ICCROM

VENICE OFFICE

University Postgraduate Curricula for Conservation Scientists

Proceedings of the International Seminar

Bologna, Italy, 26-27 November 1999

UNIVERSITY POSTGRADUATE CURRICULA FOR CONSERVATION SCIENTISTS

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International Centre for the Study of the Preservation
and Restoration of Cultural Property
Via di San Michele 13
00153 Rome, Italy

E-mail: iccrom@iccrom.org

http://www.iccrom.org

Layout and text editing: Cynthia Rockwell

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Contents

Organizing Institutions

ICCROM

Project Team:
Marc LAENEN, Director General
Rocco MAZZEO, Project Coordinator
Liliana RIZZO VECCHIO, Administrative Assistant

UNIVERSITÀ DEGLI STUDI DI BOLOGNA, ITALY
Facoltà di Scienze Matematiche Fisiche e Naturali

Project Team:
Fabrizio BOLLETTA, Dean of the Faculty
Sandro TORRONI, Chemistry Department
Greta PIOVANI, Administrative Assistant
Luisa LANZARINI, Assistant

PARTNER UNIVERSITIES

AACHEN UNIVERSITY, GERMANY
IBAC, Institut für Bauforschung Rheinisch - Westfälische
H. Rainer SASSE

ARISTOTLE UNIVERSITY OF THESSALONIKI, GREECE
Department of Civil Engineering, Division of Structural Engineering
Ioanna PAPAYIANNI

UNIVERSIDAD DE OVIEDO, SPAIN
Department of Geology
Rosa M. ESBERT

Foreword

Since its inception, ICCROM's main concern has been to define and promote a professional approach in the conservation of cultural heritage. Together with proper attitudes and ethics, a professional approach includes the development and application of scientific methods and standards and disseminating this information among conservation professionals.

All of ICCROM's well-known training courses are based on science and ethics. An international network of scientific professional organizations, institutions and individuals is mobilized to realize these main objectives. The course on Scientific Principles of Conservation has been one of the core ICCROM training courses, addressed to interdisciplinary teams of mid-career professionals, teaching a holistic approach in conservation practice and promoting a shared, complementary responsibility.

While there are many recognized national and international training initiatives where conservator-restorers, conservation architects, archaeologists and art historians can be trained in order to achieve their specific professional skills, there are no training opportunities either in Europe or elsewhere for young scientists wishing to specialize in conservation science. The basic education of a conservation scientist is generally in one of the natural and/or physical sciences, normally followed by a gradual familiarization with conservation-restoration problems in the field. In other words, they often learn on the job, slowly acquiring expertise.

Heritage conservation requires diversified competencies, and the number of scientists who devote themselves to conservation is increasing to keep pace with the growing importance of diagnostic studies and research on conservation therapies.

ICCROM took some initiatives to respond to this important need: a survey on needs and provisions for the training of conservation scientists, specific courses for conservation scientists in collaboration with English Heritage and the Institut français de restauration des œuvres d'art, and a first discussion at the meeting of the International Council of Museums-Conservation Committee in Lyon in October 1999.

The University of Bologna hosted a follow-up seminar in which the role of scientists in the conservation process was further defined, together with the skills and attitudes needed in this field. Training opportunities and scenarios were also explored.

ICCROM wishes to thank the Rector and the Faculty of Mathematical, Physical and Natural Sciences of the University of Bologna for having offered the opportunity to address this important lacuna in the training landscape for heritage conservation.

Marc Laenen
Director-General

Remarks from the University of Bologna

Dear Colleagues, Ladies and Gentlemen,

For some years now, the University of Bologna has been deeply concerned in the matter of cultural heritage.

After the opening in Ravenna of a new Faculty of Conservation of Cultural Heritage, which is mainly devoted to humanities studies, the Faculty of Mathematics, Physics and Natural Sciences has addressed its interest to the role of a Conservation Scientist whose technical and scientific capacities integrate with humanities knowledge.

This is the main reason we accepted with great pleasure the proposal made by ICCROM in Rome to organize this seminar. It is our conviction, in fact, that the outcome of the seminar will be of great help for any future development.

This year, our Faculty has activated an undergraduate diploma for Diagnostics Technician applied to Conservation and Preservation of Cultural Property. The diploma programme takes three years. During the first two years, the training curriculum includes subjects that are typical of a scientific programme, for instance mathematics, computer sciences, physics, chemistry, biology, geology, etc., and also subjects related to humanities studies such as art history, archaeology and history.

The third year of the diploma programme includes an experimental course with a laboratory specialized in restoration. The aim of this diploma is to form and train technicians who will acquire a good knowledge of the history of works of art and the ability to suggest the most suitable and advanced techniques for restoration and conservation of a work of art.

The teaching activity of the Faculty in this particular field is not limited to this diploma. In fact, annual programmes of conservation chemistry are also included in the Graduate Degree Course in Chemistry (the Italian 'Laurea' Degree) and in Environmental Sciences.

Moreover, many programmes of our Faculty courses deal with chemical and physico-chemical techniques applied to the diagnosis and restoration works of art.

In the Bologna area, the teaching and training activity of the university is associated with an important research activity carried our by several research and study groups within the university and other research organizations (CNR, ENEA, etc.) dealing with various aspects of conservation and preservation of cultural heritage.

No doubt, a conservation scientist must receive a strong scientific education. Our Faculty is therefore ready to approach the problem of creating a European inter-university postgraduate programme in Conservation Science. We are fully aware that many problems will have to be addressed, but at the same time we hope that this seminar will give us some indications or even suggestions.

The highly interdisciplinary character of the course of studies and consequently of the conservation scientist is the biggest issue: We all know how difficult it is to get experts belonging to scientific, technological and classical cultures to work together. We are, however, convinced that the Science of Conservation is the ideal terrain on which we must meet the challenge.

The profile of a Conservation Scientist is that of a technician capable of:

i) understanding the nature of materials;

ii) interpreting the processes of deterioration;

iii) critically evaluating the results of analyses performed; and

iv) finally suggesting the most suitable restoration techniques to be adopted.

This should be done not only from a purely scientific viewpoint, but also on the basis of a background in history and art.

Certainly, this goal will not be achieved with a mere few years of study, but will probably require long applied training. Nevertheless, the project of educating and training Conservation Scientists is certainly very appealing!

Fabrizio Bolletta
Dean of the Faculty

Remarks from the UNESCO Venice Office

On behalf of the UNESCO Venice Office, I would like to thank the organizer for inviting our office to this important seminar. Indeed, the organizer is to be commended for this initiative, since conservation is one of the unique domains in which culture, science and technology interact. None of these three areas is sufficient by itself. Their strength lies, rather, in interactions among them. It is hoped that today's seminar will be an opportunity for a constructive dialogue among experts in different fields of heritage conservation.

Monitoring World Heritage Sites

As you well know, UNESCO administers three international conventions in the field of heritage preservation, one of which is the Convention concerning the Protection of the World Cultural and Natural Heritage (1972). This Convention sets up a World Heritage List, on which currently 582 sites (445 cultural, 117 natural, and 20 mixed sites) are inscribed as heritage of universal human value. Article 29 of this Convention also invites States Parties to make a periodic report on the conservation status of World Heritage Sites in each country. In this connection, it is hoped that the scientific principles of conservation will be further popularized among administrators, and conservation scientists will be actively involved in the preparation of such monitoring reports, as well as other operational projects.

UNESCO Forum – University and Heritage

In addition, may I take this opportunity to provide some information on the UNESCO Forum – University and Heritage. Launched in 1996, this Forum is an international network now comprising 225 universities from 54 countries, with departments specializing in the heritage field. Set up by UNESCO, this Forum had its first meeting at the Polytechnic University of Valencia (Spain) in 1996 and entered its operational phase during its second seminar in Laval (Canada) in 1997. To date, over 30 joint projects – adopted by the universities at the Forum's third session at Deakin University in Melbourne (Australia) in 1998 – have been on-going worldwide. The 4th Forum was held in June in Paris, with the participation of university rectors of the network. And I believe, the UNESCO Forum – Heritage and University– can be an important vehicle for introducing basic knowledge in conservation sciences, first, at undergraduate level, which will allow the development of a graduate course for conservation scientists.

Stone Conservation Course in Venice

Turning now to UNESCO activities relating to conservation sciences in Venice, let me talk about our experiences in the International Course for the Technology of Stone Conservation. Organized since 1976 in Venice, this Course is still operational with a strong support from ICCROM, the Ministry of Cultural Properties and Activities of Italy, University of Architecture in Venice and local experts in Venice. Through the lectures, laboratory sessions, and actual site works, students from different parts of the world are exposed to the conservation sciences, namely, application of chemistry, biology, geology, and physics to the conservation of stone. Throughout the course, students will also learn about different disciplines related to stone conservation, ranging from the ethics of conservation to art history, urban planning, case studies in other regions, etc.

Based on the accumulated knowledge and developed network, the Scientific Committee of the Course has recently decided to prepare a manual on the technology of stone conservation. This manual, to be published both in printed and multimedia format, intends to provide a solid knowledge in conservation sciences related to stone conservation. Although it has a basic target for future course participants, once completed, it will be distributed internationally, and utilized on the occasions of several international training courses that have been recently supported by our Office. For example, training courses in the Russian Federation, Poland, Bosnia and Herzegovina, as well as joint activities with the Office for Scientific and Technological Cooperation with Mediterranean Countries established in Naples by the Italian National Research Council (CNR-SMED), etc.

For future heritage managers

In addition, the work of conservation and preservation of cultural heritage is, by its very nature, multidisciplinary. Ideal management of cultural heritage requires different professions, including conservation scientists, art historians, engineers, conservator-restorers, urban planners, information scientists, administrators, politicians, etc. It is therefore recommended that a postgraduate course for conservation scientists will take a multidisciplinary approach, without of course losing its focus on sciences. This approach is increasingly indispensable to situate heritage conservation in a broader context of sustainable development and environmental protection. In short, the goal of the postgraduate course is to train future managers of cultural heritage with strong scientific rigor and communication skills.

Furthermore, in order to fill the gap between academic education and vocational training, which is often pointed out in this field, it is hoped that the new graduate course can be an opportunity for exchanges among academic researchers and conservator-restorers. For example, in some countries, master craftspeople and masters in traditional conservation technologies are invited to deliver lectures at universities. Traditional conservation technologies are often scientifically valid and can be made available at less cost. They can play a complementary role to modern conservation technologies, when employed appropriately. Also, the course can be designed in such a way that mid-career conservator-restorers can refresh their knowledge in conservation, allowing them to obtain recognized qualification.

Conclusion: Sharing Knowledge Among Universities

Principles of conservation sciences have been applied to different heritage materials under different climatic and environmental conditions in order to identify possible solutions to locally specific problems. It is through this constant application that conservation sciences have advanced and improved. As Venice is known for stone conservation and Norway for wood conservation and so on, each place has created its own 'knowledge base' made available by conservation sciences. And universities and specialized centres have been playing an important role in establishing such a 'knowledge base' utilizing it for sustainable development of the community, and maintaining and transmitting it through education to future generations.

In this connection, UVO would like to welcome the initiative of different universities and specialized centres to share their specific know-how for young conservation scientists through the creation of a new postgraduate course.

In order to facilitate such sharing, some innovative ways might be identified in the actual running of this project. The establishment of an on-line list of international experts, electronic publication of basic texts, organization of intensive international courses, participation in concrete heritage restoration projects of international cooperation as course requirements, etc. can be brought to your attention as an example.

UVO's future support will be provided, in particular, to the participation of experts from developing countries and countries of transition in the pilot graduate course. As a next step, it is also hoped that a similar course will be developed, through international cooperation, in selected universities in such countries.

Akatsuki Takahashi
Programme Specialist
UNESCO Venice Office

Remarks from the Italian Ministry of Cultural Heritage and Activities

Dear Colleagues,

While, at the last minute, I am forced to miss our meeting in Bologna, I cannot fail to express both my sincere appreciation and my fullest support for the 'spirit' of it on my part and on behalf of my office.

At long last we can see together – from the many paths of our profession – Art Historians and Archaeologists, Conservators and Conservation Scientists, Museologists and other professionals alike trying to bridge the 'gaps' we all know in both training and practice of conservation. Some of these gaps – in my experience – have an impact on the final quality of our work and therefore, in other words, on the 'well-being' of our cultural heritage. For this reason, at least, both policy-makers and employers should give their attention to the debate in Bologna.

The nature of modern conservation as a professional practice inspired by scientific methodologies, guided by scientific knowledge, confirmed by objective evidence and supported by constantly updated, multidisciplinary information is well known to all of us; nevertheless we still have to agree on how we could better transfer this consciousness in our training processes. Especially we must try to do so without any lowering of specific standards but rather by increasing interchange across the 'doctrinal borderlines' we all have experienced in the past.

Looking forward to reading the proceedings of your debate, I wish you all the best for your work.

Giovanni Scichilone
Chief Inspector, Archaeology
General Direction for Artistic, Archaeological,
Architectural and Historical Heritage

Preliminary Survey on the Feasibility of a Training Curriculum for Conservation Scientists: results and proposals for future developments

Rocco MAZZEO and Marisa LAURENZI TABASSO
ICCROM
Rome, Italy

Introduction

When discussing the role of Science for Conservation we would like to focus particularly on the role of the natural sciences and scientific disciplines in the field of conservation. The scientific disciplines that currently have the highest impact on conservation are biology, chemistry, geology and physics. Computer science must be added to this list as a cross-disciplinary tool, vital not only in the application of the above disciplines but also for documentation, circulation of information, virtual reality, etc. As a whole, the natural sciences applied to conservation are frequently referred to as 'conservation science,' but, for the sake of clarity, it is necessary to mention that the same expression is also used to mean overall conservation activities based on a systematic, scientific approach.

The relationship between science (as defined above) and conservation of cultural heritage has been the subject of several learned debates since at least the early 1950s in Europe and North America.

The noted art historian, Cesare Brandi, was the co-promoter and first director of the Italian Central Restoration Institute (ICR). When discussing the fundamental theoretical principles of the restoration of works of art, he defined as the 'methodological moment' the moment when the work of art is recognized both for its physical nature and for its dual aesthetic and historical value, in view of its transmission to posterity. Brandi also states that the imperative of restoration and conservation, first and foremost, concerns the materials through which images [and values] are made manifest. From this statement, the first and basic axiom of Brandi's theory follows: *only the material* [of a work of art] *can be restored* (Brandi 1963).

Consistent with the latter observation, Brandi says that in conservation practice, both aesthetic and historical values must be considered and respected, and science plays a vital role in achieving this goal. At an important conference on the applications of nuclear methods, while stressing the importance of scientific disciplines, Brandi

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was proud to mention that the ICR had been set up in 1939 and developed since then according to these views (Brandi 1976).

In recent decades, the role played by the natural sciences in the conservation field has moved slowly from a mere application of analytical techniques used for authentication to a means of characterizing the condition of works of art and seeking solutions for their preservation.

In order to investigate the present situation and medium-term trends in the field of Scientific Research applied to Conservation (SRC) of cultural heritage, ICCROM launched in 1997 a worldwide Survey on Scientific Research for the Conservation of Physical Heritage. Institutions and bodies that give economic support to SRC, as well as organizations and bodies that carry out SRC were surveyed.

The survey results confirmed the role of scientific disciplines in the conservation of cultural property and its expansion in recent years. Nowadays, it is reasonable to speak about 'conservation science' as a specific branch of applied science.

The 128 institutions (distributed over 42 countries) considered in the analysis of the survey results did not represent the totality of those where SRC activities are performed but they can certainly be considered a good, if not excellent, sample of this universe.

It was found that scientific research in conservation was carried out only in about a third of the countries surveyed, while the rest of the world is probably still missing this important component for the conservation of physical heritage.

The main results, which are relevant for today's discussion, showed that SRC always gives priority to the improvement of the conservation of physical heritage; this aspect is also used, in most cases, as an indicator of the effectiveness of SRC.

Apart from the availability of resources and structures for the development of SRC, an awareness of the importance of this type of activity is clearly seen in the survey results: on a global level, only 12% of the institutions consider SRC as 'secondary' in their policy.

An interest in studies related to cultural tourism, especially in developing areas where increasing investments in SRC are already taking place or are planned, was confirmed. Indeed, it is felt that the results achievable through SRC activities not only contribute to better conservation of cultural heritage, but can also help improve neglected areas that may become attractive for cultural tourism.

The relationship between SRC and training activities – at the moment rather patchy and confined principally to the training of conservator-restorers – needs to be strengthened.

Furthermore, a rather poor definition of the professional profile of conservation scientists (CS) and their scarce 'visibility' at the socio-economic level emerged clearly from the survey.

This work served as a basis for a more detailed analysis of professional and training needs for CS. Therefore, building on the first picture of the situation and the cooperation network developed for the above-mentioned survey, another survey was launched by ICCROM in 1998 with the financial support of the EU.DGX (ICCROM 1999). The research closely investigated the present needs and specialized training offered for CS with particular reference to their professional profile and the employment situation and trends.

Both desk (literature reviews) and field research were further developed. Questionnaires and letters were sent to a wide variety of organizations and individuals active in the field of conservation, including:

- European research institutes;
- European education and training institutions for conservator-restorers;
- eminent CS who have made a significant international contribution to scientific reflection about the role of science for conservation;
- members of the ICOM-CC Working Group on "Scientific Methods of Examination of Works of Art;" and
- participants of the 1997 and 1998 ICCROM courses on Non-destructive and Micro-destructive Analytical Methods for the Conservation of Works of Art and Historic Buildings (ANMET).

In all the different groups contacted for the field research, a striking result was the broad consensus on the usefulness of CS in conservation-restoration research and practical activities.

Within this context, CS must be clearly aware of the fact that they are not conservators but rather 'conservation technologists,' i.e., "scientists who apply to practical conservation specific skills related to one of the natural sciences" (Torraca 1982) and who develop different kinds of research activities, from the pure to the applied or developmental.

The primary practical objective of CS activity would be "... to provide knowledge or technical information which enables more effective preservation and conservation of cultural heritage, be it fixed or moveable cultural property" (Tennent 1997).

However, what arose from the survey is that this profile should be further investigated as to the attitudes, skills and knowledge expected today from CS for the conservation and restoration of cultural heritage.

The conservation scientist: who is (s)he?

The natural sciences form part, though in varying proportions and through different training methodologies, of the knowledge and skills of both the CS and the conservator-restorer, with some basic differences.

The natural sciences do not play a central role in the education and training of the conservator-restorer, who combines the study of natural sciences with other disciplines, such as art history, conservation ethics and aesthetics, and with the acquisition of specific professional skills for treating artefacts, be they movable or immovable cultural heritage. This finding is confirmed by the field research on education and training institutions for conservator-restorers, in which the weight of scientific disciplines within curricula ranges from 5% to 37%.

The basic education of the CS is generally in one of the natural sciences. That is normally followed by a gradual familiarization with and specialization in conservation-restoration problems in the field: "Most conservation scientists, myself included, received their training in chemistry, or another scientific discipline, and learned the profession on the job" (de la Rie 1999).

Nevertheless, if the contribution of CS to conservation activities is a highly specialized one, based on a sound educational background, the specific training in certain disciplines integral to conservation science is obtained in the field. The reason is that: "although conservation scientists, as a rule, have an academic degree in one of the sciences, the situation is in a sense worse (*than for conservators*) because there are virtually no training programs in conservation science *per se*"(de la Rie 1999).

Due to this 'empirical' element in the acquisition of knowledge and skills, it is perhaps useful to recall that for some "it may in some cases be difficult *from the outside* to distinguish between the conservator-restorer, the biologist, the chemist, etc., depending on how much the individual scientists specialize into each others' fields." (Larsen 1998). The difficulties may also arise from the complexity of such a multidisciplinary approach to problems, as is required by conservation science. A consequence is that: "art historians – and conservators to some extent as well – have difficulty understanding conservation scientists and vice versa." (Talley 1997).

If the CS community has a very clear vision of its own professional role and scientific contribution to conservation-restoration, misunderstandings have sometimes arisen on the part of conservator-restorers as to the role of sciences for conservation and their contribution to conservation science, to different types of research activities (pure vs. applied or developmental) and to the management of conservation activities within interdisciplinary working teams.

This situation can be correlated with the issue of scientific communication in science for conservation. If desk and field research stress the importance of communication skills in developing the professional profile of the CS (who should act, according to some, as a sort of 'cultural mediator'), recent scientific literature points out the lack of specialized media, the phenomenon of so-called 'premature publication' and, more generally, the need for a higher quantity and better quality of information exchange regarding science for conservation.

Following the above consideration, a CS today might be defined as a scientist who, with a degree in one of the scientific disciplines (natural sciences), acquires further knowledge in conservation (ethics, history, ancient technologies, specific scientific aspects) which allow him/her to contribute to the study and conservation of cultural heritage within an interdisciplinary team.

The Conservation Scientist's profile

What knowledge and skills make up the professional profile of the CS?

Is there a single profile or does training in one particular natural science produce diverse profiles of the CS?

More specifically, what should be the educational background of the CS, and what proportion should be maintained in his/her training in the two components – conservation and science?

Skills

There are a variety of circumstances under which a CS can develop different types of research, ranging from pure to applied, in order to improve the effectiveness of conservation activities and provide knowledge that is essential to decision making.

As to the field of study of CS, different kinds of research activities can be listed according to their final aim:

- *identification* of constituent materials including the provision of information on their provenance, production techniques and dating;
- *assessment* of condition and decay factors and explanation of the causes and processes involved;
- *monitoring* of chemical and physical parameters and of biological agents to check the evolution of the decay process;
- *understanding* of the effects of the environment on the deterioration of works of art,
- *contribution* to the specification of products and methods for conservation; monitoring of the performance of conservation treatments;
- *specification* and *definition* of scientific methods and analyses to be employed in the examination of works of art in order to explain their condition, history and technology, as well as to determine the suitability of materials used for their conservation;
- *communication* of research results "in a way that takes all the important information, synthesizes it and presents it so that it is digestible to conservators, curators, art historians, designers, administrators, architects, building engineers, fellow scientists and, not least, the general public" (Tennent 1997).

The discussion as to the role of different research typologies makes particular reference to the professional context in which the research is developed and to the possibility of using the results of such research for conservation activities, also in relation to cost-effectiveness.

Based on personal experience, Tennent makes a detailed analysis of four professional contexts in which CS can be employed: the museum laboratory, university departments, national conservation laboratories and the private sector.

Didactic activities addressed to the other professionals involved in the conservation field must be considered as an important part of the above-mentioned skills of a CS.

Knowledge

As already stated, the scientific disciplines that, at present, are seen as particularly relevant to conservation are biology, chemistry, geology and physics. It is therefore obvious that a CS would have a good background in one of these disciplines, to which information on the theoretical and practical aspects of conservation must be added.

Analysis of recent literature on this issue (seen from both the conservation and science standpoints) confirms that the debate is far from over, especially concerning the weight to be given the two components, with particular regard to: a) the basic level of education in the natural sciences, b) the knowledge of art history, conservation ethics and aesthetics and c) the ideal level at which to introduce conservation science knowledge (undergraduate, postgraduate, further training).

Price (1992), while considering the essential requisites of the CS profile, expresses his opinion on training education and opportunities which make possible the acquisition of knowledge and skills in both camps: "the Conservation Scientist must have a good grounding in both conservation and science, and there are many ways in which this can be achieved. (…) both the conservation and the science have to be acquired along the way, and most people acquire first one and then the other. In my view, it is usually better to get the science first. This will consist of at least a first degree in a science subject, which will provide the basic knowledge and the grounding in scientific principles that are essential for research. Next comes the conservation, and this too may entail a degree or a diploma course. (…) Other possibilities include a PhD in an archaeology department or employment in a museum laboratory. What is vital is that the training should be more than just a casual encounter with objects and with conservation. (…). In one way or another, one has to acquire a 'feel' for objects and for conservation and to be able to communicate effectively with curators, archaeologists and finds specialists." The issue of communication skills, in fact, has acquired growing importance in the development of the CS profile and his role within interdisciplinary working teams.

According to Price, the opposite scenario, namely "acquiring conservation first and science second is a harder route, though not impossible." Finally, he considers a third possibility: "is it possible to acquire the science and the conservation simultaneously?" Aware of the fact that some three-year degree courses have been planned in this way, Price observes that: "one wonders, however, whether a combined course – even a three-year course – can really provide sufficient grounding in both topics, and whether students would prove to be insufficiently trained in either."

Professional contexts, employment opportunities

CS play a key role in developing scientific research for conservation and in making a contribution, within multidisciplinary working teams, to a "concerted approach to problems …" that "does not oversimplify the issues." (Tennent, 1994).

As indicated by the survey results, the professional context for a CS ranges from museums to conservation centres. Moreover, the demand for the conservation of cultural heritage is growing, and the dependence of conservation-restoration activities on the natural sciences is increasing as well. Despite this trend, employment opportunities for CS are still extremely limited, due, among other things, to the inevitable financial restrictions that conservation activities generally have to face.

This issue emerges clearly from both the desk and field research, and also has a direct impact on the possible establishment of a specialized university curriculum for CS. Many contributions by eminent CS explicitly mention the need for a cost/benefit analysis before planning a specialized curriculum, due to the employment situation.

On the other hand, a need for better or more specialized training for CS was mentioned in a great majority of the responses, together with the increasing role played by the natural sciences (and therefore by CS), not only in the field of research but also in the planning and implementation of conservation activities. The 'value' of the heritage to conserve cannot be governed only by monetary criteria; therefore the investment in training for CS must also be evaluated considering the 'invaluable' advantage of improving the quality of conservation activities through better trained and educated personnel. Apart from this ethical consideration, however, it is also advisable to carry out, along with cost/benefit analysis, a further analysis of the market and the economic aspects of conservation and maintenance, given the influential role played by the natural sciences. This investigation should also study how best to stimulate job opportunities for CS.

The education and training of conservation scientists, entry requirements and current training opportunities

Many interesting considerations and suggestions came out of the survey regarding this issue.

Entry requirements

As to the type of educational background required, both in SRC centres and in conservator-restorer training institutions, an academic background at first degree level (or even postgraduate in a few cases) is generally called for. Chemistry is the most frequently mentioned degree, and there is a tendency, especially in the training institutions, to identify a CS as a conservation chemist. An educational background in other natural sciences (biology, geology and physics) is less likely to be requested, in view of participation in interdisciplinary teams and for education and training activities in European courses of conservation-restoration.

Need for specific training

As to the educational level of CS, the need for a specialized background in the natural sciences as well as a specialization in conservation-restoration, including teaching activities, emerges clearly from the responses of all the institutions and individuals considered in the survey field research.

Various proposals on how to reach the desired educational level were advanced:

- set up specific degree courses for CS (for the various scientific disciplines);
- organize short, intensive seminars to further train natural scientists;
- design a postgraduate curriculum for CS.

The last of the proposals listed above mostly came from eminent CS, ICOM-CC members and ANMET course participants, i.e., from those who are personally involved in the field as CS themselves.

As to what such a curriculum should involve, only general prerequisites and ideas were listed.

Current training opportunities

The inclusion of specific courses on conservation in natural science degree courses is considered a viable solution, but it is also seen as totally insufficient to provide the background necessary to face the complexity of problems posed by conservation activities. The few existing courses are mainly at postgraduate level. They appear to be concentrated in the UK (De Montfort University) and Canada (Queen's University).

Theoretically and practically, these postgraduate courses are, in fact, designed both for students with a basic education in natural sciences and in conservation-restoration. It would seem that a sound background in one of the natural sciences is not considered a prerequisite, as, on the contrary, is recommended by CS who are currently employed in the field.

As to other training opportunities, they are mainly found in the field through on-the-job training and participation in scientific meetings and seminars. This situation seems to be closely correlated with the system of scholarships-internships for senior students (who develop the final phase of a PhD, or more rarely a Master's). A possible drawback of this type of training is the lack of certain crucial skills and knowledge related to conservation activities (art history, ethics, aesthetics, etc.)

The need to acquire higher levels of knowledge through education is countered by an analogous need for advanced research and analysis skills and techniques. Starting from this, three requirements emerge:

- closer cooperation of research institutes and training centres with academic institutions, at an international level;
- the need to entrust teaching and training not only to academic personnel and specialists in 'pure' sciences, but also to "top-rate, experienced CS;"
- the inclusion of considerable laboratory work in the curriculum, not only to improve analytical and technical skills, but also to enlarge the number of potential placement opportunities.

Future developments

To sum up the results briefly illustrated in the previous paragraph concerning the possible ways to train CS, there seem to be three most feasible paths:

1. courses at graduate level;
2. postgraduate level courses (PhD or equivalent);
3. postgraduate level short courses.

Each of these paths has advantages and some drawbacks:

- graduate level courses make it possible to reach the required specialization in a shorter time with respect to postgraduate training; on the other hand, by focusing on conservation issues, they dedicate less time to the basic discipline, with the risk of lowering the qualitative level of the training provided. Moreover the graduate, being already specialized in the field of conservation could hardly take advantage of job opportunities outside that field;
- the main advantages of long postgraduate courses lie in the possibility of building on an already acquired, sound scientific background. It is also easier to integrate the university training with that provided by research centres specifically dedicated to conservation, where the students can be in direct contact with conservation problems, thereby gaining practical experience. The longer time required to enter the profession and higher economic investments are the main drawbacks of this type of option;
- short postgraduate courses are easier to organize and relatively less expensive than long ones. In the short run, they can be a feasible answer to meet the most urgent needs but they can hardly be considered to be an ideal solution; in fact, due to their brevity these courses cannot deal with the wide range of issues related to conservation. Furthermore, legal recognition, at the national and international level, of such courses is probably rather difficult.

Due to the interdisciplinary character of the 'conservation discipline,' where various professionals with different educational backgrounds and professional experience must collaborate and reciprocally understand each other, the discussion on how to develop the most suitable path must involve specialists from academic institutions, scientific research centres specializing in conservation and schools for the training of conservator-restorers.

Further to the selection of one of the above-proposed levels of training (or of any other alternatives that might be suggested), many other points, still at a general level, should be discussed, before drafting a course curriculum (or course curricula).

Here are just a few examples of points of discussion:

- should postgraduate courses be common to all the various natural scientists (biologists, chemists, engineers, etc.?) or should they have some parts in common (e.g., conservation ethics, history of conservation, ancient technologies, etc.) and other parts specific to each discipline?
- should the courses (be they under- or postgraduate level) cover the globality of the aspects of conservation, or should they be specific for the different typologies of the type of property to be conserved (e.g., paintings, paper and archival materials, architecture, museum collections, metals, etc.).

Objectives of the Bologna Meeting

As we have seen in the previous paragraphs, the issue of training CS for a better, more useful contribution of the natural sciences to the conservation of cultural heritage has many facets and aspects that need to be discussed.

The Natural Science Faculty of Bologna University warmly complied with ICCROM's initiative and in collaboration with three partner universities (Aachen, Oviedo and Thessaloniki) began to investigate viable solutions for the definition of concrete initiatives.

Moreover, the University of Bologna kindly offered to host a meeting where the hottest topics could be discussed at a multidisciplinary and inter-institutional level. Therefore, today we have brought together natural scientists from universities, eminent CS, historians and conservator-restorers working in research centres and schools specifically dedicated to conservation.

From the results of the two surveys that ICCROM carried out in 1997 and in 1998-99, and from those noted at the meeting of ICOM-CC held in Lyon last September, three topics have the highest priority and are proposed for discussion during this meeting:

1. the professional profile of CS;
2. the educational level suitable for CS; and
3. market needs and opportunities for CS.

The objectives that we hope to reach, thanks to the cooperation of all the participants in this meeting, can be summarized as follows:

agree on a common definition of 'Conservation Scientist;'

prepare a working document to define the role and professional profile;(knowledge, skills, attitudes) of CS in function of the proposed professional profile;

discuss possible training alternatives (e.g., graduate, long postgraduate/short postgraduate courses, courses in common for all the different scientific backgrounds, global courses on the different fields of the conservation of cultural property, courses specific for the different typologies: paintings, stone, metals, etc., or for the different problems: preventive conservation in museums, archaeological site conservation, air pollution and cultural heritage, etc.);

form an international task force composed of representatives of the universities and research, conservation and training institutions for development of a proposal for educational opportunities for CS reflecting the professional profile.

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Training Opportunities at De Montfort University

Dr Audrey MATTHEWS and Dr Belinda COLSTON
De Montfort University, Department of Chemistry
Leicester, UK

Abstract

A summary of the historical background, development and curriculum for the postgraduate full-time and part-time taught Masters Degree in Conservation Science is given. Analysis of the spread of enquiries and applicants is discussed, together with details of the newly developed distance learning format of the course.

Keywords: conservation science; training; postgraduate study; distance learning.

Training in conservation has been offered by De Montfort University Lincoln (formerly Lincoln College of Art & Design) since the mid-1970s. An academic partnership between Lincoln and the Department of Chemistry at Leicester became established in the early 1990s, which resulted in the validation of a Masters Degree in Conservation Science in 1994. The programme has run since the date of validation in both full-time and part-time formats. This enables the candidate to complete the degree in one full year, from September to September by full-time study, or over a minimum of two years part time.

Suitable graduates are admitted to the programme from both conservation and science backgrounds provided that they can offer evidence of a basic level of science to at least the UK Advanced Level. They follow one of two streams, depending on their backgrounds, in either conservation or science. The science stream provides a science base in applied laboratory techniques and materials science related to conservation. Candidates following the conservation route gain an appreciation of the theory and skills of object conservation, although they are not taught to practice as conservators.

The two routes combine for the remainder of the programme to study practical and preventive conservation, historic technology, advanced techniques in conservation of metals, organic and inorganic materials (two modules), the museum environment, and project preparation and methodology. All candidates complete a research project, which accounts for a third of the final mark, at the end of the period of taught study. Projects that are linked to museums and allied institutions are encouraged by the course

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team. These are either carried out solely at that institution or in combination with access to the scientific facilities at De Montfort University.

Statistical analysis of the enquiries and applications to the course from 1994 to date show interesting trends relating to conservation science. About two thirds of all enquiries are from UK-based candidates, with the majority of other enquiries coming from Greece. However, requests for details have been received on a worldwide basis and include mailings from all continents. Analysis of the application forms received show that about 77% of applicants have training or experience in conservation and only 22% can be classed as scientists.

Detailed examination of the status of graduates and current students show that most either return to relevant work in their own country or continue to research in conservation science in academia. A minority (of about 20%) is newly trained graduates who are, or have been, actively seeking work in the field. To date, about half of this group managed to gain employment in conservation science whilst the other half have accepted work in a related one, such as scientific quality control. It is also worthwhile noting that about 14% of the group have opted to follow the course out of interest or occasionally as some form of retraining. This seems to have resulted from either an early retirement opportunity, or a wish to gain knowledge of the area, e.g., for teaching purposes.

In summary, the statistical analysis shows that worldwide interest exists for a training course of this kind, with the majority of interest stemming from those with a background in conservation. With this key statement in mind, De Montfort University is about to launch its new distance learning initiative in conservation science.

The distance learning format of the course will allow candidates to study from any part of the world using computer-based material in the form of CD study packs, Internet delivered digital conferencing and assessment, and short workshops. The course has a structured framework of stepped levels, which are based on the existing full-time and part-time modules, and allow for the study and accumulation of credits for the award of Postgraduate Certificate (PgCert), Postgraduate Diploma (PgDip), and Master of Science (MSc). It is also envisaged that some candidates in employment in the fields of conservation or conservation science may wish to follow only part of the course as a form of a continuing professional development programme.

The course team, led by the Course Leader Dr Audrey Matthews, believe that the distance learning model is the most favourable development for training in conservation science so far. This will be supported, as it has been in the past, using the skills and experience of trained conservators and conservation scientists in practice, as well as their own collective strengths and experience. Active research in the area is also of paramount importance for the up-to-date training and general benefit of students on the course. It is also hoped that this flexible approach to training will enable many more in the field to achieve an understanding and confidence in the science related to conservation.

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Authors

Dr Audrey Matthews is a Senior Lecturer, the Course Leader and an external examiner in conservation science at De Montfort University, Leicester UK.

Dr Belinda Colston is a Senior Lecturer and researcher in archaeological and conservation science at De Montfort University, Leicester UK.

Educating for Conservation Science: observations of a former student and current faculty member

Alison MURRAY
Queen's University, Art Conservation Program, Department of Art,
Kingston, Ontario, Canada

There are a number of points that I would like to make about the training of conservation scientists. My comments are based on my experience as a graduate student in the conservation science programme run jointly by the Smithsonian Institution and the Johns Hopkins University, and as a faculty member at Queen's University in the Art Conservation Programme, where conservation scientists are trained.

First, it is very important to get a degree in a well-respected, mainstream discipline, from a solid department and university. This is because it allows you to apply for grants more easily in the future and it allows you to get a job when the prospects in conservation are not good.

I think it is very positive for the conservation science and engineering students to have strong links with a conservation training programme. In this way, both groups can learn from each other in a good environment. Networks that are formed are very important for future work. It seems to me, from the outside, that this model has been used effectively in the MOLART project in the Netherlands, between the FOM and the Maastricht conservation programme. Links with conservation institutions can be very important during education, but can also be expanded upon during post-doctoral periods.

As for the requirements needed, I feel that scientists need to be introduced to conservation principles as well as having some hands-on, practical component (not to become a conservator, but to have some physical understanding of treatments). The specific skill sets needed depend on what job will be obtained at the end (museum scientist, educator, institute researcher, etc.), and this is never known in advance. Therefore, broad concepts should be taught, and the research performed should be focused. Graduates should be open to new concepts, should be able to ask the right questions, and should be willing to work with others. Of course, I am assuming that the programme is based on good, solid science.

I think that it is preferable for students to join larger, research projects rather than starting smaller ones themselves. In this way, students will have the benefit of

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equipment and expertise that professors have built up. This is the usual model that is used in science and engineering, but not necessarily in conservation, where students generally perform smaller research projects. It is really necessary that the appropriate resources, in terms of people and equipment are available to students.

Also, I think that both applied and basic research should be supported, as both are important; this necessitates that group work take place over a period time, amongst people who have different strengths. Applied research should be based on basic research, and deciding what basic research to do will be influenced by the ultimate application.

We have a programme that confers master's degrees in art conservation (MAC) with a specialization in conservation science. Students must have an undergraduate degree in one of the science or engineering disciplines. This is a very small programme, graduating one student every two years, as opposed to the treatment stream where 10-12 students graduate every year. We have had great success with the conservation scientists, even though the job prospects appear bleak. For example, in the past few years, one of our graduates began work at the Research Center on the Materials of the Artist and Conservator at the Carnegie Mellon Research Institute and another graduate went on to a PhD programme at Bradford University in England and is now on an internship at the Getty Conservation Institute.

In summary, success depends upon interdisciplinary links, appropriate resources, and practical experience. Comments on these observations will be welcome.

The Challenge of European Inter-University Postgraduate Studies in Conservation Science

I. PAPAYIANNI
Aristotle University of Thessaloniki (AUTH)
Thessaloniki, Greece

Perspectives of conservation science at the dawn of the next millennium. Social and economic aspects

As mentioned by famous art historians and scholars, some of the well-clarified characteristics of the scientific field of conservation are:

- its philosophical and intellectual underpinning;
- its interdisciplinary character; and
- the necessity for theory and practice in education.

As a social activity, conservation affects and is influenced by the socio-economic and political status quo. Conservation science will be called to anticipate the new ethical and cultural priorities and to fulfil the demands of a broader market without borders.

- The values of European civilization and humanism should continue to be the cornerstones of conservation philosophy. As noted, by the director of the Getty Conservation Institute (GCI), Tim Whalen, (*Conservation Newsletter*, Nov. 99) ... "Europe should get away from [the term] 'nationalistic'." This remark could indicate that nationalism is the antithesis of globalization.
- There are solid estimations or previsions that a high educational level, professionalism and the use of new advanced technologies will dominate in all applied sciences. For example, digital, laser and information technology should be taken seriously into account in drafting the profile of a modern curriculum.
- Conservation presents the paradox of combining traditional materials and techniques with the most advanced ones (i.e., selection of the traditional approach to natural ventilation in museums following the application of high-tech climate-control systems.)

This continuous travel from the past to the present and vice versa in an effort to interpret and preserve heritage for generations to come lends a dual dimension to conservation science and provides an important role for humanity. It helps people to retain their own cultural identity while simultaneously cultivating the mutual respect

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for different ethics that is of paramount importance for the harmonious coexistence of people in today's universal society.

Economic aspects

Since 1986, the EC has invested in a major research programme on the effects of environment on cultural heritage. The valuable knowledge accumulated brought conservation science to the top of research fields, but it is not yet widely accessible. Furthermore, there is still a gap between scientific knowledge and reality. Therefore, the field is open for conservation scientists who are called to bridge this gap.

At the third EC Conference on Research for Protection, Conservation and Enhancement of Cultural Heritage (Santiago de Compostela, Spain 23-24 September 1999), Dr B. von Droste (special advisor to the Director General of UNESCO for World Heritage) presented the dynamism of cultural tourism as a prosperous economic sector:

... "tourism is changing perspective and increasingly slanting towards culture"
... "international tourist arrival in Europe in 2010 is estimated to reach 937 millions..."
... "tourism is one of the most promising avenues for further development."

Of course, a proper management policy is needed to avoid the negative effects of tourism but this economic resource has a repercussion on the employment of CS.

One priority of European policy expressed in all European actions is sustainable development, the character of which is completely fulfilled by the aims of conservation science based on the concept of unified nature and culture. For example, the preservation of adobe houses has stimulated the revival of construction with mud bricks or rammed earth, now considered perfect materials for bioclimatic design of dwellings.

Some indicative figures showing the increasing need for Conservation Scientists are presented below: (Data taken from Greek Information System STADION S. A.)

Period	1994-2000	European resources
Budget for culture	Central	73,0 billion drs
Budget for culture	Provincial	57,0 billion drs
	Total	**130** billion drs.

Budget allocation	No. of projects	Billion drs.
Conservation of archaeological sites:	54	23.4
Restoration/conservation of monuments:	91	36.8
Museums:	32	33.9
Cultural centres:	4	4.4
Conference centres:	17	31.5
Total	185	130

From this total, an amount of about 94 billion drachmas (excluding cultural and conference centres which are modern buildings) was spent in projects where CS are involved.

Period: 2000-2006 European resources

Budget for culture: 450 billion drachmas

It is considered that a percentage of from 20 to 25 of the cost of each project concerns a study phase.

Advantages of European inter-university postgraduate studies on conservation science

There are many postgraduate educational centres (universities or institutions – some of which were mentioned in ICCROM's Preliminary Survey). Their number has increased in the past two years, reflecting a market demand for CS.

The question is: "How many of these institutions will manage to meet the high requirements of conservation education in the context of unified Europe and high competitiveness?" They have to provide:

- technology infrastructure for high-level specialization;
- up-to-date knowledge, through a system of further education of scientific personnel.

The inter-university character of a postgraduate programme could benefit from the following:

- intercultural exchange;
- distribution of knowledge relay centres resulting in better flow of knowledge;
- direct contact with the monuments of different cultures;
- a feeling for the influence of the geographical and political context on the conservation of cultural heritage;
- the specialization of each university;
- better opportunities given to students for career options in further education of scientific personnel;
- sharing information about preventive conservation to a degree that would not have been possible without collective involvement of the other partner (Whalen, GCI Newsletter).

Education in conservation in Greece

In the past (before 1998)

- Technological Educational Institute of Athens for curators (non-university level, three-year duration)
- short-term postgraduate courses supported by the EC.

Most of the conservationists have followed postgraduate studies at ICCROM, at York University, at Rome University Specialization School on Conservation or at Leuven University.

Today (in addition to those above)

- Two Inter-departmental postgraduate programmes are running at Aristotle University and at Athens National University
- Short term courses at AUTH (in Greek and English)

Employment of postgraduates educated in conservation

Public Sector	Private Sector
Ministry of Culture	Construction companies
Research centres	Freelance scientist (with contracts)
Knowledge-dissemination centres	

Are there good perspectives for the new conservation scientists? Better than those in the past: 124 restoration projects concerning monuments and sites have been approved for the 2000-2006 period with a total budget of 103 billion drachmas (data from Information System STADION).

Structure of the inter-departmental postgraduate programme of AUTH

Basic concepts followed:

Interdisciplinary character

Schools of AUTH involved: Architecture, Civil Engineering, Chemical Engineering, Rural and Survey Engineering, Mechanical, Electrical and Computer Engineering, Mathematics, Physical and Computational Engineering.

Division into two routes / directions

- Protection, Conservation and Restoration of Architectural Monuments
- Protection, Conservation and Restoration of Works of Art and Machinery

Flexibility of the programme

The course structure consists of the following educational parts, for each of which students are credited with educational units in the required courses

- Elective course
- Interdisciplinary workshop laboratory
- Seminars
- Individual practical exercise
- Postgraduate dissertation

Students may select among 22 elective courses or topics, 4 seminars in different areas.

Application of theory on selected case studies

The participation of all students in laboratory work (in groups consisting of different specializations).

This training runs in parallel with the course of lessons and is supervised by an interdisciplinary team of teachers.

The Laboratory/Studio work lasts two semesters. All the stages of a conservation study (restoration of a historic building or other architectural monument) as well as the problems anticipated are discussed and presented in four successive presentations, the final one being open to the public. Much work on site and by using laboratory equipment for documentation is also included.

Experience showed that this type of training was very productive and students responded with enthusiasm.

Evaluation of the postgraduate programme of AUTH

The programme lasts three semesters, including at least three months to prepare the diploma dissertation.

After the first cycle was implemented, a board of eight distinguished evaluators graded the objectives, contents, structure, education system, adequacy of infrastructure and scientific personnel.

The works were scored from 90 to 96.5. Two features were specially noted: the parallel co-existence of a programme offering two main directions (Monuments - Works of Art) and the usefulness of collaboration of students from different scientific areas.

The success of this programme is reflected in the students' work, which was characterized as impressive.

A First German Curriculum on World Heritage Studies

H. R. SASSE
Technische Hochschule Aachen
Aachen, Germany

1. INTRODUCTION

World Heritage Studies is a new Master's Programme organized by the Brandenburg Technical University of Cottbus (BTU) Germany. The course of study is targeted for students who already have a Bachelor of Arts or another degree related to cultural science and who want to work in a future-oriented and innovative professional field. The programme is planned for a total of 60 students (30 German and 30 international).

The courses started in October 1999 with 17 students enrolled.

The curriculum consists of four modules, two interdisciplinary study projects, a practice course (outside the university) and the interdisciplinary master's thesis. The total duration is two years, divided into four semesters.

The four modules contain:

1. Cultural Sciences
2. Basic Technical Construction and Protection of Historic Monuments
3. Basic Protection of Cultural Landscapes
4. Management

Lessons consist of lectures, seminars, workshops and various individual work.

2. MODULE 1: CULTURAL SCIENCES

2.1 Introduction

In the cultural sciences module, the following subjects are combined: anthropology of culture, sociology, philosophy and history. Courses will relate explicitly to the unresolved relationship between nature and culture. Understanding of the phenomenon, which is necessary for the analysis and understanding of this relationship, is developed with the help of theoretical instruments. Such an ability to abstract is obligatory for conceptual thinking as well as for the development of ongoing strategies.

The teaching objective of cultural sciences is to enable graduating students to act in a competent, critical and responsible manner in different fields of work. Since

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these future fields of work are characterized by cultural, social, religious as well as economic and political influences, the graduates have to be able to function in various situations and meet various challenges. Therefore, the courses in Module 1 aim at the development of social competence in the widest sense. Practical projects are planned for the acquisition of these skills.

2.2 Required Courses

World Heritage – Theories of culture (Lectures)

The concept of THE World Heritage Site and its theoretical basis. Concepts of nature and concepts of culture. Material and immaterial aspects of culture. Universalism and relativism. Culture as a motivation and as a limitation of human activities. Concepts of cultural identity. The problems of Eurocentrism and cultural dominance.

Phenomenology of the Object (Lectures)

Introduction to phenomenology and sociology; societal theory; sociological and phenomenological theories of nature and architecture; theories of action; sociology and phenomenology of perception; the social body; public theories; theories of public space; modern theories of art and aesthetics; theory and practice of power; theories of time and history.

Aesthetics and Theory of Art in the 19th and 20th centuries (Seminar)

Introduction into culturally, philosophically, architecturally and sociologically determined positions concerning aesthetics and art during the last two centuries.

Theory of Architecture, City and Space (Seminar)

The main subjects in this seminar are metropolis, urbanization, small town, deurbanization, tertiarization, globalization, new urbanism; planning theories; architecture and power; functionalism, modernism.

Workshop in Cultural Sciences (Seminar)

Interdisciplinary workshops presented by the chairs of Intercultural Studies, Theory of Architecture and Technical and Environmental History. Work on local sites and excursions are planned. The cultural-historical and sociological background of sites are examined and transformed into potential use by the local population. These workshops aim at the development of the ability to apply theoretical basics as well as the expansion of cultural knowledge, by challenging the theories of applied cultural and scientific practices.

2.3 Elective Courses

World Heritage - Theories of Culture (Seminar)

This is an extension of issues presented in lectures.

Phenomenology of the Object (Seminar)

This is an extension of issues presented in lectures.

Knowledge for the Future (Lectures)

The course includes the following topics: history of knowledge, ancient concepts of knowledge, tradition and transmission of knowledge to future generations, ethical aspects, technical and physical problems with durability and transferability of information, selection and management of knowledge, modern technologies of archiving and documentation.

Technological Assessment (Seminar)

This course includes methods, aims, political environments, institutions and examples for technology assessment and evaluation of technology. The socially oriented shaping of technology is demonstrated using examples from the field of information and communication technologies, sustainable development, material flows, energy policy actions and substitutions of technologies. Some issues of technology policies are also discussed.

Technology and Environmental History (Lectures and Seminar)

Subject and methods of technology and environmental sciences; technology, man and nature in history; economic and technical developments and their consequences for the cultural landscape; the culture of craft, trade and industry; history of the landscape.

History of Religion and Culture (Seminar)

Methods of comparative history; comparison of culture and comparative history of religion; exemplary comparative analysis of religious contents against the background of interdependencies between economy, society, politics and culture.

Ethnology (Lectures and Seminar)

An overview on the methods of ethnology. The method of field studies and its history; specific problems with field studies.

Colloquium: Spirit of the Age and Criticism (Seminar)

The colloquium is a joint event of the chairs for Intercultural Studies, Theory of Architecture and Environmental History. In these classes, students will have the opportunity to present and discuss their intentions for their final thesis. Part of the discussion incorporates the analysis of scientific paradigms. Students receive assistance with their plans and are also encouraged to discover the tendencies of the spirit of the epoch in their own methods.

3. MODULE 2: BASICS OF TECHNICAL CONSTRUCTION AND CONSERVATION OF HISTORIC MONUMENTS

3.1 Introduction

In Module 2, the formal culture-related aspects of building as well as the methods of acquisition of regional building-construction technologies are taught. Lectures cover the subjects of construction techniques and the preservation of monuments. Classes concerning construction techniques, topics of building construction in general, building materials, building chemistry, building physics, building technology and constructive conservation of buildings will be taught in addition to the preservation of monuments, the basic history of the development of cities, buildings, building technology, general technology, preservation of monuments and of art. In work groups, chosen examples of culturally specific buildings are examined as central themes. The student shall deal here with specific topics from the subjects.

3.2 Required Courses

Architecture (Seminar)

In a series of interdisciplinary workshops, professors and assistant professors examine the use of buildings as a central theme, for example buildings of representation, production buildings, office buildings or residential buildings. The main task will be to learn about the different possibilities of changing use and how to realize it economically. Professors in the historical fields may also be involved in these workshops.

Conservation of Historic Monuments (Seminar)

Issues of conservation of monuments will be addressed in workshops to be given by professors of History of Art, History of Architecture, Archaeology and Building Conservation and others.

3.3 Elective Courses

Architecture (Lectures)

Issues of architecture will be addressed in a series of lectures. The professors of design, building materials, wood construction, technical supply of the city and history of building construction give an introduction in their subjects. The lectures cover topics in architecture as the main theme. The purpose of the lectures is to give a deeper view of the complexity of building construction and the use of buildings, the use of material in relationship to special climates of different regions and use of materials in relationship to the development of tools.

Conservation of Historic Monuments (Lectures)

Issues of conservation of monuments will be addressed in a series of lectures to be given by professors of History of Art, History of Architecture, Archaeology and Building Conservation. Subjects will include building conservation in theory and practice, the concept of cultural significance, methods of research in history of architecture and archaeology; research policy, excavations, collections, research and mediation, European historical art from early Christian times up to the present.

Further discussion of these subjects within a series of interdisciplinary workshops – also involving professors from the departments of architectural and urban design as well as civil engineering – are scheduled.

4. MODULE 3: BASICS FOR THE PROTECTION OF CULTURAL LANDSCAPES

4.1 Introduction

Module 3 deals with the ecological correlation of the relationship between man and nature with regard to basic knowledge of the natural sciences. Biodiversity plays a central role in the global protection of nature and world heritage, which expresses itself on different levels of reflections (individual, population, symbiosis, landscape). Protection always occurs in concrete spatial natural heritage areas or similar objects (e.g., biosphere reserves). All concrete areas can be assigned typologically (species always live in habitats). Physical and geographical knowledge is mandatory for the understanding of habitats. It is also necessary to have a certain biological and system-theory based knowledge of symbioses and ecosystems. Protected habitats should be managed in order to conserve them.

The environment also has a solid history that should be understood in order to understand present developments. The same holds for the judicial background in the national and international field. Further, a geo-scientific extension is necessary for a better understanding of world heritage. A large part of the esteem of nature is not traditionally based on scientific-ecological knowledge but for example on aesthetic judgements. Acting requires strategies of justification; acting in the environment requires ethics.

4.2 Required Courses

Conservation of Regional and Global Biodiversity (Lectures)

Aims and principles of nature conservation, conservation of biotic, abiotic, and aesthetic resources; guiding principles of nature conservation, naturalness (wilderness), biodiversity, sustainability, cultural landscapes, legislation of nature conservation, planning instruments of nature conservation (landscape planning, protected areas, impact assessment), instruments of international nature conservation, bi- and multilateral treaties, definitions of biodiversity, the roots of the global biodiversity discussion, ethical justification of biodiversity conservation, biodiversity assessment for decision making in nature conservation, assessment algorithms, monetary and economic aspects of biodiversity conservation, the future of biodiversity.

Strategies for the Protection of Natural Heritage Areas (Lectures)

Global strategies for the protection of natural heritage areas, the UNESCO programme for world heritage, biosphere reserves, national parks and other types of large protected areas, managing large protected areas, zoning concepts, guidelines for the national implementation of world natural heritage, conflict management for integration of traditional land use systems into protected area management.

4.3 Elective Courses

Ecology of Globally Important Habitats (Lectures)

Principles of ecology, principles of plant and animal biogeography, principles of geobotany, indicator species, determinants of global distribution of habitats (climate, soils), global distribution of biomes, effects of trace gases on climate development, global aspects of productivity, effect of climatic change on vegetation; deciduous woodland biomes, warm temperate biomes, Mediterranean biome, grassland and steppe biomes, tropical and subtropical woodland biomes, orobiomes, freshwater wetlands, coastal wetlands and dunes, tundra biome, taiga biome, migratory birds, island biogeography.

Landscape Ecology (Lectures)

Aims and methods of landscape ecology; landscape elements, environmental media; landscape analysis, methods of landscape ecology; development of environmental quality aims and guiding principles on habitat and landscape scale; principles of nature conservation, landscape evaluation methods; regional planning, landscape planning, ecological impact assessment; ecological risk assessment, landscape dynamics, principles of ecotechnology, habitat management and habitat diversity, principles of ecological modeling, monitoring of ecosystems; landscape aesthetics, landscape development for recreation and recovery.

General Ecology (Lectures)

Aim and scope of ecology, structure and delimitation of ecology, evolution and ecology, basic concepts of ecology, observational levels, spatial and temporal scales; compartments of natural ecosystems, material and energy flow, water cycling, ecological goal functions, production ecology, man-organized ecosystems, abiotic factors in ecosystems; habitat ecology, natural disturbances; population ecology, demography, modeling of populations, theory of life history, strategies; niche theory, intra- and interspecific competition, mechanisms of coexistence, guilds, predation, trophic levels, food chain theory; spatial distribution of ecological entities, migration, species-area curves, zonations, ecological gradients, dynamics of ecological systems, mechanisms of succession, stability and equilibrium; ecological modeling, sampling theory in ecology; application of ecological knowledge in practice and implementation into decision procedures.

Habitat Management by Means of Wild and Domestic Animals (Seminar)

Unconventional ways of land use by means of animals, methods of habitat management, legal fundamentals, specially adapted and rare domestic animals, game-farming, animal regulation by hunting, tourism and photo safaris, nature conservation aspects, excursions.

Ecological Landscape Excursions (Seminar)

Excursions to selected landscape types of the region, excursions to relevant institutions, administrative bodies and enterprises concerned about environmental questions.

Computer-Aided Methods in Landscape Ecology (Seminar)

Remote sensing, high-resolution satellite imagery, geographical information systems, environmental information systems.

National and International Environmental Laws (Lectures and Seminar)

Function and operation of international environmental law, environmental law of the EC, EC-treaty, legislative competence of the EC in the sphere of environmental law, influence of EC environmental law on the national legal systems of environmental protection in the member states, agreements of the EC with developing countries (e.g., Montreal protocol on depletion of the ozone layer), international agreements signed by Germany.

Environmental History (Seminar)

Changing problems of the interrelations between man, technology and nature from antiquity to today; exemplary environmental problems of various historical time periods, the role of technology in solutions for problems.

Ethics and Ecology (Seminar)

Ethical issues in ecology and politics, pure and applied sciences, mainstream contemporary ethics, normative and prescribing elements of ecology, analysis and separation of ecological and ethical arguments in contemporary discourses about environmental protection, sustainable development, the ecological shaping of society and economy.

5. MODULE 4: MANAGEMENT

5.1 Introduction

For creating and protecting world heritage sites, the knowledge of appropriate forms and strategies of project management is required. Management copes with tasks of leadership that can be derived from definable aims and are dealt with in project teams. Projects are carried out in all fields of cultural and business life. In World Heritage Studies, the technical aspects are as important as the organizational, cultural, historical and social aspects.

In the field of project management of world heritage sites, an agreement is necessary about what is worth preserving, and in which dimensions the preservation and development of world heritage should be realized. World heritage managers must be able to assert themselves in complex, potentially conflicting communications and situations. They should be capable of moderating in debates between different interest groups.

Qualification as a world heritage manager calls for the capability to act in foreign cultural contexts. This course of study shall form the basics to qualify the graduates as executives in an international environment, regardless of whether they will work in international organizations, in national cultural or educational institutions or in private industry.

5.2 Required Courses

Project Management (Lectures)

Theory of project management, organization of projects, basics of project planning, computer-aided project planning and control of projects.

Economic Sociology (Lectures)

Economic sociology, sociology of work and employment studies, institutional and interorganizational analysis (politics, economy, technological and ecological development), relevant sociological concepts of technology, industry, work, and environmental studies, research methods in social sciences.

5.3 Elective Courses

Civic Involvement in Planning **Decision Processes** (Seminar)

In this seminar, theoretical starting points and practical methods for the organization and realization of public and democratic ecology discourses are taught.

Investments and Finance (Lectures)

Basic knowledge, investment decisions, investment and taxes, investment and risky expectations, decision-oriented aspects and investment planning.

Intercultural Management (Seminar)

Human interactions (leadership style, employee models of identification with executives), human-environment interaction (culturally-characterized work productivity, high regard for natural resources and the corresponding dealing with this), structural and individual plans for management.

Culture, Environment and International Politics (Seminar)

History of international development politics (modernization, dependencies, sustainable development), globalization, deregulation, roots of ethnic conflicts, supranational migration, theories of cultural development,

Marketing (Lectures and Seminar)

Strategic marketing, corporate strategy, business strategy, resource-based view.

International Economic Relations (Lectures and Seminar)

Economy with fixed exchange rates, economy with flexible exchange rates, the breakdown of the Bretton-Wood System and the problem of fluctuation of exchange rates, determinants within the development of exchange rates and the integration and cooperation of currencies.

General National Economy (Lectures and Seminar)

Basic theoretical knowledge of economy and politics in economy, coordination and allocation, free economic markets and the centrally administered economy, economic reasons for the interaction between the state and the economy.

Regional History and the Preservation of Regional **Heritage** (Seminar)

Character and methods of regional history, regional history as part of cultural history, specification of regions by comparison, science of museums and exhibitions, cultural work and history, industrial culture.

Work in Culture with an Emphasis on Regional History (Seminar)

Work with museums and cultural activities of the region. As a demonstration of the work, the preservation of the industrial heritage of the Management Technorama Niederlausitz e.V. and the work of the united museums of technology and traffic is planned. Work experience in the field of the preservation of cultural landscapes as heritage sites can be gained in cooperation with the Blankenhain open-air museum.

Museology (Seminar)

Museology occupies the key infrastuctural position between science, management, administration and the public as an organizer, mediator and manager of information regarding museology. Therefore its focus lies on the following topics:

- documentation and research;
- organization and the use of technology;
- administration and staff;
- marketing and public relations;
- organization and pedagogy of museums and exhibitions;
- historical knowledge and starting points in a culture's history;
- science of museology.

Other work included in the topics listed above is work in the field of bibliography, archivation, documentation, administration and the information and communication technologies.

Communication, Cooperation and Management of Conflicts (Seminar)

Communication psychology, client-oriented communication, analysis of transactions, body language and communication, conflict resolution , basic psychological and organizational knowledge, dimensions and didactics of self-guided learning.

Group Mediation (Seminar)

Presumption for work in groups, basic theoretical knowledge of communication, group dynamics, basic moderation techniques, subject-oriented interaction, regulation of problems, exercises.

6. COMMENTS TO BE DISCUSSED AT THE BOLOGNA SEMINAR 1999

The BTU curriculum is an interesting basis for discussion. Some general remarks are:

- ICCROM activities should not be restricted to the UNESCO World Heritage, but it is an interesting aspect which should be considered.
- A 'Natural Science' module is missing. Too much weight is given to human sciences.

- A 'Quality Control' module is missing. Some ideas are given in the paper "Care of Monuments and Quality Assurance Systems: Incompatible or Indispensable," by H. R. Sasse.
- A 'Civil Engineering and Material Science' module is missing. In module 2, these elements are not considered in their recognized importance.
- Large parts of module 3 seem to be unnecessary.

The Natural Scientist in Conservation

Andreas ARNOLD
Institut für Denkmalpflege der ETHZ, FTK
Zurich, Switzerland

Abstract

Natural science resolves problems for conservationists and contributes to all steps of the conservation process: study of the object's cultural and physical nature and its condition, deterioration, risk assessment and methods for prevention and sustained care. A conservation scientist is able to formulate the problems, to know the possibilities and limits of the methods used by specialists and to understand and evaluate the relevance and pertinence of the results. Such broad knowledge needs an academic study at the university level and practice.

A possible profile of a conservation scientist is outlined by "Recommendation no (97) 2 of the Committee of Ministers of the Council of Europe." It implies long-term research in materials, deterioration and conservation, upkeep and maintenance based on risk analysis and a multidisciplinary training of researchers and teachers.

Keywords: Conservation; preservation; natural science; methods; generalists; specialists; competence; conservation scientist; prevention; recommendation; Council of Europe.

Context

The intentions, issues, and goals of conservation depend upon public perception, appreciation, awareness and determination to take care of cultural heritage. Current practice in conservation differs widely from the intentions and goals articulated in the various charters and official declarations. Conservators, architects and restorers do all kinds of what they call restoration: the accurate preservation of the actual state as well as different kinds of restitution of historical states, renovation as well as complete reconstruction of monuments.

Natural science issues and the methods used to resolve problems in conservation depend largely on the attitude and intentions of conservationists. The appropriate scientific approach varies greatly according to the choice of the decision-makers, e.g.,

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to keep an object it in its current state or to restore it in a presumed past state, to do sustained care or to make the usual periodical repair and restoration.

Currently, the scientific potential of natural science involved in conservation is very impressive and various indeed. Physicists, chemists, biologists, earth scientists and engineers, as well as other scientists specialized in sub-disciplines, contribute with their instruments and intelligence to improve knowledge and skill in conservation. The questions and topics are numerous, and the scientists perceive and resolve problems in a variety of ways, using different phenomenological, empirical and analytical approaches. In addition, conservator-restorers also try to introduce natural-science investigations in their own work. Eventually they all assume responsibility for the results of their research that are applied in conservation.

How to trace the role of natural scientists within this multifaceted field of activity? From my point of view, a good, realistic approach would be to start from the assumption that cultural objects ought to be preserved exactly in their actual state. Then we may define conservation as follows:

Preservation of monuments means to identify the materials and values, to establish their state of conservation, to understand the kind and evolution of the relevant deterioration processes (past, present and future), to evaluate the risks of additional deterioration, and then to act in order to let them survive authentically as long as possible.

A monument or artefact has a physical nature as well as cultural significance and value. The cultural information is inseparably bound to the object's physical nature and it is completed by the written and illustrated information about it and its context. A monument or artefact thus is constituted at least by:

- its physical nature,
- its intrinsic cultural nature,
- what is known about it.[1]

Integral conservation, therefore, intends to preserve all three facets: the material itself, the message and the documentation as a cultural value. This reality also determines the attitude and methods of the natural sciences applied in conservation. Integral conservation of the monument in its actual state is the first approach of any conservation work and of the scientific contribution to it. The reasons for restorations that go beyond pure conservation of the actual state are somehow concessions to other, preferred values, such as the legibility of the message, better use or the unity of the idea. These other values not only influence the conservation work but also the scientific point of view. The issue and procedure of a scientific study will differ according to whether a stone façade has to be reworked to create a new surface or whether it has to be preserved in its current state with the original deteriorated surface. In the former case, there is no need to perform studies in preservation of the deteriorated parts, while in the latter case such studies will be the most important.

1 A ruin, e.g., may be seen and understood as an assemblage of stones, with some aesthetic appearance, but its entire nature is evident only through archaeological documentation.

Issues, methods and scientific competence

The natural sciences actually contribute, in a dialogue with conservators (architects, historian, decision-makers, restorers and artisans), to all steps of conservation work, namely:

1. Recognition of the nature, value and history of the monument with its component parts and materials (e.g., earth, stone, mortars, wood, metals, glass and ceramics, renderings and paint, etc.). That may also involve the study of the origin, technologiy of manufacturing and working, stratigraphy and dating of materials and material assemblages.
2. Inventory of the physical and cultural state of preservation of the materials and constructions (mostly fragments of the original state), including their values, damage suffered and their sensitivity to alteration.
3. Study of deterioration processes (past, present and future). That implies identifying, localizing and relating deterioration processes (past and present) to their specific causes, their internal and external condition, their evolution (rate) and effects.
4. Assessment of the risks of probable future deterioration according to points 1-3; i.e., making a prognosis based on the value and sensitivity of the object, the identified and localized deterioration processes and their external conditions of evolution.
5. Prevention of future deterioration by intervening on the general and specific causes, on the conditions of the processes and on the effects. That may involve:
   - intervening on the construction and weathering situations (statics, humidity, exposure);
   - influencing the conditions of deterioration (climate, humidity balance);
   - improving resistance to external influences (consolidation, protection of constructions, materials and surfaces – treatments);
   - monitoring the effects and the measures of upkeep and maintenance.

Of course, the actual reality still differs from that intention. Most restorers today do periodic repair work accompanied by some general measures against suspected causes of deterioration and then they carry out surface treatments presumed to improve the resistance of materials against ageing and weathering, whatever that entails.

Three types of scientific approach to monuments are currently used in the natural sciences:

Phenomenology: i.e., observation, explanation and control of the nature, state, structure and transformation of constructions and materials (as done by geologists, mineralogists and biologists).

Analysis: i.e., chemical analysis of materials, physical measurements of material and structural parameters, quantitative experiments and tests, development of analytical and measuring methods, of new products and installations (as done by chemists, physicists, engineers, but sometimes also geologists and biologists).

Empirical approach: i.e., application of knowledge and skill for practical conservation and restoration work and control of the effectiveness of interventions (as done by architects and restorers as well as natural scientists).

There are many misunderstandings among scientists working for conservation about appropriate methods (phenomenology, analysis and empirical approach) and scientific and practical competence.

At present, the term 'conservation scientist' designates any scientist working somehow and somewhere in the conservation field, regardless of his/her competence in conservation as a whole. A chemist occasionally analysing some pigments for a restorer could claim to be a conservation scientist, as could as a biologist identifying some algae, fungi or bacteria, or a geologist describing some stone structures in the context of conservation.

However, the subject matter of the conservation scientist is certainly the whole field of physical conservation. He or she must be competent in all aspects of physical conservation. There are different opinions about the scientific and practical competencies and their limits. *I am convinced that the transgression of the limits of scientific competence causes most of the mistaken and destructive interventions in conservation*

Scientific competence covers a sector of science in which a scientist is able to formulate and resolve problems by means of scientific methods and to give pertinent answers and advice.

As already mentioned, the field of competence of a conservation scientist, in its broadest sense, embraces all the disciplines brought to bear on the physical conservation of materials that have a cultural message. More specialized disciplines have a more specific field of competence. A conservation chemist, for instance, is competent within the field of chemistry applied in conservation; an analytical chemist in conservation is competent in chemical analyses made in the context of conservation, etc.

The conservation scientist is considered a generalist in conservation science and the conservation chemist is specialized in some sectors of conservation. That evokes the terms of *generalists* and *specialists* which are somewhat confusing. Things may become clearer if we relate the designations to defined fields of scientific competence. As an example, we may consider that a generalist in chemistry is a specialist of natural science, a generalist in analytical chemistry is a specialist within the field of chemistry and a generalist in X-ray diffractometry is a specialist within the field of analytical chemistry and so on. However, for mutual understanding, the kind and the field of competence must be clearly stated.

The Conservation Scientist

A possible definition of a conservation scientist could be as follows. *A conservation scientist (generalist in conservation science) is a kind of manager of the specialized disciplines. His competence enables him to formulate the problems, to know the possibilities and limits of the methods used by the specialists and then to understand, discuss, criticize and evaluate the relevance and pertinence of the results, with the objective of resolving real problems within the whole context of a given case.*

The conservation scientist's field of competence is natural science applied to all aspects of conservation. That represents a very big challenge. It is advantageous for a CS to be specialized in a sector of conservation science, e.g., stone monuments, wooden monuments, museum collections, etc.

Today's CS have a grounding in chemistry, physics, geology or restoration, followed by a few other courses and a long period of on-the-job training, mostly self-taught, to gain the knowledge and skill that enables them to fulfil at least a prominent part of the demands expressed in the definition suggested above. This is certainly not the best way to achieve the required competence.

I suppose that the community involved in conservation should define and establish conservation science as a new university discipline. This discipline uses the methods of physics, chemistry, biology, geosciences and environmental sciences just as instruments. This is nothing new; geology, for instance, uses physical (geophysics, petrophysics), chemical (geochemistry) biological (geo-microbiology) disciplines to explain the processes of earth history.

Of course, a CS does research, teaching and consulting. Such a competence needs a complete study at the university level.

The field I am concerned with is preservation of built monuments made of stone materials (stones, mortars, paints, wall paintings, etc., including ruins). A CS (generalist in this field) must be a phenomenologist (e.g., geologist, petrographer, geographer, biologist, etc.).This scientist is capable of determining the nature and the physical and cultural qualities of stone materials, of observing and interpreting deterioration forms and processes, of understanding and criticizing analytical results (chemical analyses and physical measurements), and interpreting them in regard to the interdisciplinary context on the monument concerned, as well as proposing, evaluating and controlling the different procedures for conservation.

Natural scientists specialized in problems of conservation

Apart from these conservation generalists, there are other scientists competent in particular disciplines and fields of conservation: e.g., treatment products, bio-deterioration, microclimatology, petrophysics, pigment analyses, as they already work for conservation. According to their disciplines, we may distinguish the discipline and the sector in which the scientist is specialized and competent, as for example:

- a conservation chemist competent in the formulation of consolidation products;
- a conservation physicist competent in radio-carbon dating, or in physics of buildings;
- a conservation biologist competent in biogenetic deterioration of wood;
- a conservation geologist (petrographer) competent in problems of stones;
- a conservation technologist competent in historical technology for conservation, etc.

These scientists apply their skill and knowledge to special problems in some sectors of conservation.

Postgraduate courses could improve the sensitivity and awareness of these scientists towards the problems encountered in conservation of cultural objects and give them the ability to follow the interdisciplinary dialogue about interrelated problems in conservation.

Possible profile and formation of a conservation scientist

Basic demands for science and training in conservation can be deduced from Recommendation no. (97) 2 of the Committee of Ministers of the Council of Europe.

The following selected recommendations are essential:

"Organizational and programming measures are needed to ensure the development of strategies for the protection of the cultural heritage against deterioration, as well as the development of long-term research and training ...

The strategy should encompass risk analysis by:

1. *evaluating the cultural and economic values of the heritage at risk;*
2. *establishing the state of preservation;*
3. *checking failures in structure and function;*
4. *identifying the nature and location of the deterioration processes;*
5. *monitoring their evolution, rates and effects;*
6. *making a prognosis for future evolution.*

On the basis of this analysis, practical intervention should be undertaken locally, by periodic servicing of functional equipment, repair of damage and replacement of sacrificial elements, as well as by undertaking monitoring and intervention to minimize ongoing deterioration.

Sustained monitoring should imply periodic inspection, with emphasis on the risk area, continuous observation of failures in structures, materials and functions as well as guidelines for upkeep and daily use. Maintenance implies repairs of failing points and reduction of similar risks.

The training of craft workers and professionals concerned should be promoted.

Measures should be taken to encourage the training of professionals and craft workers to gain capability of understanding the problems of deterioration and conservation in their entirety and in their interdisciplinary context. This should be promoted at university, technical and craft-worker level.

Multidisciplinary training for researchers, teachers and conservationists should be initiated in the following areas:

1. *recognition of the nature, value and history of the concerned object, its component parts and its context;*
2. *theory and general method of heritage conservation;*
3. *phenomena, processes and causes of deterioration, including the relevant analytical techniques;*

4. risk analysis and management;

5. assessment and updating of methods and techniques for sustained maintenance;

6. conservation procedures, using traditional or modern working methods, affecting the totality of the relevant phenomena ...[2] "

This recommendation implies long-term research in deterioration and conservation, upkeep and maintenance based on risk analysis and the multidisciplinary training of researchers, teachers and conservationists, i.e., research and training. The items may serve to define the individual fields of competence and the disciplines involved. Such a programme is very challenging, and the natural sciences are implicated in all items. These reflections result from a long experience as a natural scientist working for conservation. They are intended to contribute to the current discussion.

2 Recommendation No R (97) 2 of the Committee of Ministers to Member States of the Council of Europe on Sustained Care of Cultural Heritage against Physical Deterioration due to Pollution and other similar Factors (Adopted by the Committee of Ministers on 4 February 1997).

The Education, Training and Professional Activity of Conservation Scientists

J. DELGADO RODRIGUES
Laboratório Nacional de Engenharia Civil
Lisbon, Portugal

Abstract

There is little consensus on who Conservation Scientists (CS) are, what they can do, how they should be educated and trained, where they should work, etc. Apart from these difficulties deriving from the relative newness of the concept, there are also some misunderstandings about their role and place in the broad field of conservation and restoration practice.

This paper maintains that: ***i)*** the scientific background of CS should be obtained at the graduate level; ***ii)*** the complement in conservation science should be provided at the Master's level; ***iii)*** the ability to perform research and practice should correspond to a PhD degree as the basic starting point. In this scheme, the need for a training curriculum following some international standards is particularly relevant at the Master's degree level.

The involvement of CS in conservation and restoration interventions should be a normal practice from the younger stages up to the top levels. This perspective configures the need for structuring a career of CS to benefit the standards of the practice of conservation and restoration.

Keywords: conservation scientist; formation and training; curricula; professional career.

1. Introduction

The practice of conservation and restoration has gradually acquired a more visible role within human activities, and in many countries it has gained relevance and recognition by society. The growth of this activity has been accomplished slowly and with great difficulty, as it has developed through intricate paths prompted by local circumstances or even by individual personalities. In such a system, it is difficult to identify the existence (if any) of underlying ideas on the concepts, objectives and requirements necessary for raising the standards of that practice. The position of Conservation Scientists (CS) within the conservation profession is mostly undefined and uncertain,

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and it can illustrate some of the problems, difficulties and ambiguities that can be found in this domain of activity.

This paper was prepared for the international seminar on "University Postgraduate Curricula for Conservation Scientists," organized by ICCROM, and its preparation has largely benefited from the preparatory work carried out and published in ICCROM 1999[1] "Preliminary Survey on the Feasibility of a Training Curriculum for Conservation Scientists - Research Report." This paper reflects the author's personal experience and it may be biased for having been developed in a small country such as Portugal, where the problems have certainly a lower amplitude, but where the scientific and professional structures are also distinct from the average situations in Europe.

The context (at national and regional levels) has its influence on the ideas here expressed, but, nevertheless, I have attempted to extract some general trends that might be relevant in other contexts. A basic requisite for the validity of this transfer is the existence of well-defined concepts - a fact that, at first sight, still seems to need further attention.

The aim of the present paper is to contribute to the definition of what a conservation scientist is, to stress his/her role in the multifaceted process known by the general term of 'conservation of cultural heritage.' It also aims to contribute to the development of the most appropriate ways of educating and training such a professional with the final objective of delivering this training most effectively. The paper reflects the point of view of a scientist working in a research institute, with current participation in real conservation interventions, but with only sporadic forays into formal teaching activity.

2. A Career for Conservation Scientists

It is currently agreed that research for conservation should embrace multidisciplinary teams, but things are more controversial when a decision has to be taken regarding which of the different disciplines is to play the leading role in this dynamic. One thing is certain: good conservation practice requires sound scientific research, and this implies the existence of CS. Apparently this should be enough to understand what a conservation scientist is, but I think that this concept needs some further clarification.

The key question is: what is a conservation scientist? Since the term proves hard to define, let me start with a negative answer – in order to be a CS it is not enough to have prepared a MSc or PhD thesis in a subject related to the conservation of cultural items. This may be an essential requisite but it is far from being sufficient for any person to be considered a CS.

In my view, a CS is someone (by definition, a scientist) who, when facing a problem relevant for conservation practice, is capable of contributing to its resolution by using the scientific knowledge and tools belonging to the scientific branch in which he/she was educated and trained. The following paragraphs will extract some conse-

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1 ICCROM, 1999. "Preliminary study on the feasibility of a training curriculum for conservation scientists." Research report. ICCROM, Rome, August 1999.

quences from this definition, but it is still necessary to further clarify this 'simple' definition, namely because the borderlines with other professions are somehow fuzzy and the current system of professions and careers is not especially coherent and well defined.

From this definition, a CS "should be capable of contributing" to a solution but is not necessarily expected to solve a problem fully. This is a direct and obvious consequence of the interdisciplinary quality of conservation issues, but still more important, by saying this I am implying that even the young scientist can be a CS.[2] When writing this statement, I asked myself - is this a trivial and irrelevant idea or is it something that deserves consideration? I confess that I started by being of the first opinion and eventually decided that it might not be so trivial and could even bring some useful input to our main object of interest: the eventual preparation of a training curriculum for CS (*and training presupposes, predominantly, young people!*).

In a quotation from ICCROM 1999[1], Torraca (1982)[3] states that a CS "*should be a man of solid scientific background, but with enough versatility and culture to be able to understand the attitudes of all types of specialists involved in the conservation process. He should have a feel for accurate measurements, fairness in judgement, and a decision-making capability. Above all, he should never invent a new conservation process.*" A further definition by Tennent (1992/94)[4] states: " ... *the Conservation Scientist has two important current roles: (a) to provide the basic research which can justify new, possibly heretical, approaches, and (b) to act as a knowledgeable scientific mediator between the architect or designer and the custodians of buildings and their collections*" and also "*the Conservation Scientists have an important role, particularly in fostering the implementation of means of preventive conservation. (...) Ideally, the scientist will be able to develop new, simple, low-cost approaches to preventive conservation or treatment.*"

Beyond the apparent contradiction of both quotations on whether a CS should or should not invent (develop) a new conservation process (new, simple low-cost approaches), the paradigm for both definitions seems to correspond to someone with a high level of responsibility and engagement in conservation practice. Therefore, I conclude (perhaps too hastily) that typical young scientists (early in their careers) are excluded from these concepts. Torraca's quotation certainly reflects the period of its appearance and is not necessarily wrong, but, in my opinion, it would be more properly assigned to a different group of conservation agents, i.e., 'experts in conservation.' Giorgio Torraca was and is one of them, but it is obvious that his skills correspond to the top of the scale in competence, while the place for a young CS would be located

2 In other words, this means that CS are not only the top experts in conservation, but anyone working in the field that uses science to solve conservation problems.

3 G. Torraca, 1982. The scientists' role in historic preservation with particular references to stone conservation, in N.S. Price (ed.), *Conservation of historic stone buildings*, National Academy Press, pp. 13-21.

4 N. Tennent, 1994. The role of the conservation scientist in enhancing the practice of preventive conservation treatment of artefacts, in W.E. Krumbein (ed.), *Durability and change: The science, responsibility and cost of sustaining cultural heritage*, Chichester: John Wiley and Sons Ltd., pp. 165-172.

at the other extreme, corresponding to the introductory or initiation phase. More than making a detailed analysis of this scale, I am particularly interested in emphasizing that this scale is suitable for supporting my position on what defines a CS and for preparing the more appropriate curricula and means for achieving our objectives.

With the preceding words, I am pointing out that the concept underlying the term CS includes a broad range of capabilities and consequently it would be well suited to be developed through a career that integrates different levels of expertise according to the respective position in that scale. In its essential meanings, this concept fits the system of vertical careers, and can be put in parallel with the university teaching career or the scientific career in research institutes. Even in countries where the career system is different, the concept of CS is certainly better understood and its contents better defined when the context is assimilated to a complete career and not taken as a mere set of individuals with more or less expertise and competence in conservation practice.

Once this type of concept is accepted, the reasons for some incongruities and insufficiencies in the current system become more apparent. When analysing the activity of CS reported in scientific literature, de Guichen (1989/91[5] – quoted in ICCROM 1999[1]) points out the insufficient linking to real conservation problems (*"scientists are more concerned with studying the composition of objects than with proposing solutions for safeguarding them"*) and stresses the need for specific training in this area. He further considers that CS *"are afraid of getting involved in discussions with restorers and for fear of having to answer questions – which are not always well formulated – they retreat to their laboratories."* Many of us could easily corroborate these words, which certainly apply to the existing panorama of the scientific matter available in the literature. However, I do not think that we can analyse such an important topic before having discussed who the authors are and what their motives were when preparing this literature.

I personally think that professionals in the field of conservation practice do not produce most of such literature, that is to say, it is not produced by CS as explicitly defined above. Quite frequently, the reasons for carrying out research work are totally outside the scope of conservation practice and only the existence of a 'interesting' research topic or of funds for a given research justifies the selection of a given theme. This does not necessarily mean that the research concerned is useless the conservation practice; it merely signifies that the connection of the work to its practical application is not immediate and straightforward. Although accepting that scientific research should address the resolution of real problems, it is clear to me that not all the research providers have similar responsibilities.

Research topics in conservation are not forbidden at universities, but it seems clear that, unless specific agreement protocols exist, there is no way of forcing university researchers to solve real conservation problems or to be *"involved in*

5 G. de Guichen, 1991. Scientists and the preservation of cultural heritage, in N. S. Baer, C. Sabioni and A .I. Sors (eds.), *Science and Technology and European Cultural Heritage. Proceedings of the European Symposium, Bologna, Italy, June 1989*, London: Butterworth-Heinemann Ltd., pp. 17-26.

discussions with restorers." Regardless of a university's reputation, it is a fact that *"the specialism which makes for excellence in academic research may result in an overly-narrow approach to problem-solving in conservation science"* (Tennent 1997[3] quoted in ICCROM 1999[1]). As a matter of fact, much of the scientific literature available is developed in academic institutions that quite often have at least some familiarity with real problems. However, the framework where it is produced has objectives of its own that are not necessarily defined to meet the needs of conservation agents: practitioners, consulting firms, authorities. A significant amount of scientific research is produced when masters and doctorates are prepared, and 'academic' results are perfectly adequate for this purpose, so no one has any authority to challenge this system. Put simply, we could say that it is one thing to carry out scientific research on a conservation topic and another to solve real conservation problems.

In brief, I would conclude that most of the available scientific literature on subjects related to conservation science is not produced by CS in the *strictum sensum* here advanced. This is why a career for CS seems to have total justification. The CS would then be a professional searching for the resolution of real problems, prepared for participation in interdisciplinary teams and with the ability to discuss with restorers or anyone else concerned.

It should be stressed that this dual perspective does not imply the existence of any differences in capability, either personal or institutional, but rather that there is a significant difference in the objectives and in the consequent responsibilities. 'Academic' production has its own logic and pursues its own objectives, and coming from a 'sound' scientific environment, it will sooner or later make positive contributions to the practical field. In any case, it seems relevant to stress that current scientific research is not produced under the logic of a 'career for CS.' Therefore, since the expectations were defined and applied outside this logic and scope, the producers of that 'academic' research should not be blamed for the insufficiencies that might be found in its practical applications.

It seems obvious that those who pay for research should be allowed to select the object of research and control the respective results. However, I am convinced that most of the scientific research produced on conservation themes is not paid for as such; rather, it comes from scholarships, international projects, grants and other sources of this kind, where the essential practical needs are not directly taken as a primary selection criterion. For this reason, some may argue that the applicability of the results is scarce, but in fact the research was not funded for this.

Therefore I think that the organisms responsible for conservation should implement their own facilities (or should suggest this to the entities that eventually replace them in the production of conservation research) for adequate careers in conservation science and feed them with the relevant and appropriate working means. The end users of scientific research should have a strong role in the definition of the objectives, in the control of results and in the organization of the production system, but their best argument will always remain in their capacity to pay for or subsidize that research.

3. Training needs for conservation scientists

a) A possible model for education and training

As a direct consequence of the above-mentioned career scheme, a CS should be a professional in scientific research in a domain relevant for conservation practice. This also means that no one should be able to tackle all the relevant domains and, therefore, there will never be a unique course or training scenario for all possible types of CS. Leaving considerations about the balance between science/conservation needs for later, I would like to stress that a strong scientific background is an essential prerequisite for a CS and therefore only specific education in each domain can achieve such a desideratum. That is to say, university education in chemistry is required for a CS in chemical themes; geology is required for CS in geological problems, etc. In this respect, it seems logical to deduct that degrees in 'conservation' will never replace the established sectorial domains of research, and that at most these professionals will represent one more field of activity.[6]

One first conclusion could be drawn: CS require a strong background in science (no given science domain can be excluded *a priori*) and I share the idea that in a normal sequence of formation of CS, *"it is better to get science first"* (Price 1992[7] – quoted in ICCROM 1999[1]).

If we agree that the first step in the training of a CS is to build a strong scientific background, the next issue is to find the appropriate means to transform a young graduate into a professional in scientific research and to give him/her a suitable formation in conservation. To some extent, this problem concentrates the basic leitmotiv of this seminar and therefore it deserves to be analysed in detail.

The professional character of any scientific job is acquired by carrying out specific research in a gradual way, starting from simple tasks under a tutorial basis and progressing until an independent capacity is demonstrated. In general terms, this level is considered fulfilled when a PhD thesis is prepared and successfully defended. Since the person in question is to be asked to solve problems in the field of conservation, it is of the greatest importance that this research be carried out in a subject closely related to this field. In this context, one may conclude that a CS should preferably have a PhD in a subject related to or relevant for conservation practice.

As already stated, the CS also needs to obtain a good background in conservation, namely in art history, ethics and principles of conservation, and, for the moment, there are no clear ideas on how and when this material should be imparted to a CS candidate. It is clear to me that some formal teaching is necessary to obtain better results, but the best way (or ways) to do it is not immediately evident.

We could consider that some teaching at the undergraduate level would be useful, but very likely this is a utopian idea and could eventually be counter productive.

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6 This also implies that it will remain erroneous to think that ONE Conservation Scientist per laboratory will be enough to satisfy the needs in *all* scientific matters.

7 C. A. Price, 1992. Training for research in conservation, in *Archaeological conservation: training and employment*, London : United Kingdom Institute for Conservation, pp. 18-19.

In fact, this preparation, necessarily given at a very basic level, could be used at a later stage as favouring low-rated candidates (to the disadvantage of higher-rated ones) merely because they had had such an incipient exposure to 'conservation.'

A more feasible alternative could be the preparation of special courses at the Master's level where the topics more strictly related to conservation science would have a predominant position in the course syllabus.

Therefore, one possible sequence of formation of a CS could be as follows:

i) obtaining a graduate-level qualification in any branch of science (chemistry, biology, geology, engineering, etc.). A four-year course seems appropriate;

ii) obtaining a basic education in conservation science (art history, ethics and philosophy of conservation, etc.) at a Master level with the preparation of a thesis in a theme of this same area. I am thinking of a two-year course, with one year of formal teaching and one year to prepare a MSc thesis;

iii) preparation of a PhD dissertation on a subject of interest to conservation practice in the field of the degree. Typically this lasts for three to four years.

Under this model of education and training, the object of the present seminar would be addressed to defining the curriculum for item ii) outlined above. If we agree on this model, it is my belief that the preparation of a guide for such a curriculum is not only possible but also highly desirable.

b) Contributions to a possible curriculum guide

According to the model delineated in the preceding item, our effort should be addressed to the development of a curriculum guide for the phase immediately following graduation, when the 'proto-CS' enters the process of getting a Master's in 'Conservation Science.' As stated above, I have postulated that CS are expected to arrive at this point with basic grounding obtained in many different branches of science. Then, the first problem to tackle is to decide whether this Master's programme should be identical for every type of basic formation or whether some variations are to be accepted according to some grouping of the candidates' scientific background.

The more realistic approach, namely if considered for a possible recommendation from an international entity such as ICCROM, is to define the basic structure of such a curriculum and leave room for some local adaptations, according to the candidates' profiles or even to local constraints and needs. This basic structure can be taken as a guide for the preparation of a real Master's programme for CS.

As a first approach, it also seems appropriate to have two versions of this guide: one addressed to conservation of movable items and another one addressed to the built heritage. Although some interplay may happen between these two fields of activity, the number of existing CS working simultaneously in both areas is certainly very low, so it seems unjustified to make the effort to build up a unique guide for making the two possible areas of specialization compatible.

As a starting point, I consider that the actual curriculum of the ICCROM training course – ANMET *"International Course on Non-destructive and Micro-destructive*

Analytical Methods for the Conservation of Works of Art and Historical Buildings" – could be used as a preliminary version for such a guide, provided it could be extended to the typical duration of Master's programmes. Without attempting to give an exhaustive list of topics for such a guide, I consider that it should certainly include the following items:

- basic notions on art history, the aesthetic and historic values of cultural heritage, ethics of conservation;
- history of conservation, theory of conservation;
- notions on communication and on interdisciplinary work;
- scientific examination of cultural objects;
- basic notions on causes and processes of decay.

4. Implications derived from the systems of funding and management of scientific research

It is widely accepted that the publication of the results of scientific research in internationally recognized journals is enough to demonstrate the validity of that research. In practical fields such as engineering, conservation practice and others, this criterion may be enough to demonstrate that the results are scientifically sound and valid, but it is not an automatic validation as concerns their practical relevance and applicability.

To a large extent this point has strong links with the concept of what a CS is and with the possible ways for educating and training him or her. It is in the interest of the authorities that a significant amount of scientific knowledge in matters related to conservation practice be produced by professional conservation scientists, irrespective of the amount and quality of scientific knowledge produced by the academic world. With appropriate management of the instruments, authorities should be able to define the objectives of scientific research and, therefore, control the practical relevance and applicability of the results produced. Due to the recognized scientific autonomy of academic institutions, such control is not feasible and for the sake of high scientific interests, it is undesirable as well.

The authorities have a decisive tool – research funding – for defining what the research themes should be and for selecting who is researching what. A sound scientific environment should be based on a good balance between practical and theoretical research. The authorities can manage this objective by properly distributing available resources through the research centres where applied research is the main concern and for the academic institutions where theoretical research should be the essential objective. This is by no means to say that any of these types of institutions cannot carry out research outside this basic scheme. Quite the contrary, it clearly means that each type has its own typical responsibilities in this field and it is according to this scheme that responsibilities should be assessed.

Typically, the CS will find employment in research centres and conservation laboratories,[8] and both types need to work in close contact with the agencies responsible for conservation interventions. Some of these centres may even be under direct supervision of those agencies, namely in the case of the leading national authorities. This means that through a well-defined policy of incentives and funding sources - complemented with a rigorous control of how those resources are spent - it will be possible to raise the level of scientific production. Furthermore, as a direct consequence, the number of work opportunities for CS will increase and the demands for their qualification will rise in parallel.

5. Concluding remarks

The concept of Conservation Scientists is not currently included in the practice of conservation and restoration. Contributions from the scientific field are commonly used for the benefit of conservation treatments, but there is no well-defined system whereby one can identify the actors, the means and the respective responsibilities in the production of scientific research for solving the real problems encountered in practice. The reaching of an agreement on the definition of what constitutes a CS, on what is his/her role within the 'conservation family' and on what are the education and training needs would be a great contribution for raising current professional standards. The integration of CS in a structured career – developed from the first steps of the young CS up to the top level of the 'conservation expert' – would turn this concept into a more valuable one and would introduce a great deal of clarification among the different agents that are relevant participants in this field.

The production of scientific research in matters relevant for conservation practice needs to attain a good balance between theoretical and practical results, but this will never be reached through more or less vehement appeals, or by administrative or legal decrees. On the contrary, this objective can only be reached through a careful and rigorous management of funds for supporting scientific research with a clear definition of themes and priorities, the identification of the suitable players and by using appropriate control of the means and of the respective results. In this context, CS should be fundamental in fulfilling these objectives. Therefore, the most serious attention should be directed to identifying adequate profiles, developing the appropriate education and training curricula and enhancing the professional activity of Conservation Scientists.

Acknowledgements

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8 Apart from the circumstance that one single CS will never be enough for a conservation laboratory, it should be stressed that research must be carried out in groups with a significant number of scientists (the 'critical mass'). This implies that there is a limiting number below which the respective research centres are undersized.

Conservation Scientists: the missing link

Bertrand LAVÉDRINE
Director, Centre de recherches sur la conservation des documents graphiques
Paris, France

Over the past 50 years, cultural heritage has become the source of an economic stake that increasingly involves more manpower and money; the natural sciences have become an important component within this structure. In France, for example, at least three official laboratories (linked to museums, historic monuments, archives and libraries) employ several dozen scientists of varying specialities in natural science. They have the official and ambiguous title of 'Ingenieur.' Today the field is more structured and we have enough people involved to be able to distinguish between their specialities as well as categorize them. The conservation scientist is but one in this growing group. One objective of this commission could be to find an agreement regarding the role, the mission, and the training of a conservation scientist. Much attention has been paid to the definition and recognition of the conservator-restorer; now it is time to do the same for the conservation scientist. I must admit that the expression 'conservation scientist' is new in my country and does not have a translation in French. I myself discovered it about ten years ago written on a business card from North America. When I read those two words and tried to figure out what they meant, I came to the conclusion that it was well adapted to what I was doing and to the objectives of my institute. But in my laboratory, most of my colleagues refer to themselves as a scientist, researcher, biologist or chemist and then use two sentences to explain their activities. In the beginning, I did not pay too much attention to this, but now I suspect that it is a good way for them to escape their responsibilities in conservation science and do more or less what they like rather than what they should do.

Organizing a curriculum in conservation science will help not only the next generation of scientists, but also the profession itself in many ways, and I refer to three in particular: The first is to give recognition to scientists working in this field. I have often heard that conservation science is too applied, that it is not profound research and that it will not lead to a good academic career because the level of publications is not considered. There are very few high-standard scientific journals dedicated to the topic where professionals can publish their work.

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Second, it will establish a profile for a conservation scientist considering the diverse aspects of the job. Each of us has specific ideas based on our own individual experience of what the ideal conservation scientist could be. If we can agree to a good job definition, it will be easier to advocate it and help to create new positions.

Third and finally, an agreement on the role and qualification of a conservation scientist will aid in establishing a network and a professional community.

What is conservation science?

A comparison with the medical field is very convenient and we can use this as a starting point. Both disciplines have in common the art of conserving: either human health or cultural heritage. Medicine is a science with the objective of conservation and recovery of human health (the art of preventing and curing human diseases), conservation science is a science with the objective of conservation (and possible restoration) of cultural heritage (the art of preventing and stabilizing the degradation of cultural heritage) In medicine, the activities can be divided into three areas: *research* to understand diseases and create new drugs and/or treatments), *analysis* to help diagnosis; and *therapy*. In conservation science, similar categories can be drawn up:

research to understand degradation mechanisms leading to the development of new conservation material and strategies; *analysis* to help diagnosis; and *conservation*.

In medicine, the three activities of research, analysis and therapy, are the responsibilities of three different professionals: the researcher, the biologist and the doctor. In conservation, the two first steps are the duties of the conservation scientist while the conservation treatment is carried out by the conservator.

The analysis of matter is shared by two kinds of scientists involved in cultural heritage, the first one deals with art history and belongs to what we call archeometry, the second one falls within conservation science.

These activities sometimes cover exactly the same work, but in art history knowledge is the final objective of the analysis. In conservation, analysis is merely a first step, and the motivation for additional funding for conservation research is often an important, ambitious goal. In order to achieve this goal, what type of training should a conservation scientist have? If you examine the various problems found in conservation, you could easily conclude that a solid background in chemistry, physics, biology, geology, etc., is important, indeed everything. More thought is being given to the negative impact that disciplines such as engineering and chemistry can have. These are disciplines that lack a sense of history and thus tend to reduce a cultural artefact to its constituent material denying its specific nature (G. Torraca). As Michel Montaigne wrote a few centuries ago: science without self-awareness is the ruin of the soul. I firmly believe that historical and philosophical issues are among the things to inculcate in a scientist who wants to work in the field of cultural heritage, but these are hard to obtain during scientific training. Such exposure will allow them to re-establish the pre-eminence of the problem rather than the instrumental means for solving the problem (N. Tennent).

What are the basic problems that constitute the activity of a conservation scientist?

The first addresses the object, the matter itself, followed by the environment, and finally the problems of conservation materials and methods. Movable and immovable cultural artefacts require analysis for identification of materials and techniques, evaluation of the artefact's condition and development of non-destructive or micro-destructive methods. Studying the effects of and protection from the environment is a very important activity for the CS. This encompasses not only climate control and the tools for monitoring, but also the study of the effects of light, pest control, physical, biological and chemical effects of temperature, humidity, pollutants, protection of art in transit, packing and enclosures, stabilization. Interdisciplinary work with the conservator is the only way for a conservation scientist to work successfully and never forget his/her mission. To help a conservator to develop conservation treatment or to choose an appropriate consolidant, adhesive, or varnish is certainly the most risky but noble action of the conservation scientist. His responsibility could be invested for several years. As Gaël de Guichen has mentioned, to make a mistake in a pigment identification does not necessarily have a great impact, except to publish two papers in a scientific journal, the first to present the results, and the second to correct them. To recommend an inadequate conservation product or environment could have a disastrous effect on the cultural heritage and on the scientist's career. That is certainly why conservation scientists are so rare; they appear and quickly disappear as Giorgio Torraca emphasized and Gaël de Guichen mentioned here in Bologna – exactly ten years ago: conservation scientists are like satellites launched for a specific purpose but which then drift out of orbit while continuing to send ever more unintelligible messages back to earth.

The Outlook and Competencies of Conservation Scientists: premises and suggestions for training

Maurizio MARABELLI
Istituto Centrale per il Restauro
Rome, Italy

Abstract

The problem of training of Conservation Scientists (CS) must be discussed after having analysed the background of their professional competencies and experience in the complex field of conservation and restoration.

The following topics will be briefly discussed:

- the activity of the CS;
- competencies;
- limitations and difficulties in professional activity;
- employment and research funding;
- some suggestions for training and improving the activity and employment of CS.

To examine the main activities of the CS in Italy, it might be useful to look at the Istituto Centrale per il Restauro (ICR), which is a national institution involved in the conservation, restoration and repair of cultural heritage.

Indeed, this institution carries out a variety of activities, such as diagnosis, treatment, consultancy, research and training, as well as development of standards and publication of scientific texts in the field of conservation and restoration. A summary follows of these activities:

- practical restoration activity in its own laboratories and in experimental work-sites;
- teaching of restoration and conservation principles in its four-year training programme;
- teaching of scientific and technical methodologies in seminars, university degree courses, refresher courses for the Ministry of Culture and Activities and the National Research Council (CNR), courses organized by ICCROM and special international courses;

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- organizing an international conference on non-destructive tests applied to conservation of works of art, together with publication of the proceedings;
- standardization of testing methods for historico-artistic materials, treatment materials and conservation environments;
- research into new methods of analysis, diagnosis and treatment, together with development of prototype equipment;
- consultation on special conservation-restoration problems for state authorities, international institutions and other countries;
- collaboration with university institutes and the CNR, research and industrial bodies, and assignment of thesis topics and fellowships on specific research themes; and
- production of exhibitions, catalogues and various publications in the field of conservation and restoration.

More specifically, research focuses on:

- chemico-physical characterization of the constituent materials of works of art and of artistic techniques;
- study of the causes and mechanisms of decay;
- analysis and control of treatment materials and techniques;
- environmental studies;
- development of prototype equipment and diagnostic models; and
- development of new products, formulas and restoration techniques.

From what has been described above, one can extract the main activities of the CS, which are summarized below:

The CS is involved in:

- providing research and expert advice for governmental institutions in Italy and abroad;
- teaching and training activity for students of restoration, conservators and CS in Italy and abroad;
- collaboration with university, research and international institutions in Italy and abroad;
- teaching in university courses; and
- standardization projects (NorMaL – UNI groups).

In an institution where diverse professionals – CS, archaeologists, art historians, architects, conservator-restorers – are brought together in interdisciplinary collaboration, it is a good idea to understand (beyond useless formalisms and foregone conclusions) what their respective roles actually are.

Competencies in conservation, restoration and maintenance activity

- Diagnosis prior to restoration – the CS and the restorer play the main role and have this responsibility;
- Conservation and Restoration – all the experts have roles and responsibilities;
- Maintenance – the restorer has the main role and responsibility.

Nevertheless, not all these roles function perfectly together. On the basis of long professional experience, I must admit that CS encounter some difficulty in expressing their resources to best advantage in the course of their work.

Limitations and difficulties in professional activity

- No direct coordination of restoration and conservation projects;
- Some difficulty of collaboration with conservators, mainly due to marked differences in the respective professional specializations, due to the lack of a common training experience and of a common technical language;
- Difficulty at the very beginning of professional activity in orientating options and decisions in the practical field of technical research, due to a lack of training and specialization;
- In general, too much activity devoted to archaeometric problems (as opposed to conservation issues).

Difficulties encountered during restoration activity

- Some misunderstanding during restoration activity due to the overlapping of areas of competence;
- Virtually complete ignorance of objective reference standards and tests for the approval of the restoration activity.

As one can see, the difficulties cluster in two basic areas:

a) insufficient recognition of the fundamental role of the CS in conservation and restoration projects and insufficient awareness on the part of the university world of the need to plan and implement postgraduate courses of specialization.

b) lack of a common language and, in many cases, a common experience that foster true integration of the various professionals involved. Again, parallel to the lacks that I see in training and work organization, there are also, in my opinion, some deficiencies at the strategic and political level, as summarized below.

Conservation Scientist: employment and funds for research

Obvious drawbacks:

1. In the past 20 years, there has been a strong decrease of CS employed in the Ministry of Cultural Heritage and Activities (retirement, demand by universities, lack of interest on the part of the public administration); strong disproportion between CS and conservators;

2. No funds appropriated for maintenance activity and maintenance controls;

3. In general, little attention devoted to the scientific control of conservation and restoration activity.

In conclusion, the real need to enhance and improve the professional input of the CS involves the resolution of a series of problems related to methodology, training, organization and political will. A few suggestions and strategies might be as follows:

The Conservation Scientist – suggestions for training and for improving activity and employment

It is necessary to:

1. rationalize and better define competencies and action priorities of CS at the European level;

2. contact institutions and public administrations in order to sustain and improve the demand for and employment of CS at the European level;

3. discover new tools and occasions to establish better interdisciplinary cooperation and knowledge between conservators and CS;

4 plan and implement university specialization courses (Master's, PhD, etc.) for CS at the European level.

For each of the points outlined above, one can define the roles that the various institutions concerned must play in synergy and following a long-term plan and perspective. Such cooperation should certainly occur at a sopra-national level.

Goals and roles

As to point 1, to rationalize and better define competencies and action priorities of CS at the European level; *a primary role can be played by restoration institutes, ICCROM and the Council of Europe.*

As to point 2, to contact institutions and public administrations, in order to sustain and improve demand and employment of CS at the European level: *a primary role can be played by public administrations, accepting recommendations by restoration institutes, ICCROM and the Council of Europe.*

As to point 3, to discover new tools and occasions to establish better interdisciplinary cooperation and knowledge between conservators and CS: *a teaching manual of Conservation Science could be developed, containing:*

- *basic concepts of conservation;*
- *theory and general practical rules of restoration;*
- *general view of scientific disciplines for diagnostic evaluations in conservation and restoration;*
- *scientific management for conservation and restoration.*

This text could be addressed to Conservators and CS, adopting a common language.

Another good way to facilitate collaboration could be to create, at the European level, common interdisciplinary experiences, restoration plans and training courses..

As to point 4, to plan and implement university specialization courses (Master's, PhD, etc.) for CS at the European level: *courses of specialization could be organized at the European level, in collaboration with ICCROM, the Council of Europe, universities and restoration institutes.*

Following a very practical approach, one could already draw a few operative conclusions:

1. The number of CS is inadequate for justifying undergraduate courses in Conservation Science.

2. Masters and PhD courses can be encouraged and planned at the European level.

3. A Conservation Science textbook would be extremely useful for creating a common language and basic knowledge of restoration problems.

4. A Commission, at European level, should draft a text of suggestions and recommendations addressed to government authorities and universities on:

- planning and promoting Master's and PhD courses on Conservation Science for CS;
- encouraging in future a more balanced ratio between Conservators and CS;
- encouraging publication in the field of Conservation Science.

In conclusion, it should be noted that the sector of competence of CS is quite complex. As such, it should be protected and supported by scientific experts themselves, in order to avoid embarrassing oversimplifications or misguided paths of university training.

Science for Conservation: a wide-ranging discipline. A few observations on identifying realistic sub-areas for potential educational projects

Mauro MATTEINI
Opificio delle Pietre Dure
Florence, Italy

Introduction

Conservation science is a relatively recent discipline, less than half a century old. Although today's scientific conservation community is not yet large, in only a few decades it has been able to provide significant answers to various important conservation problems.

A remarkable and greater in-depth knowledge of each country's cultural heritage, as well as a much higher likelihood of its preservation, has been achieved.

It is thanks to conservation science that so many famous works of art and monuments are today better known and appreciated, not only for their artistic, historic or architectural value and meaning but also as a direct result of technology which has ensured their existence. This is, undoubtedly, a great cultural conquest.

Criteria and analysis for the definition of professional profiles and educational curricula

It is now time to put some order in the extremely wide front of this profession so as to perfect the definition of its profile and to outline adequate educational curricula for young scientists who wish to enter this field.

It is particularly important to carry out analysis in such a way so as to single out specific sub-areas in which conservation scientists can contribute. Different aspects related to both the educational background and professional activities of conservation scientists must be considered.

1. First, scientists dedicated to conservation usually have (and in my opinion must have) an **educational background** in the natural sciences. They primarily include:

- *chemists*
- *biologists*

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- *physicists*
- *geologists* and/or *mineralogists*

  Less frequently, engineers are also asked to collaborate in this field.

2. The objects that come to the attention of conservation science may belong to **different** traditional **areas** which determine as many categories of **application** of this discipline:

- *archaeology*
- *art history* and *decorative arts*
- *architecture.*

3. Subsequently, it is essential to consider the **goal** of the scientific contribution, according to which other subdivisions may be identified:

- first and foremost is the *diagnostic investigation,* both for studying the composition and the structure of old objects as well as for characterizing their state of conservation;
- second, checking and improving *materials* and *methods* for conservation work; and
- third, *preventive conservation, post-restoration monitoring* and *museum conditions.*

4. A final and fourth criterion is crucial to this analysis: the **basic typology of artefacts.** Bearing this in mind, we can identify the following principal categories:

- *polychromes on any movable support* (PL)
- *mural paintings* (MP)
- *natural and artificial lithic materials (stone, marble, terracotta, mosaics, glass, etc.)* (ST)
- *metal objects* (MT)
- *unpainted wood* (WD)
- *textiles* (TX)
- *paper* and *parchment* objects as well as *books* (PP)

By cross analysing the different criteria listed above and their related categories, it is possible to obtain tables such as those set out in Figures 1-4. Each table relates to a specific category of specialists (chemists, biologists, physicists and geologists) and in each box (created from crossing areas of application with various objectives) the pertinent categories of artefacts are reported.

Tables organized in this way should facilitate identification of possible sub-areas of conservation science.

One can, for example, evaluate to what extent a given typology of objects is represented in each box: a low evaluation signifies that a 'specialization' in that particular dominion of competence is evidently of little interest.

Any significant quantitative evaluation should be made by a representative and competent committee composed of expert chemists, biologists, etc. in the field of conservation. Unfortunately, at present this has not yet been possible but a simulated exercise could nevertheless be useful so as to understand what kind of results might emerge from such an analysis.

This requires, as mentioned, an evaluation in quantitative terms, which I have myself attempted with the inevitable limitations, however, of a partially representative analysis.

What follows, therefore, must be mainly considered a model to be verified.

In the tables in Figures 1-4, for every material typology reported in each box, an arbitrary evaluation is given whereby marks are attributed ranging from, for instance, 0 to 3. Let us give a few examples to explain this more clearly:

- *table of chemists* – polychromes on mobile supports (PL) – the box at the intersection between the 'art history' field of application and the 'diagnostic' goal. This is a very common and widespread situation: a chemist is very frequently called upon to give a scientific diagnosis of a painting or other polychromes. Hence maximum evaluation = 3
- *table of biologists* – metal objects (MT) – the box at the intersection between 'archaeology' and 'conservation': a situation that is virtually never encountered. Archaeological metal objects conserved *in situ* are rare. As is well known, most archaeological metal findings are, after their discovery, immediately taken to a sheltered environment or directly to a museum. Second, biological attack (and subsequent involvement of biologists in conservation treatments) is infrequent on metallic objects. The evaluation is therefore = 0
- *table ofphysicists* – textile artefacts (TX) – the intersection between 'art history' and 'preventive conservation' is seen as a situation in which the physicist plays a well defined role – a role that gains significant weight at museum level and which concerns the exhibition of textiles in showcases or, alternatively, under other, higher risk conditions for which light control, thermohygrometric monitoring, etc. become necessary. In other words, an active role even if not the most absorbing one for a physicist: high but not a maximum evaluation = 2

Having thus clarified how evaluation can be carried out with the above examples, let us proceed to sum up the scores related to the varying artefact typologies which appear in each box so as to obtain the overall 'score' of the box or, in other words, the "representativeness of a specialized domain for a given professional activity."

We can then sum the scores of the boxes both horizontally (by objective) and vertically (by area of application). Let me repeat that the data that thus emerge have a merely illustrative meaning. Let us, in any case, examine what could come out of this simulated analysis.

The first result is that chemists appear to form the largest category of specialists involved in conservation science (with a total evaluation of 90), whereas biologists and physicists (scores of 74 and 73 respectively) constitute a lower but consistent category with geologists (evaluation of 38) coming last.

I believe that this is not far from the reality of things. In fact, conservation problems are prevailingly of a chemical nature. As far as the lesser involvement of geologists is concerned, this is certainly not due to the quality but to the extent of their contribution. They are specialized in a certain material typology – that of natural and artificial stone artefacts – and consequently cover an area which is by definition more limited when compared to other professions located, instead, transversally in relation to artefact typology.

Chemists, biologists and physicists appear to be involved in parallel in the three areas of application we have identified (*in situ* archaeology, art history with associated areas, and architecture) (see Figure 5). For all three of these specialist groups, involvement in the art history domain would appear to be prevalent, whereas that of the geologists appears to be equally shared among all three fields.

With regard to aims, the involvement that is apparently attributable to the chemists in the field of intervention is considerably high, but this also occurs for the other two objectives (diagnosis and conservation). There does not, however, appear to be any prevalence for any particular field for the biologists. For the physicists, the area of preventive conservation seems to be more highly represented, whereas that of diagnosis for the geologists.

I am quite honestly unable to determine whether and to what extent these latter deductions are in any way realistic or not. What is certain, however, is that by providing accurate quantitative evaluations, the proposed analytical model would be able to offer much more truthful results in the fashion expounded above.

Nothing, furthermore, prohibits grouping in an alternative way (see Figures 7 and 8) which, in this case, favours analysis from another perspective.

General observations

The analysis proposed above can certainly provide a better definition of the conservation scientist's profile and the characterization of appropriate curricula for his/her training. It is, nonetheless, inevitable that there are still other evaluation criteria, different from the ones considered so far, and these, depending on the case, may carry greater or lesser weight.

With the exception of geologists, who by the specific nature of their discipline are mainly called upon to give their contribution in a particularly well defined domain of artefacts, the other specialists – chemists, physicists, biologists – carry out their activities principally in the area of 'art history and museum archaeology.' This is simply because it is in this area that the object typologies are most greatly differentiated according to their compositional make-up. In fact, we come across nearly all the artefact typologies in this area, including those most prone to deterioration from a chemical point of view - metals, marble and stone, for example – as well as those easily subjected to biological attack, such as wood, textiles and paper.

From another viewpoint in this same area, we also find the more typically composite artefacts in relation to the others, particularly the polychromes, which thoroughly engage the competence and technological diagnosis of chemists as well as physicists (as in diagnostic optical investigation). This does not mean that the other two areas, that of 'architecture' and that of '*in situ* archaeology,' are less 'important' from the standpoint of scientific competence. Think, for instance, of the great commitment of the chemists in searching for conservation solutions for preserving outdoor architectural heritage. The difference is that architectural materials are generally less diversified than their historic artistic counterparts. On the other hand, we also know that architectural surfaces constitute a typology of widely diffuse 'objects' in all countries and, subsequently, are potentially capable of frequently requiring the specialized skills of the expert geologist, chemist, biologist and physicist.

From the point of view of employment or the market, so to speak, the conservation of architectural surfaces, though materially representing a smaller area, could provide work for a significant number of specialists.

This, in fact, corresponds to the real situation and not only in relation to the broad nature of artefact typology but also in relation to the notable extension of architectural surfaces as opposed to other object types. Vast surfaces mean higher investment for conservation and, therefore, greater 'space' – in the sense of financial availability – and also for diagnostic activities of testing, post-restoration investigation, etc.

Something similar is also true for the archaeological area, although in this case the scientific contribution takes the form of archaeometry, an already well-defined discipline with better defined profiles, which only in part coincide with those of the conservation scientist.

Conclusions

In this brief paper it would certainly have been far too ambitious to try to resolve the delicate problems of defining possible sub-areas (of greater or lesser importance) towards which to direct educational curricula and the profession of the conservation scientist. The goal is indeed complex and many-faceted. For this very reason, models for analysis are needed in order to facilitate research and, from what has been set out above, to provide procedural guidelines.

What is certain is that the front of conservation science is so vast that it requires perforce the presence of highly specialized experts in sub-areas, rather than more generic conservation chemists, physicists, biologists and geologists.

What is important is to be able to identify the significant sub-areas so as to single out the appropriate related educational curricula with real subsequent prospects of employment.

CHEMISTS	ARCHAEOLOGY *(objects in situ)*	ART HISTORY DECORATIVE ARTS ARCHAEOLOGY *(museum objects)*	ARCHITECTURE	Eval.
DIAGNOSIS *(scientific investigation)*	MT WD MP ST PP 7	MT WD PL ST TX PP 14	MT WD MP ST 8	**29**
CONSERVATION *(treatments and materials)*	MT WD MP ST PP 8	MT WD PL ST TX PP 17	MT WD MP ST 9	**34**
PREVENTIVE CONSERVATION **POST INTERVENTION MONITORING** **MUSEOLOGY** *(climate, lighting, etc.)*	MT WD MP ST PP 6	MT WD PL ST TX PP 13	MT WD MP ST 8	**27**
Eval.	**21**	**44**	**25**	**90**

MT metal objects
WD unpainted wood
PL polychromes on any movable support
MP mural paintings
ST stone, marble, terracotta, mosaic, architectural surfaces (*unpainted mortar façades*), glass windows
TX textiles
PP paper, parchment, books

Fig. 1 – cross-analysis for areas of application and aims related to chemists

BIOLOGISTS	ARCHAEOLOGY (*objects in situ*)					ART HISTORY DECORATIVE ARTS ARCHAEOLOGY (*museum objects*)						ARCHITECTURE				Eval.
DIAGNOSIS (*scientific investigation*)	MT	WD	MP	ST	PP	MT	WD	PL	ST	TX	PP	MT	WD	MP	ST	**25**
	6					11						8				
CONSERVATION (*treatments and materials*)	MT	WD	MP	ST	PP	MT	WD	PL	ST	TX	PP	MT	WD	MP	ST	**24**
	6					11						7				
PREVENTIVE CONSERVATION **POST INTERVENTION MONITORING** **MUSEOLOGY** (*climate, lighting, etc.*)	MT	WD	MP	ST	PP	MT	WD	PL	ST	TX	PP	MT	WD	MP	ST	25
	7					10						8				
Eval.	**19**					**32**						**23**				**74**

MT metal objects
WD unpainted wood
PL polychromes on any movable support
MP mural paintings
ST stone, marble, terracotta, mosaic, architectural surfaces (*unpainted mortar façades*), glass windows
TX textiles
PP paper, parchment, books

Fig. 2 – cross-analysis for areas of application and aims related to biologists

PHYSICISTS	ARCHAEOLOGY (objects in situ)					ART HISTORY DECORATIVE ARTS ARCHAEOLOGY (museum objects)						ARCHITECTURE				Eval.
DIAGNOSIS *(scientific investigation)*	MT	WD	MP	ST	PP	MT	WD	PL	ST	TX	PP	MT	WD	MP	ST	**25**
	7					10						8				
CONSERVATION *(treatments and materials)*	MT	WD	MP	ST	PP	MT	WD	PL	ST	TX	PP	MT	WD	MP	ST	**21**
	4					12						5				
PREVENTIVE CONSERVATION / **POST INTERVENTION MONITORING** / **MUSEOLOGY** *(climate, lighting, etc.)*	MT	WD	MP	ST	PP	MT	WD	PL	ST	TX	PP	MT	WD	MP	ST	**27**
	6					13						8				
Eval.	**17**					**35**						**21**				**73**

MT metal objects
WD unpainted wood
PL polychromes on any movable support
MP mural paintings

ST stone, marble, terracotta, mosaic, architectural surfaces (*unpainted mortar façades*), glass windows
TX textiles
PP paper, parchment, books

Fig. 3 - cross-analysis for areas of application and aims related to physicists

GEOLOGISTS/MINERALOGISTS	ARCHAEOLOGY (*objects in situ*)					ART HISTORY DECORATIVE ARTS ARCHAEOLOGY (*museum objects*)						ARCHITECTURE				Eval.
DIAGNOSIS (*scientific investigation*)	MT	WD	MP	ST	PP	MT	WD	PL	ST	TX	PP	MT	WD	MP	ST	16
	6					4						6				
CONSERVATION (*treatments and materials*)	MT	WD	MP	ST	PP	MT	WD	PL	ST	TX	PP	MT	WD	MP	ST	11
	4					3						4				
PREVENTIVE CONSERVATION **POST INTERVENTION MONITORING** **MUSEOLOGY** (*climate, lighting, etc.*)	MT	WD	MP	ST	PP	MT	WD	PL	ST	TX	PP	MT	WD	MP	ST	11
	4					4						3				
Eval.	**14**					**11**						**13**				**38**

MT metal objects
WD unpainted wood
PL polychromes on any movable support
MP mural paintings
ST stone, marble, terracotta, mosaic, architectural surfaces (*unpainted mortar façades*), glass windows
TX textiles
PP paper, parchment, books

Fig. 4 - cross-analysis for areas of application and aims related to geologists

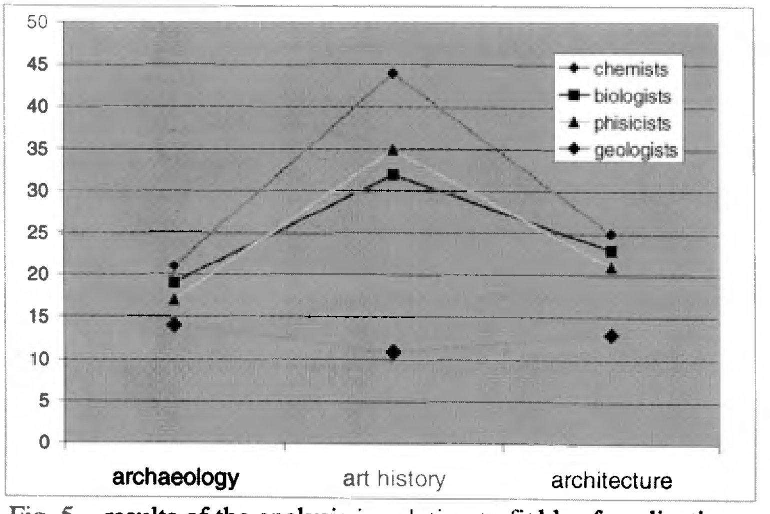
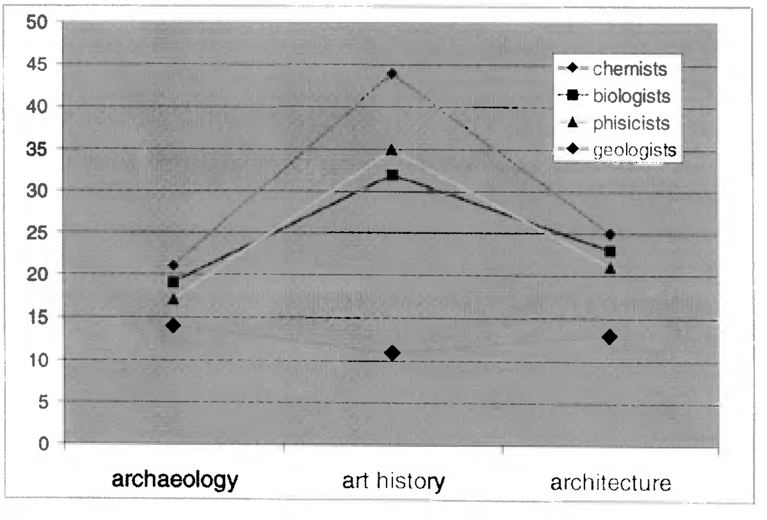


Fig. 5 – results of the analysis in relation to fields of application



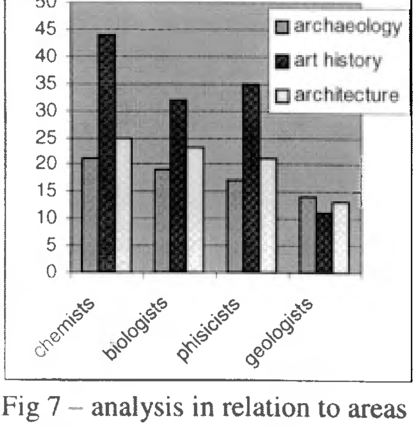


Fig 7 – analysis in relation to areas

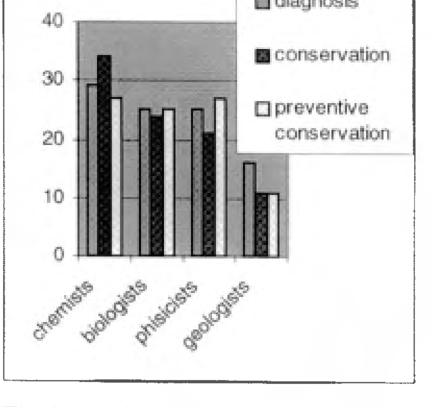


Fig 8 . analysis in relation to aims

Conservation Scientists at the British Museum

Andrew W. ODDY
Keeper of Conservation
The British Museum, London, UK

In 1919, the Trustees of the British Museum sought the advice of the (Government) Department of Scientific and Industrial Research about the conservation of antiquities and works of art. As a result, Dr Alexander Scott was appointed as a consultant scientist and, in 1924, Dr Harold Plenderleith was employed to research into the chemistry of conservation.

From the opening of the Research Laboratory at the British Museum in 1920 until 1975, the number of scientists employed to work on conservation was rather few:

R A Mallet	1922-24
Harold Plenderleith	1924-59
Robert Organ	1951-65
Anthony Werner	1954-75
Donald Bissett	1959-64
David Baynes-Cope	1960-84
Andrew Oddy	1966-present
Susan Bradley	1972-present
Vincent Daniels	1974-present

Robert Organ is a physicist, but all the others are (or were) chemists and it is chemistry that was traditionally seen as the most appropriate route into conservation science. With two possible exceptions, all the scientists in this list joined the British Museum with the intention of making a lifelong career in the care of antiquities. Since the middle 1970s, this has not been the case.

In 1975, the British Museum established an independent Department of Conservation and there was a gradual increase in the number of conservation scientists to six, although the number has recently fallen to five because of the economic situation. During this time, 16 people have joined the Conservation Science Group and their names will be known from the literature. However, unlike earlier times, 11 of these have left the profession because of better pay and career prospects in industry, or in

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order to study for a PhD. Only one person has gone to study for a PhD in a topic relevant to conservation science and another has gone to be a conservation scientist in another museum.

The role of the Conservation Research Group at the British Museum is to:

- research into mechanisms of deterioration of antiquities and works of art;
- research into new methods of conservation treatment;
- test and approve for use new materials proposed for use in conservation;
- provide advice and support for conservators engaged in field trials of new conservation methods and materials;
- carry out service analyses for conservators in order to assist in the diagnostic stage of conservation treatments;
- provide advice and support to the Museum in the field of preventive conservation; and
- provide a (commercial) testing service for materials to be used in the construction of showcases and storage areas (the 'Oddy' and similar tests).

At the British Museum we make a distinction between conservation science and archaeometry. The former is the study of the mechanisms of deterioration of antiquities and works of art and the investigation of materials and methods for treating the decay. Archaeometry is the application of science to the dating of objects and to the investigation of how and of what they were made. Of course, there is a 'grey area' of overlap between these two fields, but on the whole it is possible to distinguish between what a conservator needs to know in order to conserve the object and what a curator need to know in order to publish an object.

Throughout the past 25 years, British Museum conservation scientists have been trained as chemists or material scientists, but none of them has had any formal conservation science education because, until very recently, none has been available.

What sort of people will we be looking for in the future when we have vacancies in the Conservation Research Group? Of first importance will be a good, sound degree in one of the mainstream natural sciences, but most probably in chemistry. Postgraduate research experience leading to a doctorate will be essential for some appointments, but our experience of employing (relatively) new graduates and training them on the job has been very rewarding. We would certainly never wish to exclude candidates without experience of conservation science from applying for our vacancies. However, as formal courses in conservation science come on stream, we look forward to interviewing their graduates in the future. In the end, however, it is the quality of the basic science (the class of the first degree) which will be the determining factor in selecting a candidate for a research post.

Are Conservation Scientists *Real* Scientists?

Clifford PRICE
Institute of Archaeology, University College London
London, UK

Abstract

Conservation science is a very demanding discipline, requiring of its practitioners a high level of scientific knowledge and a sound appreciation of conservation issues. Weakness in either area can lead to research that is of poor quality or to the development of misguided conservation procedures.
The paper describes a new postgraduate programme at the Institute of Archaeology, University College London, which is designed to provide students with a sound grasp of conservation issues before they proceed to research in conservation. The paper concludes by stressing the need to promote conservation science amongst school leavers and undergraduates.

Keywords: training; conservation science; research.

The complexity of 'conservation science'

"Scientists tend to look on conservation as an underdeveloped field. As a result, they are tempted to transfer directly to conservation ready-made ideas and the procedures and equipment which they used earlier. It is only after a number of unhappy experiences that they are forced to admit that the problem was not simple.

The world of conservation is full of traps and the natives are often hostile."

These words of Torraca (cited in de Guichen, 1991) epitomize the sorry experience of many, and one example will suffice. When students sprayed red paint onto limestone figures surrounding the Sheldonian Theatre in Oxford, England, the university authorities sought advice from the chemistry department. It was a seemingly easy problem for the chemists, who advised the use of sodium hydroxide as a reliable paint-stripper. The sodium hydroxide was applied; the paint came off; and all was well for a while. But, unforeseen by the chemists, some of the sodium hydroxide remained in the stone, and gradually converted to sodium carbonate and sodium sulphate under the influence of air pollution. Sodium sulphate is one of the most aggressive compounds that cause salt damage in stone, and it was not many years before the sculptures had decayed so badly that they had to be replaced.

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Conservators are confronted by extremely complex systems and by unreasonably high expectations. They may, for example, be working on objects made from several different materials, each of which has conflicting requirements. The materials themselves are unlikely to be single compounds - they may be complex structures such as bone or ivory, and they may bear evidence of previous use (e.g., tool marks, or associated organic materials whose trace is preserved only in the corrosion products). Furthermore, the demands made upon the conservator may be unrealistic; for example, he/she may be expected to make an object last 'for ever,' or to apply a protective coating that is completely invisible. A multidisciplinary approach is required, and blinkered adherence to a single scientific discipline is seldom successful.

From this background, the concept of the 'conservation scientist' emerges: a scientist who is conversant with all those aspects of science that impinge upon his/her field of enquiry, who is fully acquainted with the ethics and principles of conservation, and who has an innate sensitivity and appreciation of the cultural heritage. Not only that, but he/she must also have the ability to communicate the results of their research and to play a role in policy decisions. Oddy (1997) wrote:

"However wonderful the discoveries of the conservation scientists are, if they fail to communicate them to the conservators they have wasted their time."

And it is not only with conservators that conservation scientists must communicate:

"The conservation scientist can – and must – inform decision making at all levels in order to ensure truly professional progress in conservation." (Tennent, 1997)

Scientists are concerned with facts, and are apt to think that facts 'speak for themselves'. They do not; nor do facts make decisions. The effective conservation scientist must be able to work with facts (and sometimes with an incomplete set of facts), but also to work with non- scientists to implement the results of his/her research.

This is a tall order, and those individuals who attain it deserve great respect. They are indeed 'real' scientists, who have supplemented their rigorous scientific learning with a deep awareness of the principles and practice of conservation, and with an ability to communicate. But in practice, these lofty ideals are often not reached. Instead of 'conservation science' representing a pinnacle of scientific endeavour, the opposite is often true, and conservation science can become second-rate, indifferent science. The CS can become very introspective, aware only of what is published in the so-called 'conservation literature'; and the level of investigation can become superficial and lacking in scientific rigour.

The reasons are many and various. Some can be tackled and corrected within the conservation community; others are a reflection of the value that society at large places upon the responsible stewardship of cultural heritage. In the latter category, one has to accept that there are only so many first-rate scientists to go round, and society may prefer to attract them to the pressing issues of medical and environmental science, rather than to the 'luxury' of conservation. Nonetheless, there is a lot that can be done by the conservation community to put its own house in order. The poor quality of much of the conservation literature, and the reluctance of conservation scientists to publish in the mainstream scientific literature, have been addressed before (Price 1996). We should have much higher expectations of what is acceptable; multiple volumes of unrefereed conference proceedings, resembling telephone directories, have no place in a discipline aspiring to excellence.

The training of conservation scientists

It is against this background that we need to consider the training of conservation scientists. De Guichen, in a characteristically colourful and challenging paper, envisaged in 1989 the formation of a postgraduate training programme in conservation science (de Guichen 1991), and the subject has now been explored in much greater depth by an ICCROM research team (ICCROM 1999).

It is my contention that good science is a prerequisite of good conservation science. To put it another way, the conservation scientist *must* have a sound training in science, appropriate for the level of scientific activity to be taken. This is an important proviso. There is not just one sort of conservation scientist, and the discipline calls for well-trained, capable individuals in a variety of capacities – from the technician who operates the analytical equipment to the director of the laboratory. It is also important in this context to stress that conservation science is not the same as conservation research. Not all conservation research is science-based, and there is ample scope for high-quality research to be undertaken in conservation by those who do not have any training in the natural sciences. Current work on the economic valuation of the cultural heritage and the cost-effectiveness of preventive conservation is an example (Mason 1999).

The importance of good, multidisciplinary science, coupled to another discipline, has been stressed in a parallel field, that of archaeological chemistry. Pollard writes that:

"Our premise is that archaeological chemistry requires a thorough understanding of the background of both halves of the story, and often mastery of information from related disciplines such as biochemistry and geochemistry."

If the conservation scientist is to be properly trained in science, it follows that training in conservation will normally be acquired separately, often at a later date. For many people, this will mean a postgraduate course of the type envisaged by de Guichen and further elaborated by ICCROM.

A new postgraduate programme at the Institute of Archaeology, London

The Institute of Archaeology, University College London, has been involved in the training of conservators for some 50 years. However, its involvement in conservation research has been less robust, and this was one of the issues that was addressed in an intensive review of the Institute's conservation programmes during the summer of 1998. The review took place under the chairmanship of the Institute's Director, Prof Peter Ucko, and included four external advisors: Bob Child from the National Museum of Wales, Helen Lloyd from the National Trust, Elizabeth Peacock from the University of Trondheim, and Wallace Ambrose from the Australian National University. The

Panel's brief included both teaching and research, and a major aim was to increase the level of research amongst both staff and students.

After a week's deliberation, the Panel recommended the creation of two new courses: a one-year MA in the Principles of Conservation, and a subsequent two-year masters programme in practical conservation, for those who wanted to become practising conservators. These programmes would run alongside the existing MPhil and PhD programmes, which provide training in research.

The one-year programme is intended for three discrete groups of students:

- those who require a grasp of conservation issues before proceeding to research in conservation;
- those who wish to proceed to vocational training in practical conservation; and
- those who have received training in practical conservation during the course of their employment, and are now looking for a theoretical background and a recognized qualification.

It is the first category that is of relevance to the present paper. Note that the intention is not specifically to train conservation scientists, although that is an important component. The aim is broader: to prepare graduates from any relevant discipline for research in conservation, and it is hoped that some of those who take the programme will go on to study for an MPhil or PhD degree.

The programme is being taught for the first time this year (1999/2000), and it will be some years before its success can be fully judged. Thirteen individuals have been accepted onto it. They come from ten countries, and five are presently intending to go on to research rather than practical conservation.

An outline of the course content is given in the Appendix.

Attracting students

Due attention has already been paid to the question of employment opportunities for conservation scientists (e.g., ICCROM 1999), but relatively little attention has been given to the question of attracting good students in the first place. Few people leave high school with a burning desire to become conservation scientists; indeed, few are aware that such an opportunity even exists. Of those who are established in the field at present, it is probably true that the majority came into it largely by accident, rather than by deliberate intent.

First class scientists will not be attracted to conservation science if they do not know it exists, yet little is done at present to market the concept of the conservation scientist to those who are working towards their initial qualifications in science. One worthwhile outcome of the CURRIC meeting in Bologna would be a concrete set of proposals for promoting conservation science and increasing its profile amongst school leavers and undergraduates.

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APPENDIX

MA in PRINCIPLES OF CONSERVATION

Institute of Archaeology, University College London

Programme structure

The programme consists of four units:

- *Issues in conservation.* This course elucidates the role of conservation within the context of archaeology and museums, and provides an introduction to material culture and technology. It examines the history, philosophy and ethics of conservation, and explores professional issues in the practice of conservation.
- *Conservation in practice.* This course is concerned with remedial, preventive and investigative conservation. It includes an introduction to the deterioration of objects, and it examines the scientific principles that underlie the practice of conservation. Students also learn how to undertake condition surveys and assessments.
- a course selected by the student from a range of options, including: Cultural heritage; Museology; Museum communication; Public archaeology; Defining and managing the archaeological resource; Conservation and management of archaeological sites; Museum and site interpretation; Heritage, tourism and landscape; Archaeology, heritage and the media; Themes, thought and theory in world archaeology; Databases in archaeology (half element); Archaeology, multimedia and the internet (half element).
- a 15,000 word dissertation on a relevant topic.

Entry qualifications:

Applicants should normally have a first or good upper second class Honours degree from a UK university (or an overseas qualification of an equivalent standard). Relevant experience (e.g., in conservation, archaeology or museums) is an advantage. Students who intend to proceed to the two-year Masters programme in practical conservation will require some background in chemistry (e.g., to A-level) and will need to provide evidence of manual dexterity and normal colour vision before admission to that programme.

The Expert Center as an Example of an Independent Work Environment for Conservation Scientists

Andreas QUEISSER
Expert Center for the conservation of cultural heritage
Laboratoire de Lausanne – EPFL, Switzerland

Abstract

The disciplines of natural and materials science are often the academic background of conservation scientists. Given that the conservation of monuments and sites also demands traditional craftsmanship, special technologies and application skills, there is a basic problem of collaboration and know-how transfer between all partners involved in the decision making process to obtain optimal results.

The Expert Center is a model of an independent work environment for conservation scientists that try to take this problem into consideration. This implies that the conservation scientist leaves the laboratory – still keeping his/her analytical tools and methods in mind – and confronts the real practical needs and open questions, exploring all accessible resources. The conservation scientist must be able to analyse and translate particular problems and solutions into a language that is understandable for all the other parties involved in the task. When this communication is working, it generates interesting synergies, which will save time and money in the planning and execution of conservation work.

Introduction

The international charter for the conservation of monuments and sites (Venice Charter 1964) states that the conservation and restoration of monuments must have recourse to all the sciences and techniques that can contribute to the study and safeguarding of the architectural heritage (article 2). It is essential to the conservation of monuments that they be maintained on a permanent basis (article 4). To reach these goals, many skills are necessary.

About 25 years ago, the practical needs of conservators and architects responsible for the conservation of monuments in Switzerland provided, almost simultaneously, an important impulse to set up scientific activities at the Swiss Federal Institutes of Technology in Lausanne and Zurich. Since then, both laboratories have given their

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inputs to conservation science, at both a national and an international level by providing academic research and addressing practical conservation concerns.

The important need for scientific research in the field of conservation remains, but the role of conservation scientists changes as well. Today the need for suitable selection and evaluation of the great amount of information in conservation science, technology and materials has become an important task.

A new role for conservation scientists

There is an increasing demand for qualified and neutral consulting to resolve practical concerns in the preservation of monuments. Often the definition and prediction of the key problem requires extensive analytical skills and knowledge. Decision-makers, such as architects or building owners, ask for transparent and well-documented solutions, with adapted, economic and sustainable approaches to the conservation problem. In times of small public budgets, consulting conservation scientists can provide a useful service by contributing diagnoses based on their extensive knowledge in conservation techniques.

In the past 10 years, the preservation of buildings and monuments has become an important activity in the Swiss building industry. This highly competitive market offers many different materials, techniques and systems. New, specialized enterprises have also sprung up. The evaluation of the best or most suitable solution needs an enormous overview and experience. A second issue is the optimal execution of treatments. Good craftspersons who still know traditional techniques are rare, and the application of new conservation techniques and materials to historic monuments can involve important risks. Ideally any treatment should be guided by a suitable preliminary examination (aptitude tests) and established, controlled conditions. Evaluation of the behaviour of materials and their compatibility with the monuments, especially in view of long-term effects, is a complex task, which also calls for systematic scientific approaches.

In conclusion, it can be stated: a neutral and problem-oriented definition of conservation goals and the application of the best conservation techniques can avoid mistakes and save money in the preservation of monuments. Owners who want to safeguard the cultural, economic and aesthetic values of their buildings or monuments understand the importance of a precise definition and control of the conservation goals. Therefore, conservation scientists are, often as material specialists, important partners in the network among architects, authorities, conservators and owners, as shown in Figure 1.

The Expert Center as an independent work environment

The Swiss concept of the Expert Center for the conservation of cultural properties is based on the realization that the complex task of neutral consulting requires the collaboration of qualified and experienced people in various fields of conservation science. The Expert Center has two laboratories in Lausanne and Zurich. As a local center of competence, each of these pursues the same goals:

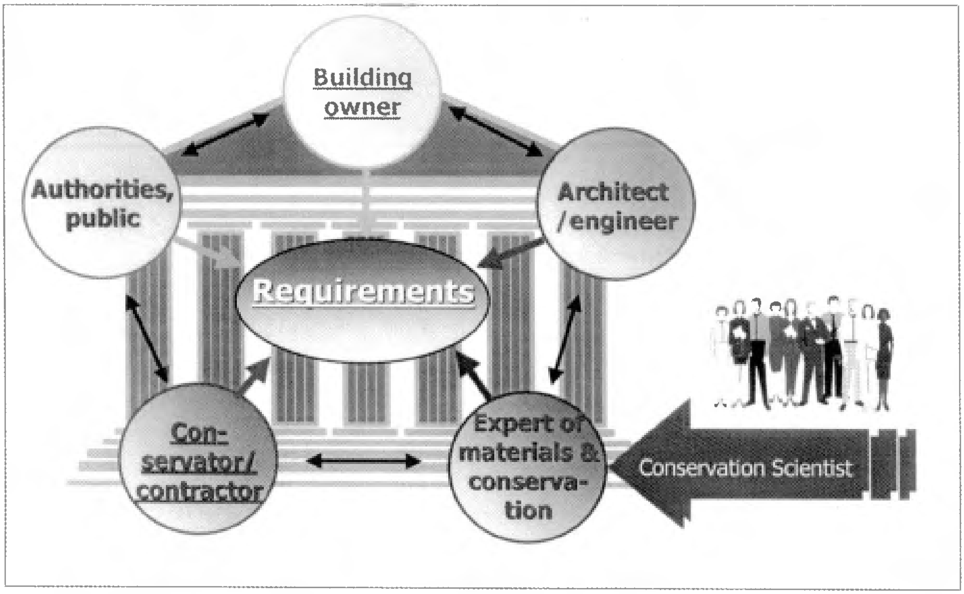

Fig. 1: The professional environment in the conservation of monuments

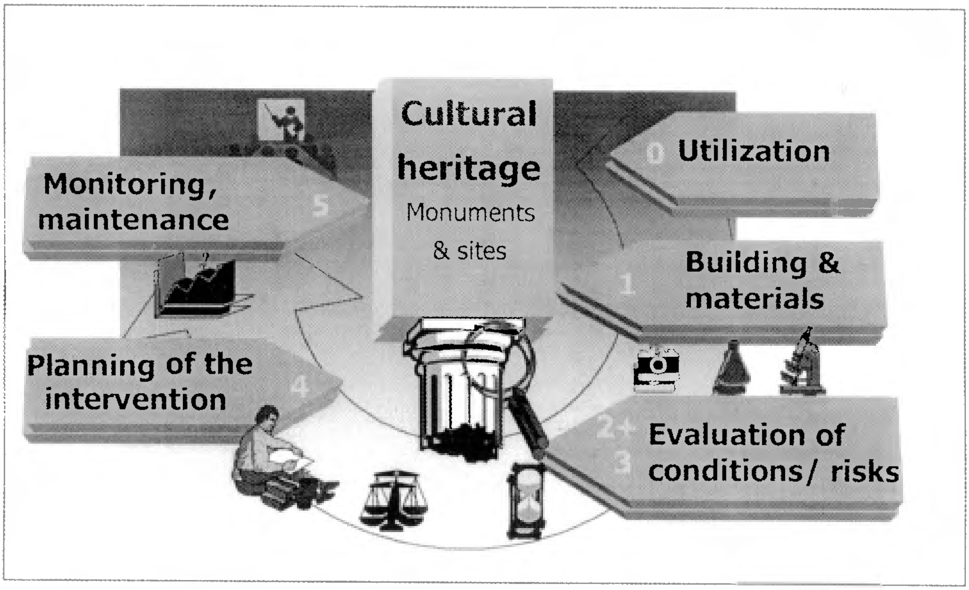

Fig. 2: Different tasks in the conservation of monuments

- A reputable consulting service
- Specific research activities geared to practical needs
- Teaching and knowledge trar sfer
- Networking

All four of these goals are intended to form an organization that works on a scientific but also practical level. They are complementary in the sense that they give each other inputs: The consulting experience provides important impulses for applied or basic research activities. The teaching and demonstration of methods obliges one to revise knowledge and techniques. Having a network of experts in the different fields of conservation provides a broader range of experience and a good opportunity to compare different approaches and viewpoints in order to develop convincing conservation and maintenance concepts.

As shown in Figure 2, the conservation of monuments involves different tasks. An important aspect is the suitable evaluation of conservation in coherence with the future usage requirements of the monument. Tasks could also be to organize suitable long-term surveys, in order to quantify a conservation problem and to avoid a dubious intervention. In confronting the real practical needs and open questions, the conservation scientist explores all accessible information resources.

The acceptance of conservation scientists as partners in the planning process and follow-up of practical conservation treatments increases with their ability to provide applied and problem-oriented solutions to the conservation task. The scientist must be able to analyse and translate particular problems and their solutions into a language that is understandable for all partners involved in this task. When communication is working, it generates interesting synergies, which will save time and money in the planning and execution of conservation treatments.

Since the results of the work of the conservation scientist are often not directly visible, the importance of his contribution is sometimes disputed. But as has already occurred in other disciplines, medicine or law for example, the service character will be probably accepted in time, when the practical use becomes obvious.

In this sense, the Expert Center is an organization that permits the conservation scientist to work in a network, using several analytical tools and a common infrastructure in order to provide different services and engineering input. Research activities assure an innovation process. Thus the formation of conservation scientists as experts for the conservation of monuments also covers an aspect of 'on-the-job' training to obtain necessary experience.

Supply and Demand: conservation science in market competition

S. SIMON
KDC – Konservierung & Denkmalpflege Cons.
Olching, Germany

Educational aspects

Conservation science has steadily gained acceptance in recent decades. Nevertheless, whereas the academic training of conservator-restorers has been extended and improved worldwide, the field of conservation science is still not integrated into academic structures. What characterizes a good conservation scientist? In my opinion, the first requirement is that one be a good natural scientist; beyond this one should have a solid background in conservation and restoration.

Given this condition, it seems to be convenient to set up a postgraduate curriculum for conservation scientists. The incorporation of conservation science as an optional interdisciplinary subject in faculties of chemistry, physics, biology and earth sciences should be promoted. Most of today's conservation scientists have never followed special courses, such as conservation ethics or ancient art technologies.

The European public is discovering its responsibility for cultural heritage and its maintenance. There is greater awareness of the economic value of monuments. Restoration responsibilities have moved from craftsmen and building contractors to scientific restorers educated at the polytechnic or university level.

Damage diagnosis, restoration planning and quality control of conservation measures are three main fields of intervention for conservation scientists. With respect to the importance of these fields, and notwithstanding the excellent advantages of a 'learning by doing' education, the establishment of a postgraduate curriculum for conservation scientists is strongly advisable to keep up with the rising challenges of monuments care in the future. The quality standards applied should be appropriate for the monument and the work of art concerned, for the restoration skills as well as for the conservation scientist's work.

Market aspects

Conservation of cultural heritage and the work of all partners involved in this area are subject to normal market rules. More and more, monuments and works of art are

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regarded as capital 'production' goods, which – like all others – require capital investments to maintain their value. This economic perspective is steadily growing in importance, especially in view of the development of tourism. UNESCO studies forecast enormous growth rates for tourism, especially in and from Asia for the coming decades.

Cultural heritage, and its presentation will become the main assets in competition for tourism: For example, the significance of the excavation of the Terracotta Army of the first Chinese Emperor, Qin Shihuang, in Lintong on the development of tourism in the People's Republic of China cannot be overestimated. The discovery of the first head on 29 March 1974 and the subsequent opening of the museum to the public in 1979 signaled an economic development, which for 20 years has provided continuous profits to shareholders, not only in Lintong and not only in the province of Shaanxi, but throughout China.

Apart from the traditional players in the market (conservators, architects and craftsmen), scientific restorers and conservation scientists have obtained a certain position in recent decades. The traditional players have not conceded the place voluntarily. The ICCROM SRC survey has revealed that opportunities for conservation scientists to carry out leading functions within their organizations or administrative bodies are still very limited. However, developments during the last decade, at least in western Europe, show a rising acceptance for the involvement of conservation scientists in the market of monuments care. Such acceptance is mainly due to secondary damage as a consequence of restoration interventions and underlines the importance of cost/benefit analysis in cultural heritage management.

The market itself has a strong influence on the role of participants: Some conservator-restorers have started to offer services in neighbouring fields, such as building construction or conservation science. On the other hand, conservation scientists can offer application services, additional to their core activities. This implies well-known problems to assure the quality of work.

This feature is characteristic for rapidly developing markets and poses certain problems: Very often – as the main money is still made within the core business – price dumping in the neighbouring fields creates a tough competition. Public clients (and others) are usually forced to choose the cheapest offer, not taking into account cost/benefit ratios. Due to a lack of standards within the new market, cost/benefit analysis is undertaken very rarely.

Still, the competition among conservation scientists also has a very positive side effect. In competing with each other to assure quality standards, they help to create further acceptance for their profession and thereby enlarge the market. In this respect, the competitive struggle provides not only advantages for the clients, but also for the conservation scientists themselves.

Main assets of freelance conservation scientists

Flexibility is the main asset of freelance conservation scientists. It provides:

- quick implementation of modern analytical techniques into practical application;

- ability to respond to practical questions – bridging the gap between purely academic science and practical conservation.

Flexibility also facilitates the ***multidisciplinary approach*** as one of the main features of conservation science. Communication skills and a basic understanding of related sciences are necessary preconditions for successful performance.

This implies the importance of a close ***cooperation of freelance conservation scientists with public institutions and universities***. Two examples referring to future challenges are given:

a) Development of Simple Intervention Strategies

Recent trends in conservation science have concentrated on the development of new, mainly high-tech methods for damage investigation and conservation, especially of mural paintings, cast bronze and monuments built of natural stone. Many of these trends will influence conservation practice in the future in a positive manner. On the other hand, it should be taken into account that a good part of the world's cultural heritage is located in remote areas, where there are no logistic conditions for the use of the high-tech conservation equipment common in industrialized countries, and where even access to the object by car is difficult.

Furthermore, there are numerous monuments and sites endangered by human (war action) or natural catastrophes, which urgently need immediate intervention, following the principle "prefer screws, not glues."

Under these circumstances, ***simple intervention strategies*** must be developed and applied. Further development and diffusion of basic and non-destructive techniques (e.g., *in situ* capillary water absorption measurements, ultrasonic testing), which can be applied easily and provide a high information density, is desirable.

b) Standardization

At the same time, basic research should be promoted, avoiding the typical R&D applicability characteristics. In stone, bronze or mural painting conservation, for instance, there is an urgent need for standard procedures for evaluating the effectiveness of consolidation and protective treatments. These standard procedures cannot be created by either the empirical approach of restorers or by isolated (case) studies of scientific laboratories with a background in applications. These investigations are beyond the capacities of freelance scientists, who can only intervene at the later stage of practical implementation.

Conclusion

The future will show in which direction the conservation market will develop. Probably, the demand for scientific conservation consultancy will grow with the rising perception of the economic values of cultural heritage. As the general prospects seem to be positive in the long term, conservation science will perhaps not be outperforming but develop within the market and its powerful mechanisms of supply and demand.

Quality assurance, especially concerning the educational aspects of conservation science is crucial. Therefore, as a freelance conservation consultant, I strongly support ICCROM's initiative for an academic curriculum for conservation scientists.

Job Description – Definition: an analysis of the place for a conservation scientist in an institution

Ágnes TÍMÁR-BALÁZSY
Hungarian National Museum
Budapest, Hungary

Abstract

In the late '70s and '80s, when the National Centre of Museums existed in Hungary, nine scientists worked in that central institute. Their jobs covered several areas, such as carrying out research in the conservation field, providing advisory and work service for the Hungarian Museums, including preventive and remedial conservation. Apart from teaching sciences in the various training programmes of the institute, they supervised the students' final projects, as well as being responsible for organizing the programmes themselves. Other responsibilities were organizing national and international conferences and symposia, editing the annals of the Hungarian conservators and producing conference proceedings. Last but not least, five of them supervised the care of objects in 19 county museum organizations of Hungary contracted by the Ministry of Culture.

In 1990, the Department of Research and Training in Conservation was attached to the Hungarian National Museum while other departments of the previous institute were privatized. The term 'conservation scientist' (CS) was no longer used, and the five remaining scientists were called conservators, although many of them did not carry out practical conservation. Their work in education was held to be a luxury for the museum, and they continued material investigation and advisory work on the side.

On the basis of this experience, the author questions whether job descriptions can be used for formulating a definition of the profession.

One of the advantages of the fact that the issue of the role of conservation scientists has recently been put into the spotlight is that a process has started. It is to be hoped that it will result in a definition of the CS profession. One of my ideas was to investigate the job descriptions of Hungarian scientists working in the conservation field in order to see whether they could be used in shaping the definition.

In the Department of Conservation and Training of the National Centre of Museums, nine scientists were employed from the late '70s through the '80s: two

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chemists, one electro-physicist, two chemistry and biology teachers, and four chemical engineers. Their jobs involved several areas, such as carrying out research in the specialized literature, adopting successful methods of object conservation, carrying out research into using Hungarian products instead of Western ones, and providing an advisory and work service for the Hungarian Museums, including preventive and remedial conservation. Apart from teaching sciences at the institute's various training programmes and supervising the diploma works and final projects of lower-level training programmes, they were responsible for organizing these educational programmes as well. Also among their tasks were regularly organizing conferences and symposia at national and international level and publishing the proceedings, editing the annals of the Hungarian conservators and producing a periodical containing translations of articles or abstracts from the specialist literature in foreign languages. They also felt responsible for putting together a good library and continuously improving it.

On top of all this, they were often responsible for exhibitions on conservation, sometimes in the context of an industrial fair (Hungarokorr) or in a museum. Nor should we forget their attendance at international meetings and conferences, representing not only themselves but also the field of conservation in Hungary. They contributed considerably to putting together the publications or papers of conservator colleagues who were not so advanced in publication. Last but not least, five of them were supervisors of care of objects in the 19 county museum organizations of Hungary contracted by the Ministry of Culture.

Upon looking back to this period and analysing how this wide range of tasks could fit into their working time, I must confess that perhaps a quarter of their time could be used for research, adaptation and reading specialist literature, another quarter went to teaching, including preparation, and the remaining half of the time for organizing, editing and administrative work. In view of these pressures, many of them became very frustrated, especially those who preferred carrying out research and making a career as a scientist – especially because this was not their decision but the expectation of the director at that time. Others could digest the fact that they were hindered in carrying out scientific work and served the conservation field in another way. The achievement of the majority of the Hungarian conservators might have been a result of the heavy training, organizing and editorial commitments of the scientists working in the institute. This can be considered as a self-sacrificing attitude, however, as their work went more or less unnoticed.

In 1990, the situation changed dramatically. Five departments of the institute were privatized, and the Department of Conservation Research and Training was attached to the Hungarian National Museum. The original idea of the relevant department in the Ministry of Culture was that this group would continue its work in the field of research and training, including its advisory role. However, the museum management had a different idea. The five remaining scientists became part of the Conservation Department of the museum and have been called 'conservators' despite the fact that only two of them carried out practical conservation at that time; the others did not treat artefacts. The priority of this department was conservation of archaeological and historical objects or works of art and preparing the museum's exhibitions. Research and advisory activity lost its importance completely. However, notwithstanding several attempts, the museum management was unable to get rid of the training activities. Ultimately, training was perceived as a luxury in the work of the department and was kept as a foreign body within the institution on the fringes of its main activities.

The job descriptions of the scientists changed considerably. Some of them were obliged to become conservators, and research and teaching were no longer expected from them. They were told that this was the only way to keep their jobs in the museum. Another scientist colleague, who was previously the best in materials investigation, became an expert in preventive conservation and made herself useful for the museum management in that way.

Despite their changed job descriptions, the above-mentioned scientists still tried to carry out some research and advisory work, as well as material investigation, responding to the demands of students and colleagues in the field. In comparison to the previous situation, the difference was that they had to do this on the side. They tried to serve two masters, which resulted in an extra workload and often involved their weekends.

As a consequence of this overview, I could not say that any of their job descriptions could be used as a definition of the profession of a conservation scientist. Their position has reflected a very peculiar situation in both cases, depending very much on whether they worked in an independent research and training institute or within a museum conservation department. Upper management or the personality of the general director also played a determining role in their job descriptions.

If these people were asked to formulate a definition, the results would be highly subjective and each one would be different. One individual might prefer research to any training or organizing activity. Another would choose research combined with practical conservation. The third might like to dedicate herself to material investigation and editing the Hungarian conservators' annual. The fourth is fed up with teaching and organizing the education of conservators. The fifth wants to be the head of conservation and in the meantime act as an adviser in the field of restoration of old buildings, as that is a lucrative field.

After carrying out this review, it became clear to me that neither the job descriptions nor the wishes of individuals are suitable for formulating a definition. In preparing this contribution, my aim was simply to show how specific the role of a scientist has been in the Hungarian museum field.

I also concluded that if I were asked to make a definition of the profession of Hungarian conservation scientists, I would start with considering the expectations of 1. Conservators, 2. Curators, 3. Scientists, 4. Collection managers, and look for the common points. I would also consider the different skills required for different tasks and would not expect a scientist to be a polymath.

Training Facilities for Conservation Scientists: graduate versus postgraduate study programmes

Johannes WEBER
Institute of Conservation Sciences and Restoration Technology
University of Applied Arts
Vienna, Austria

Abstract

Based on the obvious need for scientists specialized in various fields of conservation, the paper briefly discusses features of possible training programmes. For a variety of reasons, the establishment of a well coordinated network of postgraduate courses for scientists, rather than a regular university study programme, would be the best approach to improving the situation.

Keywords: conservation sciences; training.

There is little doubt that conservation based on modern technical and ethical standards needs the involvement of sciences. One response to this awareness is the increasing amount of science courses included in many of the conservation training courses, especially those at academic levels. In many places it is felt, however, that the amount of scientific education has reached its limits at the cost of reducing the quality of other (e.g., technical and artistic) aspects of the training.

Conservators emerging from such training centres have a comparably high understanding of scientific procedures. They tend to estimate the role of conservation science in their work highly and are able to evaluate its potential and limits, but they are not scientists themselves.

In a number of other training centres in conservation, science still ranks at the lower end of lecture subjects.

On the other hand, most of the scientists working in the field of conservation have rarely had any direct experience with conservation or even works of art when they leave their universities. When, for one reason or another, they start to work in the field of conservation sciences, they usually need quite a while to gain the necessary specific experience. The major topics likely to be missing in a scientist's educational background are the following (in alphabetical order):

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- Analysis and testing under the specific conditions of works of art
- Art history
- Archaeology
- Architecture
- History, ethics and philosophy of conservation
- Neighbouring scientific disciplines
- Techniques and materials of art and architecture
- Technical disciplines
- Traditional and modern techniques and products of conservation and restoration.

This seems to be quite a high number of topics, and the question must be raised as to whether and how it is reasonable to incorporate them in the syllabus of a scientific training programme. Considering the pros and cons of university study programmes in conservation sciences versus postgraduate training programmes for scientists, the author is very much in favour of the latter, and proposes the following arguments to support this opinion:

- A strong scientific background should be a prerequisite for any conservation scientist, since he/she should be able not only to perform repeated tests and analyses in the service of conservation, but also to develop hypotheses and prove them scientifically, to innovate and adopt methods, to stimulate new approaches, etc. No undergraduate or graduate student training of any highly interdisciplinary nature can provide such a sufficient in-depth education in sciences. It can, however, be quite useful to offer basic courses on the principles of conservation to students interested in the topic (such as those, for example, offered regularly by the author for students of Earth Sciences at Vienna University). These courses can only provide a glimpse of the potentials and needs of science in conservation; they are by no means sufficient to form conservation scientists, but may serve as a base to whet the interest for this specific field, and may contribute to the preparation of future researchers to be in some way involved in conservation.
- Once a master's degree in science has been attained, a PhD dissertation could deal with a scientific subject relevant to conservation. Quite a number of conservation scientists have entered their professional career in this way, but also many other graduates start their careers without ever producing a dissertation in the specific field of conservation sciences.
- Additionally, it should be mentioned that scientists who crossed into the world of conservation from other fields of work have made important contributions to the development of scientific aspects of conservation, applying their experience from industrial or other research areas. In any case, conservation science cannot be limited strictly to a number of especially-trained conservation scientists: researchers from other fields will eventually be involved with individual problems posed by conservators.

- Conservation science itself is a broad field where specialization in specific areas of conservation is the rule. Thus, for example, a scientist working in a paintings department of a museum is supposed to be an expert in paint materials and techniques as well as in their conservation and related areas, but not in the architecture problems of stone consolidation or moisture and soluble salts. This indicates that even a single graduate training course in Conservation Sciences would fail to produce ready-made conservation scientists, since the topics are too widespread to be covered by a single syllabus.

A far better alternative to a regular university study programme is to have a number of international postgraduate training courses in conservation sciences and conservation addressed to scientists, such as those organized by ICCROM or other institutions. So far, however, such courses are held only sporadically and cover only specific topics; thus, it would be highly desirable to establish and coordinate a network of various postgraduate courses, held annually, for example, for the duration of one month and hosted by different universities or other educational centres.

In consideration of the above, the next step would be to define the general topics of postgraduate courses in conservation science and identify appropriate venues for the courses.

Conservation Scientists: what's in a name?

A. Elena CHAROLA
Graduate Program in Historic Preservation
University of Pennsylvania
Philadelphia PA, USA

"Lo que natura no da, Salamanca no presta"[1]
Popular Spanish saying

Abstract

The question of the training of conservation scientists is addressed by first analyzing how this profession has developed and the influence science courses have had in the training of conservators. A distinction is made between 'conservation scientists' defined as scientists who have acquired an education in conservation, and the suggested development of graduate programmes in 'conservation science' which would train 'scientific conservators,' defined in this paper so as to differentiate them from the previously mentioned conservation scientists. The role that both of these professional figures could have in the world of conservation is discussed. Suggestions for the programmes required to form these professionals are also given.

Keywords: conservation scientist; technician; training; education; scientific conservator; scientist in conservation.

Introduction: definitions

There is no doubt that the conservation of cultural heritage requires an interdisciplinary approach including contributions from historians, archaeologists, art historians, curators, architects (in the case of historic structures), conservators and scientists. Of all professionals concerned, the last mentioned require the highest investment if they are to contribute to conservation. As pointed out by Torraca (1982) "conservation is a difficult field for scientists" since they need to acquire a background in conservation theory and to develop sensitivity to the value of the objects involved.

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1 What nature does not give, Salamanca (Spanish University founded in 1220) does not lend.

To date, most scientists working in conservation have obtained the extra knowledge necessary to be functionally operative through their personal interest and inclination. This has led them to acquire the ambiguous and unscientific name of "Conservation Scientists." Simultaneously, the importance of including science courses in the training of conservators was realized and has been implemented systematically for the past thirty-odd years with the expectation that training conservators in science would help them solve most of the routine problems encountered in conservation. However, seldom are problems in conservation 'routine,' and the limited scientific background that conservators receive during training generally does not allow them to clearly identify the problems they face.

In view of the need for better or more specialized scientists in conservation, as discussed in the Preliminary Survey (Mazzeo *et al*, 1999), the ***training*** of 'conservation scientists' is now being considered. As mentioned previously, the name 'conservation scientist' is ambiguous as well as misleading. Ambiguous, because the scientific discipline is not defined, and misleading because it implies that one type of training can produce the wide variety of scientists currently referred to as conservation scientists. Moreover, these chemists, physicists, geologists and biologists not only are trained in one science but are also often specialized in one particular area of that science. Considering chemistry as an example, the various chemists who are currently active in the field of conservation cannot really replace each other, since one may be a specialist in analytical techniques, another in organic chemistry and a third in environmental chemistry. Rather, they complement each other and their contributions are equally important. So how can a curriculum be designed to train chemists, not to mention scientists in general, in a field so vast and expanding?

To train a scientist, defined by the American College Dictionary, as one "versed in or devoted to science, especially physical or natural science," in each of the various scientific disciplines considered, requires a *minimum* of five to six years, including the undergraduate training, to complete the first graduate degree. Decreasing this training to include subjects such as art history and theory of conservation, may result in a professional who loses both in knowledge of the discipline and in the 'scientific approach.' The latter is the most valuable asset in a scientist's training and best developed during the completion of the research required by a doctoral dissertation.

Nonetheless, a programme that gives a balanced approach to the sciences and conservation could serve to train graduates in specific techniques for a given type of material, e.g., EDS analysis of glassy materials. But these graduates could hardly be called conservation scientists; rather, 'scientific technicians in conservation' or even 'scientific conservators' would be more appropriate. Neither of these names will probably be accepted, since *technician* has a lower status and *scientific conservator* would probably not be acceptable to conservators in general arousing similar reactions to those awakened when the now accepted name of Conservator-Restorer was suggested [Bergeon *et al.* 1998]. For lack of a better name, 'scientific conservator' will be used for these professionals in the rest of this paper.

In summary, the currently accepted name of Conservation Scientist used to define scientists who are currently working in conservation, should not be used for graduates of a programme that will essentially produce expert technicians. Or, if this is the title given to the future graduates of such a programme, those trained scientists who have devoted much time and effort to understanding conservation need to find a better name to define themselves. This could be 'Scientist in Conservation' with specification of the science branch in question.

Discussion: training and education

There is a distinct difference between training, the "process of learning a skill or discipline," and education, the "process of being educated," i.e., receiving intellectual, moral and social instruction. As has been pointed out by Breslow (1998), both are of importance even in the formation of chemists, and one cannot be diminished in favour of the other. In the case of scientists who aim to be part of a conservation team, the education part would probably require even more attention. Hence, one possible solution to the problem of training scientists in conservation is to first train the scientist – since this is already being done worldwide – and then provide a post-doctoral ***education*** in conservation. Although this appears to be the most desirable solution, it may not be practical if it does not reflect the current needs in museums and other institutions dealing with conservation.

This leads to another question: what do museums – to limit the discussion to movable objects – need to assure the conservation of the pieces they hold? Unfortunately museums have finite funds, which must be used for the management of the collection, including acquisitions of new pieces, installation and re-installation of galleries (so that the museum is made attractive to the general public), art historic and eventually archaeometric research, and conservation. Within conservation, conservators take the key positions while conservation scientists can only be afforded by larger institutions. And even larger institutions may not have the full spectrum of conservation scientists that in theory would be desirable.

Hence, from a practical point of view and taking into account the economics of training and employment, a *scientific conservator*, to use the previously introduced definition, would be useful. These graduates, who could be trained in a four-year programme, could fulfill the current needs in the field of conservation. They would also serve to establish better communications between Conservator-Restorers and Conservation Scientists, since their training would bridge the gap between the two professions, a point that has been systematically stressed [Price 1992; Tennent 1994 and 1997; Talley 1997]. However, it should be understood that these scientific conservators will not be trained to carry out research but to perform the aforementioned 'routine' analysis that is the basis of the support required by conservation in museums.

To carry out research, the so-called 'pure' research that will lead to scientific advances, as defined by Price (1992), scientists trained to develop this activity, i.e., at PhD level, are needed. For this research to be applicable to conservation, scientists from any discipline have to invest time and energy in acquiring the necessary background, i.e., ***education***, as has been happening to date. This does not preclude that extraordinary scientific conservators could carry out such research (since natural gifts go beyond training) but that these graduates cannot be expected to perform it routinely.

Conclusions: suggested training programme(s)

From the above discussion it is clear that the most viable solution to currently perceived needs is training of *scientific conservators* through a graduate programme. The students, having received an undergraduate degree in science would follow a 2-3 year programme plus at least a one-year internship in a museum laboratory or equivalent institution where they would train in a specific analytical technique and material type.

On the other hand, the education of *conservation scientists* could be improved by the development of post-doctoral courses in conservation theory and practice. While this may sound fairly straightforward, developing such courses will require some thought. Conservation theory may be covered in a general course but it should be remembered that its application could vary significantly depending on its focus, i.e., artistic or archaeological objects, historic buildings, monuments or archaeological sites. The question also arises as to whether technical courses need to be developed to complement the training of these scientists. For example, if a scientist is to deal mainly with the built environment, should courses in basic construction principles and techniques be included? Or history of architecture? Ideally, it would be desirable if all of this material could be covered in a one-year curriculum leading eventually to the development of a formal programme. Whether such an initiative will prove useful and practical is yet to be established.

In summary, the present indiscriminate use of the term 'conservation scientist' has led to confusion and much fruitless discussion. Conservation needs much more than 'a' conservation scientist, and the best way to describe the situation is by using an example from the art world: the 1938 woodcut by Maurits C. Escher, *Sky and Water I.* This shows birds flying at the top and imperceptibly changing into fish swimming below. The gradual transition from one beast into another clearly depicts what is needed in conservation: facilitated communication between birds and fish. This could be provided by the intervening entities, which are neither fish nor fowl, but also differ among each other. What is needed are appropriate names to differentiate their level of training, thus accurately describing their position within the conservation world.

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Training Options for Conservation Scientists

Marie-Claude CORBEIL, PhD
Canadian Conservation Institute
Ottawa, Canada

Abstract

To help establish the qualifications of conservation scientists (CS), the input of several groups is needed: conservation scientists, who developed the profession, gradually set standards, and have a clear idea of what the job involves; clients, i.e., people who use the information and services provided by conservation scientists (this includes conservators, curators, archaeologists, art historians, etc.); employers who hire conservation scientists to achieve specific goals. In this article, training options for conservation scientists are discussed from the point of view of the employer, and their practicality considered from the standpoint of the trainee. Training options include university programmes at the postgraduate level and on-the-job training complemented by professional development.

Keywords: conservation scientist; definition; university programmes; on-the-job training; professional development.

Introduction

As a scientist at the Canadian Conservation Institute (CCI) in Ottawa, Canada, I have participated over the years in selection boards to hire scientists, either on contract or for permanent jobs. I was also actively involved over several years with writing job descriptions for conservation scientists in preparation for the Universal Classification System, a new classification system to be implemented next year in the Canadian federal public service. I gradually developed a special interest in issues such as job qualifications and requirements, and I chose to address these issues today, as well as their impact on the potential development of training programmes for conservation scientists.

I would like to start with a brief definition of the profession of conservation science and a general assessment of the state of the profession today, based on my own perception rather than any kind of systematic research.

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Definition and current status of conservation scientists

My definition of a 'conservation scientist' would be the following: it is a person trained in science who applies his/her knowledge to the conservation of cultural property. This may sound very simple, but the simplicity of this definition hides the variety of tasks involved in conservation according to the CAC/CAPC *Code of Ethics and Guidance for Practice*, [1] conservation includes examination, documentation, preventive conservation, preservation, restoration and reconstruction – as well as the diversity of materials and objects that can be designated as 'cultural property.' For example, a conservation scientist may be a biologist who studies pests and ways to eradicate them, an engineer who studies shock and vibration sustained by paintings in transit, or a chemist who studies the materials of works of art and artifacts, or evaluates commercial products and conservation processes. The conservation scientist may also specialize not only in a type of activity, but in a type of material – the evaluation of commercial products and conservation processes used in the treatment of textiles, for example. Similarly, the title 'conservation scientist' encompasses many levels in the profession. Some larger institutions will make a distinction by using titles such as 'assistant conservation scientist' or 'senior conservation scientist,' but in most cases conservation scientists are called 'conservation scientists,' whether they are performing more 'entry level' work or are involved in leading-edge research at the top working level.

The large majority of conservation scientists working today were not specifically trained in conservation science. They obtained a university undergraduate degree and, in some cases, a postgraduate degree, in one of the natural sciences. They were hired by a research institute, a gallery or a museum, and learned gradually about their specific area of conservation science, other areas of conservation science, and conservation in general, depending on their own curiosity and enthusiasm. Their degree of specialization depends on the particular working environment, from highly specialized as found mainly in research institutes, to broad knowledge based, as found mainly in museums and galleries. As well, their level in the profession depends largely on the career path offered in the institution for which they are working. A large institution may offer different working levels, while that might be irrelevant for a smaller institution.

What is the conservation science profession made up of today? As in many other fields, it is a heterogeneous crowd, where you find a bit of everything: talented people and mediocre people; good communicators and people who may have trouble getting their point across; high-profile researchers and hard workers. In my opinion, this situation is quite normal. First of all, it would be unrealistic to expect all conservation scientists to be top-class scientists, researchers, communicators, teachers, and so on. But most importantly, I do not think that this is needed, as I will explain later.

Basic requirements for positions in conservation science

To help establish the qualifications of conservation scientists, the input of several groups of people is needed:

- conservation scientists, who developed the profession, gradually set standards, and have a clear idea of what the job involves;
- clients, i.e., people who use the information and services provided by conservation scientists (this includes conservators, curators, archaeologists, art historians, etc.);
- employers who hire conservation scientists to achieve specific goals.

These three groups are not listed in any given order of importance or priority and they overlap to a certain extent. They will each contribute to the debate and perceive the whole question from a different angle. I will focus on the point of view of the employer. However, since I am first of all a practising conservation scientist with a specific educational background and experience, there is no doubt that it will be hard for me to be perfectly objective. Since what comes out of our discussion may have an enormous impact on young scientists entering the field in a few years, I will therefore also consider the practicality of training options from the point of view of the trainee.

There are many different employment opportunities for scientists in conservation, the principal ones being conservation institutes, museums and galleries, research centres, and training programmes for conservators. The qualifications that employers are looking for when hiring a conservation scientist may vary greatly from one type of institution to another depending on the specific needs and budget. For example, employers may be looking specifically for a scientist with a chemistry, physics or biology background, and they may be able to afford a recent BSc graduate, but not a PhD or a BSc with several years of experience in conservation science. Employers may request experience in conservation depending on whether they want the scientist to have immediate impact or if they are willing to train the new employee on the job. Employers today have to work with existing limitations regarding academic training and experience, since undergraduate or graduate training in conservation science is not a well-established education path.

Therefore, it is important to ask employers to define what they need in terms of qualifications, and not in terms of specific degrees, to avoid being limited to existing educational options. Based on the qualifications required, a decision could be made about the best way to obtain them. It is only by doing so that we will be able to determine if new programmes are needed, and if so, what form such programmes should take.

There is a general consensus in the professions of conservation science that conservation scientists need to be first of all good scientists. Consequently, conservation scientists have to be trained first as scientists (biologist, chemist, physicist, engineer, etc.). This is done at the undergraduate level by specializing in one science, or a combination of sciences (a major and minor). Considering what conservation science covers, I think it is fair to say that an undergraduate programme in conservation science could never adequately cover all sciences and their specific applications in conservation, and, eventually, other topics such as art history or archaeology.

Thus, we start with an undergraduate degree in science. But another factor comes into play. Today in Canada, and probably in the United States and possibly in Europe as well, there is a tendency to devalue the bachelor's degree in science. In my own specialty, chemistry, interesting openings increasingly require that the successful candidate hold a master's degree, if not a PhD degree. The most talented people often continue at the postgraduate level. Therefore, the best recent graduates today are often the ones who hold not only a bachelor's degree in science, but also either a master's degree or a PhD degree in science.

So, the conservation scientist typically holds a master's degree in science, which is good because it means that, hopefully, he/she would have been exposed to research and become familiar with the dissemination of scientific results through publication in peer-reviewed journals and lectures at scientific meetings. Good written and oral communication is no doubt a plus for a conservation scientist. Therefore obtaining a postgraduate degree (MSc) is an asset.

Training scenarios for conservation scientists

University Programmes

And then what? One might assume that the next logical step would be to specialize in conservation science at the PhD level. However, earning a PhD implies working on a specific project that will generate new knowledge. This means that the scientist would not be exposed to all aspects of conservation science and would have to choose the area of conservation science he/she wishes to specialize in early on.

This scenario imposes several limitations. First of all, this type of training should not be limiting, since there would be no guarantee that the graduate would find a job in the same area of conservation science that led to his/her PhD, if at all in conservation science. Such a specialization in conservation science would be feasible only if it provided a sound scientific training, which would not prevent the scientist from obtaining a job in another area of conservation science or in another field of science. The second limitation is that such a training path would produce only PhDs in conservation science, while employers may not necessarily need such high qualifications, especially for entry level openings.

Another option is to create a Master's in Conservation Science programme which would be different from the traditional MSc programme, where students may have to take a few courses but work most of the time on a specific research project. This new programme could, for example, consist mainly of courses on the various aspects of conservation science and related disciplines, and internships. Then, the conservation scientist would hold three degrees: a BSc, an MSc, and a Master's in Conservation Science. Although in theory such a degree is offered at Queen's University in Canada as a specific stream of the Master's in Art Conservation programme, it has produced very few conservation scientists so far. For example, none of the twenty conservation scientists practising at CCI have academic training in conservation science.

Again, there is not much choice for employers, unless we consider the possibility of an additional PhD degree after the Master's in Conservation Science, specializing in a given area of conservation science. The same warning given before applies: such a PhD programme should also provide a sound scientific training, which would not prevent the scientist from obtaining a job in another area of conservation science or in another field of science. However, in this case, with half of his/her university training having been specialized in conservation science, what would be the chances of the scientist being hired outside the conservation field?

Professional Development

So far I have discussed training in conservation science taken in universities, prior to finding a job. Another option is for the employer to offer scientists training after they have been hired. This training, a combination of on-the-job training and professional development, would be tailored to the specific needs of the employer. The professional development component should preferably be offered by training institutions such as universities in order to insure a certain level of quality, and to avoid the multiplication of 'improvised' training initiatives.

This means that the employers have a choice regarding the level of scientific expertise they require (MSc or PhD), and can subsequently offer additional training related to the job. There are also disadvantages to this scenario. First of all, this would be time-consuming, and it could take several years before a scientist would be fully qualified. Secondly, this would be quite an onerous endeavour for many employers, and probably a totally unrealistic one in some cases. This is, however, the model used at CCI.

Conclusion

After examining training options from the point of view of both the employers and trainee, I reached the conclusion that specialized training in conservation is better to take place after a scientist enters the conservation science profession, and should be a combination of on-the-job training and professional development. However, I would like to stress the importance of establishing a high quality curriculum of professional development activities that would be comprehensive and adapted to the needs of the employers.

Several institutions are already involved in teaching scientific topics, not necessarily only to conservation scientists. The quality and level of knowledge being dispensed varies quite a lot, mainly because the target audience of these courses is sometimes too large or not well defined. It is essential to bring all players together and make the best of the expertise found in many institutions around the world.

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The Situation of Cultural Heritage Conservation Scientists in Algeria

Messaoud HAMIANE[1] and Rachida ZADEM[2]
1–Department of Materials Engineering
Faculty of Engineering Science
University of Boumerdes
Boumerdes, Algeria

2–Ministry of Culture
Algiers,Algeria

Abstract

Major human resources and materials have been mobilized to safeguard the Algerian cultural heritage, yet they have proven to be insufficient to remedy the problems of deterioration. It is in this perspective and as a complement to other well-established institutional efforts, such as archaeology, architecture, museology and art history, that the exact sciences and technology of the University of Boumerdes (USTHB) have joined the effort. The conservation of cultural heritage requires various competencies in order to give archaeologists and scientists all the elements necessary for assessment, critique and control. For this purpose, the Algerian state, through the Ministry of Culture and in collaboration with ICCROM, plans to organize conservation courses in the near future. Identification of the agents responsible for deterioration and remedies to preserve and restore every type of object or monument call for particular techniques on structures and aspects of the physico-chemistry of materials, which are little known. That lends weight to materials science as a domain reinforcing scientific conservation. The University of Boumerdes is setting up a department of materials engineering and a specific postgraduate programme, which could be put to the service of the development of conservation science.

Keywords: Cultural heritage conservation; scientific materials conservation; natural sciences; archaeology; university; Algeria.

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1. Introduction

To safeguard the importance of sites recognized as UNESCO world heritage sites and other cultural property, the Algerian state through its Ministry of Culture launched an action aiming at preservation and made a considerable effort, including setting up the human resources and necessary materials. Unfortunately these means have proven insufficient to remedy this problem.

Some inestimable archaeological wealth exists in different places and regions of Algeria, and it requires protection against all forms of deterioration (chemical, natural change, pollution, physical destruction, etc.).

The opportunity to participate in the seminar on scientific conservation arose thanks to previous contacts with the Algerian Ministry of Culture. We are here today because of our great interest in this domain. Therefore it is a great opportunity and an honour to attend this international seminar. We are grateful to the promoters, and particularly ICCROM, for the invitation.

With the same objective in mind, Algeria intends to organize courses in the near future in collaboration with ICCROM; we intend to start with courses of conservation, due to the fact that the various Algerian institutions have so far not offered this type of training.

2. The place of scientific conservation in the profiles and programmes of Algerian universities.

In matters of conservation and restoration, the preservation of the physical, aesthetic or historical integrity of cultural heritage is an important factor. It is in this perspective and to complement other well-established institutional efforts, such as archaeology, architecture, museology and art history, that the department of exact sciences and technology of the University of Boumerdes (USTHB) has joined the effort. The Algerian institutions that currently offer studies in cultural heritage preservation do not include a programme on scientific aspects. One mentions, for example:

- The Academy of Fine Arts (ESBA), under the tutelage of the Ministry of Culture and also with the educational supervision of the Ministry of Higher Education.
- The Humanities Faculty (University of Algiers), including departments offering options such as: archaeology, history, museology, conservation and classical studies.

Among the courses taught in these institutions, we found decoration, design, history, history of art, painting and drawing.

Thus, these programmes do not prepare archaeologists to face the scientific side of conservation (diagnosis, physico-chemical characteristics and other properties), owing to the fact that they do not include scientific information (chemistry, physics, biology, geology, mineralogy, materials science).

The programmes on natural sciences and technology at the universities of Boumerdes and Bab-Ezzouar do not prepare scientists to face the specific nature of cultural heritage as seen in its different aspects: materials, aesthetics and history.

However, the University of Boumerdes quickly understood the existence of that lack in the various programmes of study, and responded favourably to this initiative. It was felt that conservation of cultural heritage requires various types of expertise in order to provide both areas (archaeology and science) all the elements necessary for assessment, critique, control and an important role in the conservation of cultural heritage.

The Faculty of Engineering Sciences is among the four faculties at the University of Boumerdes, which was created as one of the various national institutes. It includes nine departments, namely: biology, food technology, manufacturing technology, electric and electronic engineering, treatment of fluids, mechanical engineering, industrial maintenance and finally the Department of Materials Engineering. The courses taught in the latter department can play a determining role in the project for scientific conservation, namely with: physical chemistry of silicates; general technology of silicates; technology of materials (ceramic–glass–concretes–binders); solid physics; materials science; chemistry; physics and so forth.

The University of Boumerdes offers postgraduate programmes, as do many other Algerian universities. For acceptance, one must have a diploma as a state engineer and successfully pass an entrance examination, as well as a specialized postgraduate preparatory programme. It is in this setting that the Engineering Science Faculty of Boumerdes intends to develop its works of research and survey together with the Ministry of Culture and other national or international institutions. Candidates must have an undergraduate degree and be proposed by their employers. There is also a second postgraduate-level doctorate programme, which the university offers to holders of a Master's degree or equivalent recognized diploma.

3. Materials science as a domain reinforcing scientific conservation

There is no doubt that the strength of nations of today and tomorrow is closely linked to the use of science and technology. The weight and extent of the progress that has been achieved show that there is a drive to reach ever higher levels of economic and social well-being. So for the preservation of cultural heritage, it is indispensable to identify the agents responsible for its deterioration in the short or medium term.

Remedies must be found to preserve and restore every type of object or monument according to the established diagnosis.

A survey of these problems showed the importance of particular techniques of diagnosis of structures and aspects such as the physico-chemistry of materials and biodeterioration, including: chemical composition; mineralogical composition; physico-chemical properties (porosity, density, water absorption) or physico-mechanical properties (mechanical resistance to flexion, compression or traction). Features of materials can affect:

- ancient museum objects
- collections or other statuettes lacking a fragment or a piece
- monuments and sites of large scale
- stoneware tiles, mosaics and decorative pieces

- other materials of value

All these indicate the importance of materials science and the role it can play in scientific conservation.

4. Conclusion

In Algeria, as in all countries in development, some very important capacities exist in quantity and in quality, but they are far from being fully exploited, and personnel is not always used in an efficient way. Unfortunately, this state of enormous need is found in all sectors, and notably in the conservation and restoration of our cultural heritage. Technological and economic development is being opened by market competition and widespread internationalization, and will probably be crowned by socio-cultural development, based mainly on the history and culture of the country. Nevertheless, there is growing concern about the disappearance of cultural heritage in the different regions of Algeria. Heritage is being attacked daily by deterioration, and environmental dangers are becoming increasingly invasive. Actions to protect heritage remain below expectations and the fundamental necessities. A structure is needed to regroup potentialities and materials – technological and human – or perhaps (why not?) build a complementarity between the archaeologist and the scientist.

Algeria needs the means to perform modern investigations, and it also needs conservation specialists in order to better encompass problems of conservation and therefore preserve our cultural heritage appropriately.

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The Importance of Conservation Science for the Progress of Conservation: possible alternatives for Latin America

Luiz A. C. SOUZA
Center for Conservation and Restoration of Movable Cultural Properties (CECOR)
Federal University of Minas Gerais
Minas Gerais, Brazil

Abstract

In this presentation we discuss some aspects regarding current practices in conservation training, research and the market in Brazil. These factors reinforce the need for well-trained professionals in conservation science, in order to be able to control the quality of the interventions as well as to contribute to the scientific training of conservators.

Introduction

First of all I would like to thank the organizers for the opportunity to be here in Bologna to discuss such an important issue as the training of conservation scientists. I am well aware that there are many questions to be discussed here, including the concept of what a conservation scientist is, as well as the several activities and disciplines he/she should perform and have training in, but given the short time we have, I will concentrate my observations on some of the aspects we are experiencing now in Brazil and also in other Latin American countries. But before going into the proposed matter, please let me clarify that focusing on Latin America does not mean that there must be a specific training for this part of the globe, since natural sciences are universal.

Conservation and restoration practices and training in Latin America have changed substantially in the last ten years. In some countries, conservation centers have developed first, following the initiative and dedication of people trained abroad, mainly in Europe or North America. In these centers, which were institutionally linked to the Ministry of Culture and/or the National Institutions for the Protection of Cultural Heritage, the initiatives for training in conservation and restoration have resulted in agreements and collaboration with universities, which have then started to develop *curricula* for the academic training in conservation and restoration, at different levels,

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some at the undergraduate level, and some at the postgraduate (specialization) level. The situation now is clearly different from the beginning, because with the passage of time most of the academic programs have evolved and developed their own ways, sometimes even imposing, unfortunately in my opinion, an unnecessary dispute between academically trained conservators and those pioneers who were trained on the job.

But how does conservation science fit into this reality? Together with the conservators who created the first conservation centers, there were, in most cases, very dedicated science professionals, the majority of them being chemists, who established and created the nucleus of the conservation science laboratories, helping the conservators to study and identify the materials and technology of construction of the objects in process of restoration, as well as developing and studying materials and products from their specific regions in Latin America, in order to test the possibility of their use in conservation processes. These people were also responsible for the initial steps in the science training of the conservation-restoration students. It is incredible to think that such a small group of people, sometimes only one person in a whole country, would respond – or try to – to most of the demands coming from the conservators, doing mainly analytical work. As for their training in science in conservation, most of it came from internships in institutions such as the Institut Royal du Patrimoine Artistique (IRPA), in Brussels, as well as some institutions in the US, such as the Fogg Art Museum, and of course at ICCROM in Rome.

Coming back to today's reality, together with the changes in the conservation-restoration practice and training in Latin America, there are also many substantial changes in the role played by cultural heritage in today's society. Recent years have been characterized by the establishment of neo-liberal policies in most of the Latin-American countries, practically forcing the central governments to pass on several of their responsibilities to state and municipal governments, which frequently do not have the necessary knowledge, personnel and tools to perform a responsible job. The market for conservation-restoration has boomed, not necessarily because of an increase in awareness about the importance of the preservation of our cultural heritage, but also because of the pressure for cultural tourism and development, which transforms the cultural heritage in a possible source of revenue for historic cities, where the populations are having less and less access to jobs. It is incredible to realize that funding agencies such as the World Bank and the Inter-American Development Bank are investing, generally as loans to central governments, unbelievable amounts of money in projects involving restoration of buildings, integrated in a perspective of urban planning and sustainable development, but unfortunately most often without the necessary basic knowledge of the materials and their decay processes. As a result of these changes, conservation-restoration of both movable and architectural properties has become a very attractive commercial activity, and there is now the danger of several irresponsible interventions, because of the lack of the necessary training and professionals. The above mentioned model of the very few science professionals dedicated to analytical work in conservation, trying to help and work in collaboration with their conservator colleagues no longer works, because of the tremendous amount of work to be done, as well as the need for deeper research in areas such as integrated pest management, biodeterioration and climate control, materials degradation, new conservation materials and techniques, building and object interventions.

It is in this context that I would like to stress the need for the academic training of conservation scientists. There is a urgent need for the dissemination to the scientific communities of the importance of the natural sciences to the conservation of cultural properties, and in my opinion we should now count with the help of the national science councils and universities, in setting up national programs for training in conservation science, in order to fulfil the needs for the better quality of the interventions, as well as to develop a group of professionals who will be responsible for the work in collaboration with conservators, helping them to solve problems, developing new conservation materials and processes, as well as contributing to the necessary scientific training of the future conservators who will be acting in the field. It is only through the investment in today's science students that we will be able to count on future professionals in conservation science. The contribution of internationally recognized conservation institutions, where conservation science is performed as part of teamwork, involving contributions from different professionals such as architects, historians, librarians, archivists, conservators, engineers, is also a very important issue. As part of the academic training of future conservation scientists, internships in these institutions should be common practice, as happens in other fields of science, where international networks and exchanges of students and researchers are well established.

As a member of academia, I feel that, in the present situation, the universities are playing a more and more important role of providing to society, and not just the market, the professionals who will be responsible for fine tuning the changes we are all going through. Conservation scientists are, in my opinion, an essential part of this reality.

Conservation Science: the needs and potentials

Abdolrasool VATANDOUST
Research Center for Conservation of Cultural Relics (RCCCR)
Tehran, Iran

Abstract

This paper describes the significance of conservation science and the very important role played by conservation scientists in an overall conservation project. It briefly describes current experience gained in the field of conservation and conservation science in Iran with a view to other countries. Finally a proposal is made for training of conservation scientists.

Introduction

The impact of the application of different branches of the natural sciences in better conservation and restoration of artistic and historical materials has long been appreciated by conservators and curators, yet, unbelievably, not enough attention has been paid to this very essential subject. Conservation is taught in many universities and colleges in various countries of the world but there is virtually no single academic course on conservation science.

It is now certain that the pace of deterioration in our century has gained considerable momentum due to various deterioration factors, notably air pollution. Acidity acting on paper materials and textiles, humidity triggering the corrosion processes of metal artefacts, fungi, termites and other biological agents destroying organic materials, soluble and insoluble salts leading to degradation of stone – these are just some destructive agents to be mentioned.

Conservation and preservation of cultural and historical relics is a science whereby the goal is achieved through extensive research and the use of various methods and procedures, namely: protection, maintenance, restoration, repair, consolidation, revitalization, rehabilitation and reconstruction.

The art and science of conservation of cultural and historical relics, like many other branches of science and technology, developed considerably in the twentieth century. As we begin the twenty-first century, the rate of development has gained significant momentum. Now with the help of sophisticated and complicated physical instruments, techniques and methods based on investigation and multilateral survey,

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it has become possible to travel into the materials of which the work of art is composed and/or through the layers of encrustations produced as the result of reaction between a relic and its surrounding environment. Thus it becomes possible to throw some light on obscure aspects of the object's history, as well as helping conservators in better fulfillment of their duties. Nowadays, with assistance from sciences such as chemistry, physics, biology, geology, osteology, microbiology, nuclear physics and computers, and together with the close cooperation that exists between science and art, the identification and conservation of cultural, historical and artistic relics have entered a new phase. This gives hope for the survival of these valuable remnants of our past for a long time to come.

Thus *Conservation* can be defined here as all operations taken in the past, present or future with the goal of prolonging the age or durability of an object or a monument. The *Conservator* is the person who will take all the necessary actions, including restoration, to see that this goal is reached. *Conservation Science* is the discipline whereby one defines an object's state of health, the mechanisms of decay, illness and deterioration, the relation between the object and its environment, and the physico-chemical characteristics of the materials from which the object is made. The *Conservation Scientist* is a professional (chemist, physicist, geologist, biologist, etc.) who has complemented his or her scientific background with knowledge of historical and artistic values and performs the tasks of conservation science. According to ICCROM's Survey of Scientific Research for the Conservation of Physical Heritage (SRC), and with the help of collaborating institutions for both the worldwide survey and the Maghreb survey, two distinct definitions have been identified for *Conservation Science*. The first, interpreted after thorough discussions within the project team and in collaboration with some of ICCROM's Council members, is as follows:

"All the critical and structured activities aimed at discovering new facts or collecting the existing literature through the ***application of scientific disciplines to the conservation of physical heritage****. Studies where scientific disciplines (e.g., Biology, Chemistry, Physics, etc.) are applied together with humanistic ones (History, Art History, Ethics, etc.) should be considered in the survey, while purely humanistic studies not concerning conservation problems should be excluded."*

The second one for the Americas is slightly changed:

"All structured scientific studies ***(applying scientific disciplines such as Biology, Chemistry, Geology, Physics, etc.) aimed at improving our understanding of the processes involved in the degradation of our cultural heritage (movable and immovable) and the materials composing it, development of new or improved conservation methods, and conditions for its uses and/or storage that are optimally conductive to its future preservation. Routine scientific examinations or analyses required for the planning, preparation or application of a given treatment to a particular object or monuments are not included, unless they are of sufficient generalized importance to result in professional publications.****"*

Conservation at present

It is a fact that in almost all conservation research institutions, analysis and use of the natural sciences are the main sectors of conservation research. According to the Survey results, out of 128 institutions in 42 countries responding to the questionnaires only 12% consider SRC as 'secondary.' This is an encouraging conclusion. Although absolute priority among the types of heritage on which SRC has the greatest impact was given to sites/buildings and collections, this means a concrete foundation can be built, benefiting from existing experience, for a long-term action plan in academic terms for conservation science.

Generally, conservation scientists are those who have not had academic or practical experience in the conservation field. In fact, in most cases graduates in the natural sciences (a good number of them chemists) use their skills coupled with acquired knowledge and experience during the course of their involvement with conservation and restoration works, for research in this field. Thus naturally, and as concluded from the SRC project, a majority of scientific investigations are slanted towards technological investigations using analytical methods. But undoubtedly and on a global level, the needs for further investigation on material deterioration processes and diagnostic technologies are strongly felt.

As stated in the ICCROM report, the RCCCR regional programmes in the sectors of *analysis and intervention methodologies, economic and management implications in conservation activities,* as well as in the *"mise en valeur" of physical heritage* are among major research achievements. In the RCCCR's experience, it has been found that although it is possible to train conservation scientists through their integration with conservation projects and conservation-related research investigation, the results obtained are neither comprehensive nor feasible in a reasonable period of time. In-house training of conservation scientists in Iran has been undertaken with some degree of success:

1. Long-term training within research institutions or on-the job training:

It is possible to train conservation scientists by involving them in conservation research projects. This is normally achieved within a well-organized conservation research laboratory or center. An important aim of any research laboratory or center should be the implementation of research projects whose outcome can generate a better understanding and identification of the country's cultural heritage, thereby leading to the better conservation and preservation of that heritage. In the RCCCR there are now chemists who can truly be called conservation scientists. They have been trained through self-education, participating in relevant training courses inside and outside of the country, attending various seminars and conferences and participating in research and conservation projects. A conservation project, when defined, should be considered as a research package in which all the elements of a successful programme are foreseen. These are: detailed scientific investigations concerning technological developments, deterioration processes, dating, deterioration products, weathering, treatment, restoration, preservation, training, monitoring, data exchange, publication and finally presentation of the results.

The following responsibilities could be summarized for such an organization:

- application of science in archeological research with the aim of scientific identification of historic sites and their contents by complementing archaeological finds with laboratory research;
- conservation and restoration of historic and cultural artefacts;
- basic research and analysis of cultural and historical materials with a special view to determining the developmental trend of technology in ancient times;
- research on deterioration and degradation processes, control measures and methods, and identification of traditional and modern materials used in manufacturing of historico-cultural objects;
- conservation and restoration training through holding short-, mid- and long-term courses;
- research on promotion and development of conservation methods; and
- instrumental dating of archaeological finds.

2. Academic training:

In a very few countries, conservation of cultural heritage is taught in technical universities, but in most cases, including Iran, it is found under the auspices of art universities and colleges. Nevertheless it is important to note that conservation of cultural materials is a combination of art, history and natural sciences and it is only through this consideration that a successful conservation course or project can be achieved. Unfortunately, this vital fact is not fully appreciated in many countries and consequently Conservation Science is not fully at the service of conservation. There are schools devoted solely to restoration as an artistic subject, whereas there are institutions that look upon the subject as a purely research entity.

In Iran both goals are pursued with a single approach. There are Higher Diploma, BA and MA courses in conservation and restoration of historico-cultural objects with specific definitions and objectives. The BA course objective is to provide students with knowledge and effective practical experience for conservation and restoration of cultural properties. Through revitalization, restoration and preservation of cultural heritage, graduates of the course will be able to contribute to the economy and cultural growth as well as the independence of the country.

An important aspect of the MA course (which takes two-and-a-half years, or five semesters) has been training of conservation scientists. Thus the students are selected from the graduates of various disciplines such as Conservation, Handicrafts, Industrial Design, Painting, Fabric and Clothing design, Chemistry, Chemical Engineering, Materials Engineering and Textiles Engineering. In order to guide the student to the right path of research and study, based on their educational background, six special fields or specialties have been defined as the following:

1. Materials Sciences and Conservation and Preservation of Historic Remains (Chemists, Chemical Engineers, Materials Engineering, Textile Engineering);
2. Metals;
3. Paper, Skin, Wood;
4. Glass, Pottery and Ceramics;
5. Textiles, Carpets, etc.;
6. Paintings (Miniatures, Frescoes, Murals, etc.).

Apart from basic courses such as: Physics and Conservation, Inorganic chemistry, Organic chemistry, Physics and Conservation, Pathology, History and technology of artefacts, Conservation workshop, or Conservation laboratory, specific courses are also offered to the students, such as: Polymers and consolidants, Metallography, Fibre identification, Acquaintance with Iranian handicrafts, Artefacts and their surrounding environment, Research project, Deterioration processes, Conservation.

Conclusion

Conservation science is an important subject, which has great effects on the well-being of cultural heritage in various parts of the world. Therefore it is recommended that the subject be globally considered. Accordingly, a well thought out and well-planned training programme should be defined for conservation science. The course, which could essentially be treated as a research work, should be realized at regional and international levels through implementation of projects, with the cooperation of different universities and research centers. It is also proposed that research MPhil or PhD Courses be defined in relevant universities or research institutions for various scientists. Through execution of projects and based on needs, scientists could choose and pass various scientific and field courses in various institutions in their own countries or overseas and complete the research package under the guidance of supervisors.

CPNS-Conservation Principles and Natural Science

Bent ESHØJ
School of Conservation
The Royal Danish Academy of Fine Arts
Copenhagen, Denmark

Abstract

Complex conservation problems call for multidisciplinary conservation teams. Successful integration of natural scientists in conservation is best achieved by offering shorter, add-on courses in central conservation disciplines to full academic education in the natural sciences. This approach will produce natural scientists with a good understanding of and respect for work with cultural heritage in cross-disciplinary cooperation with other conservation professionals.

Keywords: Natural science; conservation scientist; conservation principles; conservation philosophy; conservation history; ethics in conservation; preventive conservation; non-destructive testing.

Introduction

Conservation work normally consists of complex problems – material as well as immaterial. Satisfactory conservation solutions are usually best achieved when they are based on a multidisciplinary or cross-disciplinary approach to these problems. This entails an analytical phase where conservators, together with other scientists from relevant natural sciences and the humanities, assess and interpret problems and propose solutions, each relying mainly on the methodology and tradition of their own profession. During subsequent discussions, new nuances and possibilities often come to light, creating conditions conducive to finding conservation solutions of enhanced quality.

Aim

A future educational programme for natural scientists entering the world of conservation should, therefore, seek to preserve the professional skills and characteristics of each natural science, so that the interdisciplinary approach to a conservation problem is ensured through the team of professionals involved – and not through the transformation of the individual into a jack-of-all-trades. The aim of an educational programme should be to strengthen the role of each profession on the team, achieved by working

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on the interface between the professions. In other words, the goal is improved communication and understanding of the aim, ethics and working conditions of the conservation profession. Consequently, the title of my contribution is inspired by the well-known ICCROM acronym for Scientific Principles of Conservation (SPC) – as I feel my title aptly conveys the object of a contemplated educational programme for natural scientists entering the field of conservation.

Scientists

In my contribution I deliberately use the term 'natural scientists' and not 'scientists' about the target group for such a course. The avoidance of the term 'conservation scientist' is equally deliberate, as to my mind this term only serves to confuse the issue. In Denmark, as well as in a growing number of countries with conservation education on an academic level, a conservator with, for instance, a five-year education from a research-based educational establishment is also a 'scientist.' For me, the term 'scientist' is a qualitative description of a work methodology, and not an independent, descriptive job title. At my institution, conservators, humanists and natural scientists alike are employed as scientific staff with equal authority and mandatory research. Operating with both 'conservation scientists' and conservator-restorers might indicate that only the former work in a scientific way!

Entering the field of conservation

The first thing natural scientists should do if they are thinking of entering the field of conservation is to assess their general interest in cultural heritage. Having interviewed several colleagues in the natural sciences, it is my impression that an active interest in, and understanding of preservation provides the greatest motivation for and enjoyment of work with cultural property. It is also important that one is ready to make one's research contribution to the field of conservation, so that one also contributes to the development and awareness of the profession.

Form of course work

Insofar as it is desirable to maintain the specialist characteristics of the individual professions, I am of the opinion that the ideal arrangement would be to offer an international postgraduate course lasting perhaps two or three months. Such a course would seek to gather together as wide a range as possible of the natural scientific professions so that the participants would have the opportunity to exchange expectations, ideas and experience. Geologists, physicists, chemists, biologists and perhaps engineers would attend it together. With frequent intakes on such a course, it would be possible for conservation institutions to plan the flexible integration of new natural scientists in their staff teams. It might be an advantage for such a course if the participants had a little experience before they began. In any event, such an education would open up the possibility for internationally attaining a certain uniform standard for natural scientists' work in conservation – a standard that is otherwise wholly dependent on the efforts of individual institutions and local colleagues.

Curriculum

The course should take the form of an introduction to the most important aspects of conservation work – first and foremost to the main philosophical and ethical framework that applies to work within the cultural heritage field. This introduction can take the form of an exposition of international doctrines, conventions, charters and guidelines. It should be supplemented by a review of changing attitudes towards conservation throughout history, as the natural scientists in their subsequent work will encounter the consequences of the attitudes and conservation methods of earlier times. Respect for materials and authenticity are key words here, as is an overview of various geographically rooted traditions for conservation work.

The next item on the curriculum might be an introduction to non-destructive or micro-destructive examination methodology. This is an explicit wish in connection with the treatment of cultural heritage and a circumstance, which differs from work according to normal industrial standards. Natural scientists must learn to regard every cultural-historical object as a document that contains many different types of information, which can be lost if we make the wrong choices during the treatment phase. The natural scientist should be aware that the treatment phase is a kind of filter that decides which pieces of the object's information and values are passed on, and which are lost. The subject could be illustrated by a number of good as well as bad case studies.

Interpretation of analytical results is another important subject. In conservation one usually works on dead and aged material, and there are often no clear standards to go by. Not least in this field, a multidisciplinary interpretation is desirable and appropriate. In consequence, interdisciplinary communication and understanding should rank high in the curriculum, for instance in the form of a short exposition of the work methodology and tradition of the most important natural sciences – preferably illustrated by cross-disciplinary viewpoints on a specific conservation assignment. An introduction to a number of different types of conservation education and museum-based conservation labs might also add to a better interdisciplinary understanding. Examples of fruitful inter-disciplinary collaboration should be provided.

Another important aspect is to increase awareness of the interplay between environment and conservation. Take the subject of preventive conservation: classes could show how, by manipulating the storage and exhibition environment, one can increase the chances of preserving the object and thereby reduce the need for active intervention, which will always expose the objects to some form of harm and a consequent loss of authenticity and information. Here communication with architect and engineer should be stressed. I normally use the term 'conservation diplomacy' for the discipline of getting your ideas across in a nice way.

Also of importance for a natural scientist working in conservation is a thorough knowledge of the publication environment. This topic could be covered in the form of an introduction to the most important organizations, congresses, periodicals, professional networks, etc.

Finally, the traditional distinction between conservation and restoration in the conservation profession should be explained and discussed. Definitions and overlapping can be illustrated by case studies – taking an historical and geographical perspective into account.

Planning the course

With a view to drawing up an actual educational programme, an international task force should be formed with representatives from the conservation profession and the natural science and humanistic professions involved. It would be preferable if the conservation profession were to be represented by a conservation institution with international educational experience. Perhaps it would also be a good idea to have a representative from a major employer of conservators. It should then be the task force's job to draw up a concrete proposal for curriculum and teaching methods based on the available statistical investigations and scientific contributions from the various phases of the CURRIC project. A key word in the planning is introduction. The course can and should act only as a means to ensure a more flexible integration of natural scientists into the conservation field. It is to be hoped that the individual will necessarily gain experience in connection with strengthened and improved cooperation with other professionals within the field of conservation.

Conclusion

I have previously likened the conservation profession to an orchestra – an orchestra in which the various professions involved each play their own instruments. The symphony will not be beautiful and harmonious until everyone follows the same score and plays in time. By music and time I mean respect for international codes of practice and love for cultural heritage – and I do not feel there is any great need for solo performances.

Conservation Training of Architects: evolution and levels

Jukka JOKILEHTO
ICCROM Consultant
Rome, Italy

Taking a quick look at the different approaches in the field of the definition of heritage and conservation, we can identify the following trends:

- Heritage is understood as a memorial that transmits a message; in this case, the purpose is often to emphasize the message, resulting in the suppression of the historic structure itself.
- Heritage buildings are seen especially in their dimension as architectural design; here the emphasis often favours form over historicity of material, and can result in extensive reconstruction.
- Heritage buildings and sites are appreciated for their historic significance as artefacts or constructions built in a different time and in a particular socio-economic and cultural context; as a result any restoration should be based on a respect for historicity of material. (This is the basis for the Venice Charter and international guidelines.)
- Cultural heritage is understood as living and continuous, capable of continuing traditional skills and working methods; this is particularly relevant to living rural or urban settlements, where the aim is to encourage the use of 'appropriate technology' respecting the traditional building patterns and historic values, but also allowing new constructions to accommodate present-day requirements.

It is worth noting that at present about 70% of construction practice is focused on existing buildings. This is true not only for the work of contractors, engineers and architects, but also for the building industry, which needs to develop new techniques and instruments to fit the requirements of existing buildings and the environment. Comparing the attitudes that generally mark the approach to the design of new buildings and the conservative rehabilitation and restoration of existing historic structures, we can see the following differences:

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New buildings and constructions	Existing historic structures
Buildings do not exist yet;	Buildings already exist, and are associated with particular historic and other values;
Design and project are based on needs, norms and taste;	Treatments need to be based on the knowledge of the character and significance of the buildings; building norms and definition of use should be made accordingly;
Design of details and equipment can be done on the basis of commercially available material.	Design of details and equipment should be adjusted to the existing building and site.

It is clear that there is a fundamental difference when approaching a new design and when dealing with an existing historic structure. This difference is reflected in the 'culture' of the designer. It is therefore necessary for all architects, engineers, planners, and technicians who deal with the existing building stock to be properly instructed and trained. While restoration of listed buildings and protected monuments is often in the hands of architects and conservation specialists who have received specialized training, the so-called 'ordinary building stock' remains the target for the building industry and for architects and technicians who may not be familiar with the policies that govern the conservation of buildings or areas as cultural heritage.

The typical career of an architect involved in conservation of historic buildings would include the following phases:

- *Basic professional study* in architectural design; this phase may (and should) already include study of the history of architecture and technology, the issues of maintenance and repair, knowledge of traditional materials and structural systems.
- *Practice in building and design*; in this phase, an architect should develop a good knowledge of the appropriate field, and have experience particularly on existing building sites;
- *Specialized training*: this phase includes in-depth studies in conservation policy and legal frameworks, understanding of historic architecture and technology, development of new creative approaches to find solutions in challenging situations;
- *Roles in teamwork*; an architect, especially when dealing with existing building stock, needs to develop conflict solving and communication skills, the capacity to lead teamwork and the willingness to listen to and consult other disciplines.

Specialized training of architects in the conservation and restoration of historic buildings has evolved together with modern conservation policies. It has been justified since regular design-oriented training has not met the requirements of understanding the character and significance of heritage resources. Such training first started in France and England and was later introduced in Germany and Italy, but it has mostly developed since the Second World War. Currently conservation training exists in most European countries and in North America, but there are also programmes elsewhere: Latin

America, some Asian countries, and more recently in North Africa. Training can be justified if there is consciousness of heritage and the need for its conservation. Training should be part of the career structure of several disciplines, including the building profession, sciences and humanities.

In the nineteenth century, restoration of mediaeval structures needed knowledge and skills that ordinary classically oriented training did not guarantee, such as in-depth history of architecture and traditional building skills. Today, we should add conservation science, survey and consolidation of historic structures, and the analysis and planning of historic areas. Conservation training has become increasingly necessary since the 1960s, when traditional building technology was dropped in favour of modern design and techniques. While some programmes, such as the Palais de Chaillot School in Paris and the recent course in Tunis, are oriented mainly to architects, many training programmes are open to other professionals involved in the conservation of historic structures, including engineers, town planners, art historians and archaeologists. This factor poses particular requirements, but also meets the challenge of teamwork in modern conservation practice.

There are three types of training seen as complementary: undergraduate (integrated in architectural school curricula), postgraduate diploma, MA or MSc courses, and professional refresher courses. The ICCROM course on Architectural Conservation (ARC) has been a mixture of the last two, being addressed to mid-career professionals (average age 35), but also having academic links. Many MA courses mainly address young architects (under 30). There is an increasing trend at universities to introduce a conservation option in undergraduate studies; in Europe, this suggests consciousness of heritage, but it also reflects the market, as some 70% of an architect's practice consists of work on the existing building stock. The focus of such training is thus shifting from public buildings and monuments to residential and vernacular buildings and historic areas. Postgraduate training requires a larger market than undergraduate study. Often, the market can only justify one MA course per country. Several programmes are open to engineers, planners and historical disciplines in order to attract students, and some schools address the international market (Leuven, Edinburgh, London, Rome). While a number of universities organize full-time training (generally one year), a part-time option is also often offered.

At the end of the millennium, we see heritage conservation as a necessity, and as part of healthy community policy. It is a modern discipline and requires the participation of several professions, including scientists and technicians. Due to the need to learn about what exists, it is fundamentally different from design-oriented and theoretical disciplines. This does not mean a lack of creativity and critical thinking (indeed, these are at the root of modern conservation), but it is also based on communication and collaboration across boundaries, and necessitates specialized induction of all parties.

Final Report

R. MAZZEO and M. LAURENZI TABASSO

An International Seminar was hosted by the University of Bologna, Faculty of Mathematics, Physics and Natural Sciences, on 26–27 November 1999 to discuss Conservation Scientists: their role and professional profile and the ways they are trained.

The need for such a discussion emerged from the results of two surveys that ICCROM carried out at a global level; one, in 1997-98, on Scientific Research for Conservation and the other, in 1998-1999, more specifically dedicated to understanding the relationships between scientific research and training of scientists. The latter was carried out in the framework of the Concerted European Training Action (CETRA) project, financially supported by the DG X of the European Union.

Apart from Bologna, three other universities were partners in this initiative: Aachen (Germany) – Institut für Bauforschung, Rheinisch, Westfälische Technische Hochschule; Thessaloniki (Greece) – Department of Civil Engineering; Oviedo (Spain) – Department of Geology.

Seminar topics

The topics to be discussed at the seminar were drafted on the basis of the results of the "Preliminary Survey on the Feasibility of a Training Curriculum for Conservation Scientists" carried out by ICCROM. In addition, a discussion on this issue took place in Lyon, in September 1999, during a special session hosted by the ICOM-CC Working Groups on "Scientific methods of examination of works of art" and "Training in conservation and restoration." The following points were included:

- clarification of the role of scientists involved today in the conservation of cultural heritage;
- definition of the professional profile (knowledge, skills, and attitudes) required for the profession;
- analyses of the place and responsibilities of conservation scientists;
- assessment of market needs for the conservation scientist profession;
- assessment of the need for and feasibility of setting up specific training for conservation scientists.

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Main objectives of the seminar

- Agree on a common definition of "Conservation Scientist;"
- Prepare a working document for the definition of the role and professional profile requirements (knowledge, skills, attitudes) of conservation scientists;
- Evaluate current training opportunities for conservation scientists in function of the proposed professional profile;
- Discuss possible training alternatives (e.g., graduate, long postgraduate/short post-graduate courses, courses in common for all the different scientific backgrounds, global courses on the different fields of conservation of cultural property, courses specific to the different typologies: paintings, stone, metals, etc., or for the different problems: preventive conservation in museums, archaeological site conservation, air pollution, etc.).

An interdisciplinary group of more than 50 experts attended the seminar. They represented scientific departments of universities, scientific research institutions whose activity is entirely or partly devoted to the conservation of cultural heritage and schools of conservation-restoration. The majority of the participants were from European Union countries , but other European countries were also represented, as well as countries in North and Latin America, North Africa and the Middle and Far East.

Also present were representatives of the UNESCO Venice Office and the Regional Office for Science and Technology in Europe (ROSTE), the Italian National Research Council (CNR), the European Confederation of Conservator-Restorers Organizations (ECCO) and the European Network for Conservation-Restoration Education (ENCoRE).

It is important to stress that the problem of training Conservation Scientists (CS) was discussed at an international level by an audience where, together with CS themselves, specialists from other areas of the conservation world were also asked to collaborate.

The first day of the seminar was dedicated to presentations by the invited universities (whose representatives were asked to illustrate their ongoing initiatives in the field of conservation and to discuss the need for specific initiatives devoted to the training of CS), by 18 eminent conservation scientists from Europe, North America, Latin America, North Africa and Asia and by three specialists in other areas of the conservation world, who were asked to debate on the proposed topics, on the basis of their long-standing experience.

An extensive discussion paper prepared by R. Mazzeo and M. Laurenzi Tabasso (ICCROM) was presented. The results of the two surveys carried out by ICCROM on Scientific Research for Conservation and on the Feasibility of a Training Curriculum for Conservation Scientists were illustrated and proposed as a basis for discussion.

The principal important points raised by the universities were:

Bologna (Italy):

The strong interest in conservation demonstrated by its various scientific departments was pointed out. Furthermore the desirability of developing initiatives in collaboration with partner universities in other countries was confirmed.

Aachen (Germany):

A German curriculum for World Heritage studies addressed to conservation managers was illustrated. The Master programme is organized by the Brandenburg Technical University of Cottbus.

The importance of quality insurance, which is still missing in the field of cultural heritage, was stressed.

Thessaloniki (Greece):

The structure of an inter-departmental postgraduate programme addressed to a multidisciplinary audience was illustrated.

Other issues related to the seminar topics were highlighted:

- conservation is a social activity affected by the socio-economic context;
- travel from the past (traditional materials) to the future (innovative materials and techniques) gives a diachronic dimension to conservation science;
- the European Union has invested in cultural heritage conservation since 1986;
- the importance of cultural tourism;
- 20% -25% of the Greek budget on conservation projects is based on diagnostic studies.

De Montfort (United Kingdom):

One of the few structured education initiatives where CS and Conservator-Restorers are trained together was illustrated and discussed. The course is a postgraduate Master in Conservation Science.

So far only 1/3 of the applicants were natural scientists. Training by distance learning is being developed.

Queen's (Canada):

Queen's University has a small programme that gives master's degrees in art conservation with a specialization in conservation science. The entry requirement is an undergraduate degree in one of the science or engineering disciplines. Only one student graduates every two years.

The contributions from the emine it conservation scientists can be summarized as follows:

- there is very good agreement on the definition of the profile, skills and fields of activities of CS. In some institutions and countries, however, unfortunately job descriptions do not reflect the profile of the CS, as they are entrusted with responsibilities that are far from their professional profile;
- apart from differences related to different working environments and scientific backgrounds (chemists, biologists, engineers, etc.), ***the presence of a common core of activities and skills is acknowledged and must be stressed;***
- natural sciences have an economic impact on conservation activities;
- diagnosis plays an important role in the planning of conservation projects;
- it is important to involve the European Union in the development of training initiatives within EU countries;
- the demand for scientific input is increasing, especially in architectural restoration;
- the need to develop education programmes for CS is unanimously recognized;
- several alternatives for training CS were proposed.
- the specialists from areas other than natural and physical sciences raised many interesting points concerning the training of the different 'players' in the world of conservation. Out of these points the following must be mentioned:
- the reasons for providing architects with specialization in the field of conservation at a postgraduate level were discussed as an example for the development of training initiatives for CS;
- comments from both the ECCO and the ENCoRE representatives stressed the need for interdisciplinary collaboration and raised the issue of confusing terminology. This concerns the name of 'Conservation Scientist' for the professional category as opposed to the category of conservator-restorers who adopt a scientific approach in their activities and should, therefore, be considered as scientists.

The second day of the seminar was devoted to working group sessions. Three working groups were established to discuss in parallel the following four questions:

1. ***Today what are the functions that describe the role of a Conservation Scientist?***

2. ***What basic knowledge and skills does a Conservation Scientist need today to perform his/her functions?***

3. ***How can a scientist be educated in order to acquire this knowledge and these skills – should it be at national/regional/international level?***

4. ***What is your opinion on the current trends in the market for conservation scientists?***

Even though differently phrased, the answers from the three working groups showed a very good agreement. Therefore, a final document could be prepared and was unanimously approved by all the participants in the final plenary session.

The following chapter presents this final **"Bologna Document,"** which will certainly serve as a basis for future actions related to the training of Conservation Scientists.

Curric working group members preparing the Bologna Document.

The Bologna Document

Both the results of the survey carried out by ICCROM and the opinion expressed by the seminar participants stress that, considering the increasing number of initiatives in the field of conservation and preservation of cultural heritage, there is a growing need for participation of Conservation Scientists (CS) in various activities.

Definition:

A Conservation Scientist today can be defined as a scientist with a degree in one of the natural, physical and/or applied scientific disciplines and with further knowledge in conservation (ethics, history, cultural values, historical technologies, past and present conservation technologies and practice, specific scientific aspects, etc.) which enables him/her to contribute to the study and conservation of cultural heritage within an interdisciplinary team.

1. ***Today, what are the functions that describe the role of a Conservation Scientist?***
   - Study, investigate and monitor cultural heritage and its environment with respect to conservation and preservation.
   - Define, develop and evaluate conservation concepts, materials, measures, methods and techniques and develop standards and guidelines.
   - Provide diagnosis before, during and after conservation interventions.
   - Conduct research on causes and mechanisms of deterioration and interpret scientific results for the benefit of the conservation of cultural heritage.
   - Communicate the scientific principles of conservation and promote scientific research in conservation.
   - Cooperate with other disciplines.

2. ***What basic knowledge and skills does a Conservation Scientist need today to perform his/her functions?***

A CS must have a university degree (preferably 4-5 years) in one of the natural, physical and applied scientific disciplines (such as physics, chemistry, biology, geology or engineering), and a basic knowledge of conservation theory and practice, other relevant scientific disciplines, (art) history, (ancient) technology, legislation.

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The skills needed by a Conservation Scientist are:

- to be conversant with the phenomenological approach to problem solving
- ability to formulate and carry out research
- ability to turn theory into practical solutions
- ability to work in an interdisciplinary team
- ability to communicate effectively.

Additional skills might include the:

- ability to teach
- ability to manage human and financial resources.

3. ***How can a scientist be educated in order to acquire this knowledge and these skills, should it be at national/regional/international level?***

There are two possible routes to becoming a Conservation Scientist:

- a postgraduate course in conservation science (preferably two years) including training, practice and research. Close collaboration with practising conservator-restorers and conservation scientists is essential. (An international cooperation in curriculum development facilitated by ICCROM is desirable.)
- On-the-job training as part of a conservation science team and continuous professional development (CPD) by attendance at relevant short courses.

Bologna, 27 November 1999

Invited Experts

Andreas ARNOLD
Institut für Denkmalplege
ETH – Expert Centre
ZÜRICH, Switzerland

Mauro BACCI
I.R.O.E. – CNR
FLORENCE, Italy

Franco CASALI
Università degli Studi di Bologna
Dipartimento di Fisica
BOLOGNA, Italy

A. Elena CHAROLA
Graduate Program in Historic Preservation
University of Pennsylvania
PHILADELPHIA, PA, United States

Oscar CHIANTORE
Università degli Studi di Torino
Dipartimento di Chimica Inorganica, Fisica
Gruppo Materiali Polimerici
TURIN, Italy

Giuseppe CHIAVARI
Università degli Studi di Bologna
Dipartimento di Chimica "G. Ciamician"
BOLOGNA, Italy

Marie-Claude CORBEIL
Canadian Conservation Institute
Analytical Research Laboratory
OTTAWA, Ontario, Canada

Claudio D'AMICO
Università degli Studi di Bologna
Dipartimento Scienze della Terra
e Geologico-Ambientali
BOLOGNA, Italy

René E. DE LA RIE
National Gallery of Art
Scientific Research Department
WASHINGTON, DC, United States

Jose DELGADO RODRIGUES
Laboratorio Nacional de Engenharia
Civil – LNEC
LISBON, Portugal

Eddy DE WITTE
Institut Royal du Patrimoine Artistique
Département scientifique
BRUSSELS, Belgium

France DIJOUD
Centre de Recherche et Restauration
des Musées de France, C2RMF
VERSAILLES, France

Bent ESHOJ
Royal Danish Academy of Fine Art
School of Conservation
COPENHAGEN, Denmark

Vasco FASSINA
Soprintendenza Beni AASS di Venezia
Laboratorio Scientifico della Misericordia
VENICE, Italy

Cesare FIORI
IRTEC – CNR
RAVENNA, Italy

Giovanni E. GIGANTE
Università degli Studi di Roma
"La Sapienza"
Dipartimento di Fisica
ROME, Italy

Frans GRIJZENHOUT
Netherlands Institute for Cultural
Heritage (ICN)
AMSTERDAM, Netherlands

Angelo GUARINO
Consiglio Nazionale delle Ricerche
Progetto Finalizzato Beni Culturali
ROME, Italy

Messaoud HAMIANE
Ministère de l'Enseignement Supérieur et de la recherche scientifique
Université de Boumerdes
Faculté des Sciences de l'Ingénieur
BOUMERDES, Algeria

Judith HOFENK DE GRAAFF
Netherlands Institute for Cultural Heritage
Department of Conservation
AMSTERDAM, Netherlands

Jukka JOKILEHTO
ICCROM Consultant
ROME, Italy

Giorgios KARADEDOS
Aristotle University of Thessaloniki
Department of Architecture
THESSALONIKI, Greece

Gabriela KRIST-MORODER
Universität für Angewandte Kunst
Meisterklasse für Restaurierung und Konservierung
VIENNA, Austria

Marisa LAURENZI TABASSO
ICCROM Consultant
ROME, Italy

Bertrand LAVEDRINE
Centre de recherche pour la conservation des documents graphiques (CRCDG)
PARIS, France

Salvatore LORUSSO
Università degli Studi di Bologna
Dipartimento di. Metodi per la Conservazione dei Beni Culturali
RAVENNA, Italy

Maurizio MARABELLI
Istituto Centrale per il Restauro (ICR)
Laboratorio di Chimica
ROME, Italy

Marco MARTINI
Università degli Studi di Milano-Bicocca
Dipartimento di Scienza dei Materiali
MILAN, Italy

Mauro MATTEINI
Opificio delle Pietre Dure
Laboratori Scientifici
Fortezza da Basso
FLORENCE, Italy

Audrey MATTHEWS
De Montfort University
LEICESTER, England, UK

Mario MILAZZO
Istituto di Fisica Generale Applicata
Cattedra di Metodologie di Fisica per I Beni Culturali
MILAN, Italy

Sadatoshi MIURA
Tokyo National Research Institute of Cultural Properties
Department of Conservation Science
TOKYO, Japan

Alison MURRAY
Queen's University
Art Conservation Program
Department of Art
KINGSTON, Ontario, Canada

Michalis NOMIKOS
Aristotle University of Thessaloniki
Department of Architecture
THESSALONIKI, Greece

Andrew W. ODDY
British Museum
Department of Conservation
LONDON, England, UK

Konstantina PANAGIOTOU
Aristotle University of Thessaloniki
Department of Chemical Engineering
THESSALONIKI, Greece

Renato PANCELLA
Monumental Art International Pancella (MAIP)
MONTREUX, Switzerland

Petros PATIAS
Aristotle University of Thessaloniki
Post Graduate Inter-departmental Course
THESSALONIKI, Greece

Stéphane PENNEC
ECCO
LP3 Conservation
SEMUR EN AUXOIS, France

Clifford A. PRICE
University College London
Institute of Archaeology
Department of Conservation and Museums
LONDON, England, UK

Andreas QUEISSER
EXPERT-CENTER pour la
Conservation du Patrimoine Bâti
Laboratoire de Lausanne – EPFL
LAUSANNE, Switzerland

Raffaella ROSSI MANARESI
Soprintendenza per i Beni Artistici e Storici
BOLOGNA, Italy

Cristina SABBIONI
Istituto ISAO – CNR
BOLOGNA, Italy

Giovanni SCICHILONE
Ministero per i Beni e le Attività Culturali
Ufficio Centrale per i Beni A.A.A. e S.
ROME, Italy

Katriina Similä
ICCROM
Rome, Italy

Stefan SIMON
KDC Konservierung & Denkmalpflege Cons.
OLCHING, Germany

Tej SINGH
National Research Laboratory for
Conservation – NRLC
LUCKNOW, India

Luiz A. C. SOUZA
Universidad Federal de Minas Gerais
Centro de Conservação e Restauração
Bens Culturais Mov. (CECOR)
Escola de Belas Artes
BELO HORIZONTE, Brazil

Alberto de TAGLE
The Getty Conservation Institute
LOS ANGELES, CA, United States

M. Kirby TALLEY, Jr.
St. Petersburg International Center for
Preservation
ST. PETERSBURG, Russian Federation

Akatsuki TAKAHASHI
UNESCO Venice Office
Liaison Office for the Safeguarding of
Venice
VENICE, Italy

Norman H. TENNENT
Netherlands Institute for Cultural Heritage
AMSTERDAM, Netherlands

Agnes TIMAR-BALAZSY
Hungarian National Museum
Faculty of Object Conservation
BUDAPEST, Hungary

Lambertus VAN ZELST
Smithsonian Institution
Center for Materials Research and Education
WASHINGTON, DC, United States

Abdolrasool VATANDOUST
Research Centre for the Conservation
of Cultural Relics (RCCCR)
TEHRAN, Iran (Islamic Republic of)

Rik VOS
Netherlands Institute for Cultural Heritage
AMSTERDAM, Netherlands

Johannes WEBER
Hochschule für angewandte Kunst
Meisterklasse für Restaurierung und
Konservierung
VIENNA, Austria

Rachida ZADEM
Ministère communication/culture
Direction du patrimoine culturel
ALGIERS, Algeria

Who is a Conservation Scientist? What does a Conservation Scientist do? How is a Conservation Scientist trained or educated?

Over 50 representatives from scientific departments of universities, research institutions and conservation-restoration schools from around the world met in Bologna, Italy in November 1999 to discuss these questions and to consider current trends and other related issues.

This publication presents the results of an ICCROM survey on the feasibility of a training curriculum for conservation scientists plus 24 papers highlighting experiences and looking at the issues and challenges from the points of view of

- Universities
- Conservation Scientists from Europe
- Conservation Scientists from North/South America, Asia and Africa
- Specialists in other conservation areas

The seminar also resulted in 'The Bologna Document,' which should serve as the basis for future action in defining the role and profile of Conservation Scientists.