument for air-conditioning in museums and galleries if objects of art are to be seen at their best.

Perhaps the greatest need of all, as indicated already, is a closer understanding between the outlook of the student of art history and that of the scientific investigator. Co-operation for practical ends like conservation and protection there must obviously be. But the ultimate aim is a more intimate fusion of the two ways of thinking, such as would lead to the appreciation of a work of art as an object of the profoundest symbolism. Some of the great masters were intellectuals of a high order, as well as supreme craftsmen. To know them better is to broaden our concept of natural philosophy.