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Arts Trade Association Dinner: Speech Research (1963-1967): Article 10

Garry Thomson

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S SCIENCE SERVING ART?

y Garry Thomson
ational Gallery, London

well-founded and far-sighted policy of conservation can invoke a great deal of nteresting scientific research, the author argues. The result could be the saving of many reasures which otherwise threaten to deteriorate comparatively quickly

may be timely to question whether ientists are doing all they could for art. e all regard art, surely, as one of the ry important possessions of civilization, hich ought to be cared for with due ought. Civilized people have the simple sponsibility of looking after objects of gh artistic and historic value, whether eated 15 000 years ago or yesterday.

this article I shall examine how we ight increase the effectiveness of just e branch of art conservation, that of ientific research. But first, to get re- arch in this context into true perspec- e, let me mention some wrong notions out science to be found both outside and side museums.

ome misconceptions—Neither conserva- r nor art-historian takes particular easure in discovering fakes, which are thing more than unpleasant diversions om their true business. Fakes are not ually detected by scientists, but by art- storians who, except in rare cases, can adily detect them by anachronisms of le or inferior quality and technique. ice an important fake is suspected, how- er, it is logical to ask for an examination a scientific specialist, who may well be le to provide concrete evidence one way the other.

e usefulness of chemical analysis in the useum is accepted by all but diehard ditionalists. A restorer needs to know much as he can about the structure of e object under his hands: thus he makes e of microchemical analysis, special ms of photography, spectrography, chro- tography, and other techniques. These ne techniques can add to the corpus of owledge of the history of materials and hnology, and to the understanding of terioration.

e work of analysis is pretty mundane, course, unless the analyst can apply his ults either to a framework of history to an increased understanding of emical and physical change. If he can this intelligently, he becomes rare and uable. Museum directors, not being entists, find it very difficult to evaluate e usefulness of many of the other kinds science, unless their imagination is far- ching; but the case for analysis at least clear to them. There is now some pro- ion for it in most of the major world museums.

But analysis is only the beginning of science. Although a worthwhile research project is expected to take three years or more, the scientist still needs to justify himself; if he works in a museum for some years without any tangible results, people begin to get sceptical about his usefulness. Alternatively, the pressure of continual demands for advice, once he has acquired a reputation, may side-track him. Thus it is that many a museum scientist, starting with well-conceived, long-range projects, is forced by necessity into a never-ending round of incomplete solutions to improperly formulated workaday problems.

Professor H. J. Eysenck recently wrote that "it would probably be true to say that concentration on *apparently* unimportant issues and laboratory investigations of problems of theoretical interest characterizes a maturing science, whereas exclusive preoccupation with direct practical questions is often characteristic of a pre-scientific stage". We have now reached a stage where the old priorities no longer hold, and we must move from pre-science to the proper application of the scientific method.

Even though the highest price ever paid for a picture—about £820 000 for Rembrandt's *Aristotle contemplating the bust of Homer*—amounts to no more than one day's military aid to South Vietnam, or one large computer, we can at least convert the last two to man-hours, and know that the men who did the job got most of the money. It is disturbing, however, to know that a quite negligible proportion of the present price of every major classical picture benefited the painter himself. Yet when objects become great rarities and national assets, their "value" rises inexorably to fit their new status.

At least some good things come of it, however, if the picture enters the relative safety of the museum: the relatively skilled care by the staff; and the possibility of financing research for better care in the future. Any argument which bases maintenance cost on the value of that which is maintained, must give conservation even more than it needs, for the national collections have become literally priceless.

The record—The success or failure of science depends on what one thinks is due to science rather than to the mere application of commonsense to new materials and methods. One hopes to find a well-defined project of research carried through to a conclusion which is both an advance in its own right and leads in turn to some small change for the better in museum conservation policy. But my own observations point almost always in the other direction—to the scientist as mediator between the craftsman and modern technology; in short, to an incomplete fulfilment of his role.

Picture cleaning is a skilled craft involving, first, the removal of dirt and discoloured varnish; secondly, the ensurance of the security of the paint on its support (possibly by transfer to a new support); and thirdly, the restoration of missing areas by applying new paint.

Operations at the first stage profit by a technical knowledge of solvents; and those at the second by the use of adhesive technology. But for the third stage, artistic and aesthetic capabilities are paramount. All other restoration processes must pass through three similar stages—the removal of dirt and corrosion, insuring the physical security of the object, and the final treatment for appearance. But to a true conservator the second stage is overwhelmingly the most important aspect because it is concerned with the future safety of the object, public argument concentrates almost exclusively on very fine issues connected with the first and last stages.

Significantly the importance of science in relation to aesthetics could be said to vary for different kinds of art, the ratio being low for pictures but relatively high for metal work.

Let us now consider briefly some of the more technical operations which take place in the conservation department of a large museum, and the usefulness of science to these operations.

Fresco transfer—Italy is the land of frescoes, and many of them are deteriorating at an alarming rate. The two chief agents of destruction are water movement and sulphur dioxide.

If there is water transport from inside the wall to the air in front of the fresco, evaporation at the surface of the fresco causes deposition of the salts dissolved in the water. Deposition often occurs underneath the paint surface, causing it to blister and flake.

True frescoes are constructed by applying pigment in water to a still-wet lime (calcium hydroxide) plaster. The pigment is bound to the surface by the conversion of hydroxide to carbonate. This is where the reaction ends—until sulphur dioxide strays into the atmosphere as a by-product of industrialization. Oxidized to sulphuric acid, the gas readily converts a firm layer of carbonate to a powdery one of sulphate. Transfer of deteriorating frescoes has been undertaken so that they can be redisplayed in a safer environment, such as a museum. In other cases frescoes have been brought to museums from remote localities, for example from Sinkiang to Leningrad.

The safety of the paint layer is first assured by applying a "facing". This is a textile or paper, bonded to the paint surface in several layers by an adhesive which can later be removed without damage to the paint. The facing must be supported to take the weight of the detached fresco. Fresco and wall are then parted, using one of several methods, all calling for skill and patience. The plaster back may then be further thinned and levelled so that it can be mounted on a new support and the facing removed. Synthetic adhesives have been used for both facing and final support, but they have by no means yet replaced traditional glues.

Preventive treatment of fresco decay *in situ*, as opposed to rescue operations, calls on architectural knowledge of damp-proofing. The removal of sulphur dioxide from enclosed environments is an undeveloped technology which is entitled to more help than it gets from museums, the main beneficiaries.

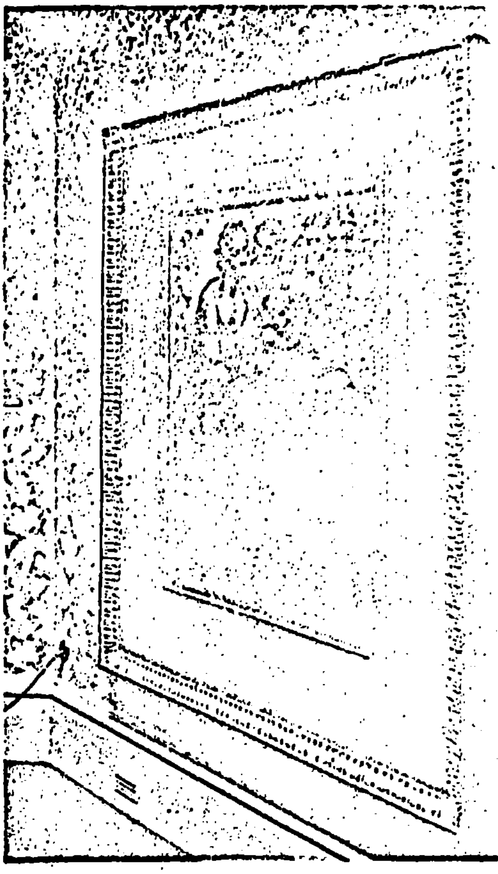
Electrolytic treatment—While picture and textile restoration proceed in the atmosphere of the studio, metalwork is dealt with under more rugged laboratory conditions. Electrolytic techniques have been associated with museums since at least the 1920s. A large museum laboratory such as that at the British Museum will have facilities for the electrolytic reduction of corrosion on silver, copper, bronze, lead and iron, as well as apparatus for intensive washing.

Much more important than the improvement in appearance brought about by reduction of corrosion is the detection and elimination of "bronze disease", which arises through the presence of cuprous chloride and its conversion in the museum to green cupric chloride, resulting in active corrosion. A good bronze patina is usually preserved for its beauty, but any signs of "bronze disease" are ruthlessly eradicated; practical methods have been worked out for doing it. This is an example of how conservation research has got no further than the need to solve particular problems of treatment. But further progress on this and other forms of metal conservation may well depend on more fundamental studies of, for example, slow corrosion mechanisms in buried objects.

Deacidification of documents—Of all the museum materials requiring study, cellulose is in a category on its own. Consider all the written documents, textiles, and implements made of cellulose in the form of paper, cotton, linen, and wood. Cellulose

Right *An example of good—though not perfect— conservation. The Leonardo cartoon,* Virgin and Child with St Anne and St John the Baptist, *as it now hangs in the National Gallery. Before hanging the picture was minutely examined by the Conservation Department for security of its surface, and small adhesive repairs were made. Level of illumination is controlled below 150 lux, but visual acuity is high because of the absence of reflections. Ultra-violet radiation has been eliminated by filters over the lamps. The air, both in front and behind the cartoon, is kept at constant relative humidity and temperature*

Below *An example of bad conservation. In the 1920s wax was recommended for the surface treatment of flaking frescoes. But it actually increased flaking in many cases, owing to water movement building up salts beneath the impregnated layer. This detail, from Winchester Cathedral before recent conservation, shows flaking, especially along cracks, caused by the earlier treatment with a wax emulsion. Courtesy, Central Council for the Care of Churches*



is a prey to all four of the major museum enemies: photo-oxidation, humidity change, air pollution, and biological attack. The paper on which this article is printed, being of relatively poor quality, could be made to illustrate attack by all these four in less than a month.

The state of conservation of cellulose as textile and paper also well illustrates the state of the art as a whole. As in medicine, the very sick and very important are painstakingly repaired. Missing pieces are duplicated; textiles are stitched or stuck to supporting fabrics; documents are laminated by a process which takes long enough to prevent its application on a large scale.

Meanwhile, because of lack of funds or misdirected enthusiasms, strong sunlight continues to play on delicate textiles, museums—even new ones—remain without humidity or ultraviolet control, and the sulphur dioxide concentration both outside and inside museums shows no signs of falling.

The technique which lends some semblance of science to paper conservation is exemplified by the well-established Barrow process (see *New Scientist*, Vol. 17, p. 138). Since Barrow has worked for years specifically on the conservation of paper, this is not a borrowed technique but one for which conservators can take direct credit. Book papers become acid either because acid materials like alum were used in their manufacture or because of sulphuric acid from sulphur dioxide pollution. Acid embrittles paper by hydrolysis of the cellulose. Barrow soaked paper first in calcium hydroxide, which neutralized the acid present, and then in calcium bicarbonate, when the excess lime is precipitated as carbonate. A later development for books involves a single spray of magnesium bicarbonate. The paper therefore comes out of this treatment impregnated with a slight excess of solid alkali. The paper is physically weakened by this deacidification process, and is therefore laminated between sheets of specially plasticized cellulose acetate, at about 160° C.

The literature on cellulose degradation is woolly and contradictory. Neither the mechanism of "dark attack" by sulphur dioxide nor the course of photo-oxidation is understood with any clarity. The part played by constituents added during manufacture is even more obscure. But cellulose is a highly variable natural material, and there is bound to be a complexity of interacting degradation processes. Chemistry has only just evolved to the stage when it is capable of dealing with such problems.

The Future—These three examples are perhaps untypical in that they look to the prevention of future decay. It would surprise most readers to discover that the largest part of contemporary "conservation" throughout the world is concerned predominantly with *present* appearance. Where the future is considered this is mainly from the negative point of view that the materials used in repair should be at least as durable as the object repaired, and that they should in general be removable with safety if anything goes wrong in the future. Even this is a comparatively recent change, contingent upon the introduction of synthetic resins.

Good scientific research is self-perpetuating. There must be a programme, but the significant growing points are found where things don't go as expected, and the significant scientists are the ones who discover these anomalies.

To convince the sceptic how necessary research is, we need only re-examine the three examples above from a forward-looking point of view. Through the fundamental questions which they raise, fresco transfer, reduction of corrosion, and deacidification of paper could become the inspiration for the following studies:

1 (a) The effects of moisture movement on slow change.
  (b) The chemical effects of air pollutants on museum material.
2 Slow corrosion processes in metals before and after their transfer to museums,
3 Surface chemistry, with emphasis on photo-oxidation, of museum material.

The point I must emphasize is that any conservation problem, while appearing to require a mere mechanical solution, entrains a lot of unanswered questions. It is not even easy to ask the right questions. The four studies above would each have to be broken down to a number of precise questions from which research could be hopefully initiated: such as whether moisture cycles can induce fatigue failure in moisture-absorbent materials; what the detailed course of the degradation by SO_2 of cellulose is; whether diffusion through micro-pores rivals ionic diffusion in a typical slow bronze corrosion; or how surface reactions differ from those at 10 microns depth in an organic surface film. Note the two characteristics which stand out in this branch of chemistry: solid-state reactions and an emphasis on very slow processes. Now the success of science in conservation research should be judged from its usefulness not only to conservation but to the general progress of scientific knowledge. Is this proposed research already in progress with better facilities elsewhere?

Though the chemistry of solid-state reactions is relatively new and undeveloped (apart from metals) we can expect much help from it. Metallic corrosion, being of huge economic importance, is lavishly researched, though little of this research is applicable to antiquities. To a smaller extent, the smogs of Los Angeles have forwarded the progress of air chemistry. The emphasis, then, is on reactions too slow to be the concern of this world of planned obsolescence. These are almost outside the range of existing institutions, and may be different in interesting ways.

University or museum laboratory?—The hard figures on employment of science graduates in conservation in Britain at present are as follows:

British Museum Laboratory	5
National Gallery Laboratory	3
Victoria and Albert Museum Conservation Department	2
London University Courtauld Institute of Art	1
Ministry of Public Building and Works Ancient Monument Laboratory	1

More by chance than by good management I think it would be fair to say that Britain is in the lead in research and scientific advice—but the resignations of only one or two scientists could put us near the bottom of the ladder.

Furthermore the desire to solve problems in a fundamental way, whether strong or weak, is likely to be defeated by circumstance. Most of these scientists are employed to advise, and this means that they must spend much of their time explaining scientific facts in non-technical terms, and carrying out rather lowly experiments on the behaviour of manufactured products. Both are admirable exercises—in moderation. This is the line of least resistance, and the country has the right to expect more from scientific conservation.

I don't frankly think that the training of conservators and scientific research could be organized together. Certainly training could not be modelled on the lines of university teaching, since a proportion of both teachers and students would not be science graduates, so that there would be a much bigger gap between teaching and research.

In the hope that some unified policy can one day be formed, I will end by listing only what is needed for proper scientific research. First, there must be enough science graduates to form a viable group; the "critical mass" is probably about 4-6. A set-up with perhaps one graduate in charge and one or two others on limited research grants is self-defeating parsimony. Next, there must be clear priority for long-term research. The group would plan its own objectives, and should be allowed to continue so long as it retains the respect of other scientists. Also, one needs adequate laboratory facilities and assistance, close contact with a national museum, and a university.

Finally, there must be an open door, by which I mean the laboratory must not become an over-specialized dead-end for its staff. Moreover, when reactions take hundreds of years, research must rely on a study of ancient materials for its primary data. Therefore the structure of research must be based on advanced facilities for analysis.