2017 IIC STUDENT & EMERGING CONSERVATOR CONFERENCE

HEAD, HANDS and HEART – Transcript 1 of 3

Session 1, Thursday 12th of October

Head – Scientific Research / Conservation Science and its Application

Moderator: Dr. Giovanna di Pietro

Speakers: Velson Horie, Hannah Flock, Dr. Stefan Brüggerhoff

Opening remarks

Isa von Lenthe: Welcome everybody. Can you hear me? On behalf of the Local Organising Committee it is my big pleasure to welcome all of you here at the Bern University of the Arts. Following on from the successful previous IIC Student and Emerging Conservator Conferences 2011 in London, 2013 in Copenhagen and 2015 in Warsaw, we feel very honoured to host the fourth conference here in Bern. We are very pleased to have this opportunity within our own institution to bring together students and emerging professionals across cultures, and from diverse backgrounds, in order to share our unique personal and professional journeys. In March the existing [Local] Organising Committee asked me if I would like to lead and coordinate the organisation of the event. I immediately said yes, but looking back – I have to be honest – I didn't think of all the work it meant. Through all that time, I had the enormous support of the whole Local Organising Committee and of the IIC, of you Graham, of Jo Kirby Atkinson and of Mikkel Scharff. Within the Local [Organising] Committee we met at least once a week, and with the IIC, once a month via Skype. I really would like to thank all of you for all your support, engagement, patience and power. I would now like to welcome Stefan Wülfert, Head of the Conservation-Restoration Department of the Bern University of the Arts, to the front, for some opening remarks.

Stefan Wülfert: Thank you Isa. There is really nothing as boring as lengthy welcome speeches. So, let me be very short. It is my first duty, and my pleasure, to welcome you at our university called the Bern University of the Arts, or Hochschule der Künste, in German. It's a medium-sized university offering a variety of [disciplines]: Literary and Creative Writing, Theatre and Opera, Music, Fine Arts, Design and Conservation-Restoration; the discipline mentioned last being called Degradation Design by some of my colleagues. Our university is associated to the Bern University of Applied Sciences – the Berner Fachhochschule. It is my second duty and pleasure to thank all the individuals who made this event possible, ranging from a fantastic Local Organisation Committee of very active and very responsible students and colleagues to the inspiring and supporting colleagues from IIC – especially you, Graham, thank you. Many thanks also to all the speakers and contributors. All of you worked so many hours unpaid to prepare this conference. This is great. Last but not least, I would like to say hello to our internal and external conference participants. I'm sure you will contribute to interesting discussions. Thank you very much.

Isa von Lenthe: And now I would like to welcome Sarah Staniforth, the president of the IIC.

Sarah Staniforth: Thank you Isa and just as Stefan said, I won't make a long and boring speech. It's a real pleasure to be back in Bern. It rekindled childhood memories for me, because we used to come on holiday to Switzerland. My father's exhaust fell off his car in Bern, so I've got this memory of trying to find a garage to stick it back on. But also that gave us the opportunity, while this was happening, to walk around the city. I had the good fortune to walk around the city, the old city – the UNESCO World Heritage Site – in the sun this morning. So we're very lucky as the forecast is stunning for the next three days, we're lucky to be here while it's like that. Also, the subject of the conference rekindles Sussex memories for me because in Sussex there is a Pestalozzi village which was founded as an educational charitable trust by Dr. Pestalozzi, who inspires the theme of this conference. As you'll realise, the format is very different from the biennial IIC congresses. Those are – and we've got of course the Turin conference coming up in September next year – they are the format of submitted papers. For Turin we had over 400 abstracts submitted of whom we have selected 50 authors to present. This conference is also very different from the other student conferences. I don't know how many of you have been to the Gerry Hedley symposium in the UK, but that again is presentations of students' works. This conference has developed under the tutelage of Mikkel Scharff, who is the head of the conservation course in the Royal Danish Academy of Fine Arts, to be much more thematic and to explore subjects through the media of our panels and with a lot of contributions from the floor. So, please don't hold back during the discussion periods, as much contribution from the floor as possible will be very welcome. I'd personally like to thank the HKB for hosting this conference, and to Stefan, where has Stefan gone to? Stefan, thank you so much. I know that at times you've stepped in to help coach and mentor the student Local Organising Committee, and also to Mona and Sebastian, who've played your parts as well, so thank you for that. And again Graham and Jo, who isn't here – Jo is in New York at the moment on behalf of IIC – thank you for your parts. I am in awe of your organising abilities and this really bodes well for the future of the conservation profession. The program is fantastic. You have done brilliantly with the sponsors and a very important part for all conferences is getting some additional funding. I mean, that is such an impressive list. So really well done with that. Another thing, which we very often fail to do on the first day of the IIC congresses, is to produce the list of delegates with emails. This is a fantastic document to have and it means we can all keep in touch with each other, so brilliant. It's all being broadcast live. I'm sort of looking over my shoulder, and hopefully there are hundreds of people out there. I hope there are people from the states. I had a meeting with the Winterthur students during the ICOM-CC conference and they're thinking of hosting a future conference in America. So hopefully, they're online. It won't be too early in the morning in the States. It would be fine for them, they're all up anyway. Hello, if you're there, Jo, Joyce. Okay, Isa – I hope you really enjoy the next two days.

Isa von Lenthe: Thank you very much Sarah. Before starting with the first session, I would like to introduce to you the Local Organising Committee, very shortly. So please, if you have any questions during the next two-and-a-half days, just come to any of us. We'll be happy to help. For the budget and sponsoring: Anna and Moritz. For the topic of the sessions: Isabelle, Kamilla and Theresa. For the IT, the web broadcasts: Moritz, Raphael and Ralph. For the catering: Elena. For the visits: Kamilla and Eva. For all the PR, logo and design work: Theresa and Moritz. And after the conference, for the transcription of the sessions: Eva and Anne. Thank you. As Sarah has

already said, the conference is going to be broadcasted live – it already is – so that means that questions from hopefully all over the world can be made on the blog of our website, in our Facebook group or via Twitter, linking us. The questions or comments will then be addressed to the speakers and to you, the audience. Now I would like to start with the first session and I'd like to ask Isabelle to come forward.

Isabelle Rippmann: Hello everybody, welcome to Bern and to the conference, also from me. I am Isabelle, also a student here and from the Local Organisation [Committee]. Before we start with the first session [titled] Head – Scientific Research and Conservation Science and it's Application I will shortly give you some organisational information. After this session, which ends at 4 o'clock, we will have a coffee break of half an hour. At half past four we will start with a guided tour through the studios. These tours are optional. So that we know who and how many of you are joining us for the tours, we would like you to fill in the lists we pass through now, Meret is passing them on. The meeting point for the tours will be in front of the elevator in the middle of the corridor with the Silver Lining lights on the ceiling, when you go out and turn right you will find them. After the visits in the studios, we will start with an evening reception at around 6 pm. Now I would like to you to introduce the moderator Giovanna di Pietro. Giovanna di Pietro has a PhD in physical chemistry and is a lecturer at the University of the Arts here in Bern. In addition to teaching, she's also an engaged researcher in conservation science and has taken part in projects in the Netherlands, in Australia and in Switzerland.

Giovanna di Pietro: Thank you very much, Isabelle. So actually before starting, I would like [to say that] there are still some chairs free, so if there is anybody in room 111 and 115, please don't be afraid to disturb, you can come here and fill the last places if you are there. It's quite tricky because they see us but we don't see them. It is really a great honour for me to chair a session of a conference which is organised and led by the students. This is really wonderful – especially a session on conservation science which has been identified as the 'head' of our conservation practice. This session will be organised [as follows]. There are three speakers and each of the speakers is going to speak for about 15 minutes and will answer one question that the committee has posed, so [the committee] has designed these questions. After the talks there will be plenty of time, about one and a half hour, to discuss and ask questions. I know that for many of us it is difficult to ask questions. It is difficult to be visible, to raise your hand and to speak in English. In this case, there is the technology which can help us, so also for the people here you can Twitter your questions and they will speak them aloud. You can Twitter your question anonymously or with nicknames, and if you don't have a smartphone, you can write them on a piece of paper and they will also be read aloud. Otherwise, of course, it is wonderful if you want to speak. I will now invite our first speaker. The first speaker is Velson Horie. Velson Horie is trained both in chemistry, at the Bristol University, and is also an archaeological conservator. He has worked as an archeological conservator in the North of England and then has been for 28 years Keeper of Conservation at the Manchester Museum and then research project manager at the British Library. He has about 80 publications and books – you might know the famous [book] Materials for Conservation. He will talk about the question, "What is the value of research and science in conservation-restoration?"

What is the value of research and science in conservation-restoration? Why has it become irreplaceable?

Velson Horie: "What are the drivers of scientific development of conservation and its practice?" [This] is how I have rewritten the question. A few weeks ago, I was discussing with a neighbour about diesel cars, petrol cars, and pollution. Five years ago I followed government advice and I bought a diesel engine car. That was the advice, that they are better for the conservation of the environment. My neighbour said that he stood behind a diesel car, smelled the exhaust, and knew everything he needed to know about the pollution. He didn't buy one. His senses proved far more valuable and far more useful than my logical thinking about what I had been told to do. I should have known better. Years ago, I used to do inspections of museum [storages], I would do a trip around the storage, occasionally. Before I'd go into the room, I would open the door, and not switch the lights on. I would go in and smell the room. I could smell if something was wrong, and even make a really good guess as to what was wrong, by the smell, before I would look into it. So the senses are really important.

So, a parable about iron. Archaeology has been active in northern Europe for some centuries, a couple hundred years. Although we have examples of pottery, bronze and even some organic objects, we don't have much iron left – very few iron objects survived. The conservation of archaeological iron provides a good clue about what could go wrong in conservation theory and practice. In the end, it's a success story, but it's been a long trail getting there. One of the first conservation jobs I had in the 70s was dealing with some archaeological iron which had been sitting in a museum storage cabinet for about 20 years. [The objects] were mostly collapsed to rust, small fragments. Now I had just been trained – I was an emerging conservator – so I used the techniques I had been taught. What I had been taught was to soak the iron in water to [dissolve out] the chloride ions. I had just come from chemistry, I thought I'd improve on this. I would circulate the hot water through a deioniser, to remove the chloride ions even more quickly. It was amazing how quickly those objects fell to bits, really staggeringly quick. I had forgotten what I knew as a child. If you make iron wet, it rusts. The people who invented the process had forgotten that if you make iron wet, it rusts. The people who taught me had [also forgotten]. Just because you are told it works, doesn't not mean it's true. In 1882 Krause discovered the corrosion mechanism of archaeological iron; chloride ions get in and the iron starts corroding. This proved to be correct, and therefore the idea [emerged] that if the chloride ions start the corroding [process], and if you wash them out, it will stop the corrosion. So, people did this. By 1900, it was known that this did not work. By 1900 it was known that impregnation and coating of the iron objects did not work. There were plenty of examples – Rathgen published this in 1900 – [originally] in 1895 and then in the English translation – he said that if you keep the metal dry, [the objects] will survive. But conservators didn't do that. They got more and more elaborate as I did, [inventing] more elaborate ways washing, coating, putting graphite in polyvinyl acetate to stop the water going in, which it didn't. The next leap forward came in 1982. Turgoose showed that if you keep archeological iron dry, it will not corrode. We've been there before, but never mind. Specifically, he showed that if you keep the iron chloride contamination below 20% RH, the chloride catalysed corrosion reactions will stop. So, being a good and inventive conservator, I went out and bought dehumidifiers and constructed a [storage] for archaeological metal works with a dehumidifier. I persuaded all the archaeologists to put all their metal [objects] into it. It took a lot of work, because they are just

not used to putting all their metal into one place, and all the organic [objects] into another. It was really unpleasant to work in 20% RH, really unpleasant. Anyway, they did it. You will not be surprised that this did not work very well. All the hydrated iron corrosion products and the mud shrank and cracked – [pulled] the objects a bit – and exposed an extremely reactive components to the air which they hadn't seen before. By focusing on one component of the object, one neglects others. Once again, we neglected the obvious observation. The iron objects you find in the ground have stopped corroding. If you keep them there, they will not corrode. If you put them in the storage and dry them out, they will start corroding. We now know that corrosion is kept best achieved by keeping the conditions in which they are found. Forcing change forces damage, usually. So that's my first cautionary tale. All based in science, mind you.

Some decades ago, I started a research project on the degradation and conservation of cellulose nitrate film, with the Manchester Metropolitan University and the British Film Institute. Typically, around then, cellulose nitrate cinema film was copied onto cellulose acetate film, and then destroyed. I didn't approve of destroying works of art, but that was the normal practice. Jonathan Ashely-Smith thinks that there is a limited life on [these] objects, and therefore the destruction is ok. I didn't approve, so I initiated the project. Within four months the focus of the project changed. The British Film Institute came back to us and said that cellulose acetate was degrading faster than cellulose nitrate. The science behind the use of cellulose acetate, as an archival material, was based on research at the Eastman Kodak from the 1930s to the 1960s. Specimens of processed cellulose acetate film were [placed] in Pyrex tubes at various temperature and humidity conditions, and aged, or incubated them for a while. Then they took the [samples] out and measured their molecular weight change. By extrapolating from the room temperature, they could say confidently that the cellulose acetate would remain, as an archival material, for at least 300 years. So, the film archivists would copy things onto cellulose acetate and the paper archivists laminated things with cellulose acetate film. It was done on a very large scale across the world. But in reality, cellulose acetate films and paper laminated films degraded within about 15 years. The cellulose acetate hydrolyses, producing acetic acid – called the vinegar syndrome – that changes from cellulose acetate to cellulose. The plasticiser is no longer soluble in the cellulose acetate, so it [exudes] out and forms a sticky liquid on the surface. The gelatin emulsion breaks down and peels off the surface. All this happens with reel films, in reel archives, wound onto metal reels in metal cans. The acetic acid evaporates from the film, reacts with the iron, dissolves the iron which dissolves in the cellulose acetate, [leading] to a really rapid oxidative degradation. A real mess, completely unpredicted by the scientists and their research.

So, what's the role of science in conservation? As someone trained in chemistry, it was interesting being responsible for the conservation of natural history specimens at The Manchester Museum. We had about five million objects, of which three quarters were natural history specimens. I was trained in the hard sciences, like chemistry and physics. They start from known starting points and play with those building blocks building new structures with them. Natural history works the other way around. It takes a real object, extracts information from the object and then tries to fit this new information into a new explanatory model. This information could be in the shape of flowers, the amount of DNA, the age of the collection, DDT, etc. The model constructed depends on the information chosen to study, then extracted and put together in a model.

The objects we have in conservation are filled with unknowns. The unknown original composition, unknown original structure, unknown conditions of storage, unknown deterioration, unknown synergy between all those various things reacting together to reach the present state. So, it's [the conservator's] job understand all those unknowns, to understand the object. Western science has made enormous advances by reducing a problem full of unknowns to a series of more or less disconnected problems and solving these problems. These component problems are then researched, so the solutions can be added together, providing a total solution for the object. This [methodology] works only if you know what the unknowns are. [You would need to] identify all the significant unknowns and provide a solution to each, establish the synergistic interaction between [the unknowns] and predict correctly the changes over time. It is well known that with only three billiard balls moving on a billiard table after about six or eight collisions it becomes impossible to predict what the output is going to be in detail, or in total; it's chaotic. As conservators, the objects we are dealing with have far more than three variables. There's no way we could predict what the outcomes are going to be. The common response, particularly of the outcome in a chaotic situation, is intuition – derived from experience and tradition. Weather forecasting is a good example. We have a saying Britain, "Red sky at night, shepherd's delight," which means it's going to be dry the next day. Now, weather forecasting has [developed] quite a bit since then. We now have huge supermodels in which they include as many unknowns as possible – which they can manage in about two weeks. Just to compare with how long the lifetime of our objects is – slightly more than two weeks.

So, how can we harness both science and intuition? We have excellent examples of failures and successes in conservation. The starting point of conservation research should be the object. Preliminary investigation should be done to be able to discover what those aspects are, internal or external, that cause the damage. To a large extent, this results from experience and intuition. Initially it is very difficult to predict what the significant aspects are going to be, amongst all the various unknowns that you don't know are in there. Conservators have an enormous amount of experience of the state of objects and the potential causes of damage – and most of this is unpublished. When you talk with [conservators] over coffee, with people who have been dealing with museum collections for years, and they will tell you, "I think it is […]." And it's never been published, never been written down. But, eventually, it rises to the surface. Someone has to identify a problem, and crucially, has to have a hunch on what data to gather. Going back to Natural History, you have to choose the data that you are going to study. There is an infinite amount of data to choose from and someone has to say, "Let's have a look at that." Epidemiology is a relatively new science of correlating environmental factors with changes, i.e. capturing the insight that someone has had and then quantifying it. These observations and correlations are frequently made long before a causal link is made between the cause and the effect. Going back to Krause, he identified the cause and the effect, but that was only a part of it. Conservators are accumulating vast amounts of data in treatment reports of objects. But conservators are notoriously unable to share this data. Despite many years and much cash devoted to disconnected efforts, conservators are still unable to agree even on the terminology of object descriptions and change [that has occurred]. No field, no science, can pretend to progress unless you have an agreed terminology. Only then can you share the information, the insights, the detail.

We have an enormous amount of big data, but we don't use it. Big data is the way that things are being pushed forward in many other fields where there is great complexity. Some conservation researchers are embracing that complexity in conservation. And that's what you individuals gain over your career; you get the big data and integrate it in you brain. It has got to come out. So, who is going to do this scientific research? Science doesn't give any answers which is one of the big complaint that real scientists have. Science is rather a curiosity that asks more detailed questions – better questions. Science can and has been done by anyone who "systematically builds and organises knowledge as testable explanations and predictions, i.e. questions." This definition includes any competent conservator. Any conservator who does not do this is not a competent conservator. Conservation results from a combination of applied material science and judgements on the significance of the object. The conservator uses science to gather the required knowledge, understand the unknowns, then applies these to make value judgements – they are all value judgements, we can't make a certain judgement – for the object's conservation. This means that it's the conservator who must take responsibility for defining the initial questions, and to ensure that any scientific input results in better questions. The necessary understanding of the underlying physical properties of the object, the reactivity of the materials and any other relevant issues that go around it, is considerable, as must be the explicit acknowledgement and humility about ignorance we have when addressing these questions. And still, we're going to make a value judgement in the end of it. Science is a tool, a powerful tool, whose potential limitations must be understood before being applied. By extension, a scientist is also a tool of the conservator's trade. I use scientists in the same way I'd use accountants or architects, to address a problem, to solve a problem, and come up with potential questions that I can then make a judgement about. You have got to control those influences like you would any other tool, be it a hammer or an accountant. So, the answer to the question, "Who will do this scientific research?" is the conservator. Of course, you can delegate some tasks and activities, but you cannot delegate responsibility. As with all tools, one has to choose the most appropriate one and get the best one can afford, so you get the best scientist you can afford. And how do you choose them?
This means that conservators have a considerable understanding of both the initial question and likely outputs of the research. The best scientists are really good scientists because they study their own field very thoroughly and will have little or no connection with conservation, or its questions. In my experience, there has to be a considerable – months or years worth of training – of scientists in the conservation questions, as for conservators in scientific questions and methodologies. They are different, they ask different kinds of questions, they want different kinds of answers. Both need to understand the parameters and limits of the outputs of their research.
The amount of conservation scientists is growing – their role is debatable. A conservation scientist should be a scientist who is an expert in their own field. The second [important feature] of a conservation scientist is that they are a babblefish – they can translate to conservation science and back again. But that really is the job of a competent conservator. A conservator should be able to make those translations in order to make use of that science, as well as all the other intangible significance of the object – that's the role of the conservator.

Scientific research is organised typically in three year cycles, with a significant output of it at the end of each stage. The best conservation study I know of was started by the British Museum – now the British Library – in the early 1930s. It was on how to choose the most appropriate leather for binding old books. The project lasted into the 1960s. Just about everyone who had started the project had died at that point, [resulting in] a really good set of

insights and recommendations. The research project I worked on at the British Library was to study the state and natural ageing of books since the 20th century. I made sure that by the end of the project we had a really good baseline knowledge of those books that we studied – 700 books – that could be used for decades or in the century to come, to follow the state of those books. The research has not been finished. The money had run out, but the research project had not been finished. Objects and conservators' priorities are centuries long.

Research should be carried out on the objects. Model objects and results are just that, models. They are not reality. It is always necessary to go back to the object, with the next step being the application of the research findings on real objects. Why not start with real objects? Then you get the outputs that are real, and can be applied to the reality we are dealing with. So, coming back to the title, the focus of this conference, "Where do we make decisions?" According to Wikipedia which, as you know, is the fountain of all knowledge, rational conscious processes use about 5% of the brain. And about 40% of the body's neurological processing power is in the gut. Having watched children, and myself, grow up and learn, I think the one that starts is the heart, which chooses – and is reinforced by – a multitude of sensory inputs. It is these that drive most of our choices. Finally, the 5% comes along and tries to justify the choices we already made. The trick of good conservation research is to acknowledge and build upon these subconscious influences. Then you are going to learn how to evaluate and edit their conclusions.

Giovanna di Pietro: Thank you very much, Velson, for your summary of the failures and limitations of conservation science. I would like, first of all, to check with the public if you can listen, if it was loud enough, clear enough? Everything is okay? So, I encourage then the speakers to talk closer to the microphone, please. Our next speaker is Hannah Flock. So, Hannah Flock is a paintings conservator who wrote her master's thesis on tear mending of paintings and she is currently a PhD candidate of the University of Technology, Arts and Sciences in Cologne and she collaborates with the chair in Engineering Mechanics of the University of Saarland in Saarbrücken. She will talk about the question, "When and in which context are the results of scientific analysis and research applied in conservation?"

When and in which context are the results of scientific analysis and research applied in conservation?

Hannah Flock: Okay, Great. Thank you for your introduction and I'm very happy to be here. Of course I'm not going to answer the question, "When and in which context are the results of scientific analysis and research applied in conservation?" I'm going to talk about some [of my] thoughts. The application of scientific research and conservation of artworks is wide, of course, and regarding the analytical investigation of the artworks, as well as the technological developments for conservation treatments, we do not tap the full potential. For every conservation and restoration procedure conservators need hard facts to work with. For the best decisions in our concepts we have to know first the material properties of the artwork and the individual requirements of the objects, like the characteristics, material, condition, and the dimensions of the artwork. Secondly, the properties of the conservation material, and the third [point] is the interaction between both, especially during ageing. For the

best decisions, let's say also the best compromises – and we all know what I'm talking about – we need reliable data. When we compare the analysis of the material of the artworks and the testing of materials and methods used during the conservation procedures, we compare apples with oranges. They're uneven twins. However, we need both of them to understand what we have in order to do forward-looking planning, to guarantee that we act responsibly, and assure conservation in the way of ethical correctness. Scientific working is kind of the counterpart of empiric working. It is the attempt to find more general rules and knowledge by using standardised methods. The aim is to generate reproducible statements. Empirical conclusions, repeated in a row, can show a pattern which tempts us to define general rules. But the way we generated this kind of assumed data is not safe and trustworthy. To be honest, it's only a case study. In contrast, to work in a scientific way means working methodically, systematically. Conclusions are objective. They are based on comprehensible studies and their data are obtained by reproducible experiments. Scientific working is not a case study. Furthermore, it provides objective data for different case studies. So, we reduce the risk of trial and error. The field of application is wide and therefore it is clear that the methods for scientific analysis and research are various. We need to think about the technological investigation of our artwork by analysing, for example, materials and compounds with archaeometrical analysis, such as FTIR. Additionally, comparative studies, especially literature, are usually the first step of a scientific approach. I come from the field of material testing to answer questions [specifically] concerning practical conservation and restoration treatments. The idea is always to learn more about our objects and understand the materials we use. We want to evaluate materials, technical relations and long-term behaviour. This includes first, the object itself and second, the materials we are going to use within our treatments. Or third, the whole new composition of both, before starting our hands-on job. We want to prove a forward-looking cause of action, so most of the time we use scientific analysis and research to do basic fundamental research. We generate objective data which is comparable to different case studies. For the field of material testing this means proceeding from case studies to general questions. This way of working is of course much more elaborate, and due to this fact, more time-consuming then a quick case study or conclusion based on incomplete insights. As working conservators in our workshops, we tend to say, “I saw this kind of object very often. I know the materials that were used and how they react. I also saw this kind of damage very often, so probably up to my experience, this or that treatment with this, or that kind of material, will work out.” But that is empiric working. Scientific working would be, “I have an object with a special question. I try to abstract that kind of question, generate reliable objective and transferable data, and then finally, come back to my case study.” So, material testing is specifically used to answer questions about the quality of planned treatments, or to understand the behaviour of the objects themselves. To do a kind of forecast, in contrast to empiric hypothesis. I will give you a few examples. Think about any kind of treatment, the consolidation of a paint layer, or the tear repair on a canvas with an adhesive. By material testing we have the opportunity to evaluate the behaviour of our object and its requirements. Furthermore, we can evaluate the properties of materials and treatment techniques. We can produce standardised samples and compare the mechanical behaviour of different textiles, different ground, or paint layers. We can show how they react under special climate conditions, or changes during transport, or just their long time behaviour and ageing, and many more. We can reenact almost every question we could think about for our object but we do not work on real objects. We work with standardised samples which allow us to generate reliable results and do not harm any artworks. In that way we are able to define the precise differences in the properties, for

example, of acrylic paint compared to oil paint layers. What does the consolidation of our paint layer require of you [based on] these general rules? We can compare the interaction of our consolidants or adhesives in the context of our treatment. But we can also compare pure materials. For example, is sturgeon glue really more flexible compared to other animal glues? Or, is an acrylic dispersion really more soft compared to a PVAC? Do these adhesives keep their properties in general, or how much do they depend on the treatment and technique? Material testing in general [comprises] different testing procedures to prove the properties and characteristics of different materials, by working with standardised samples, or elements, under mechanical, thermal and chemical exposure. As a function of the testing method we distinguish destructive and non-destructive techniques. In conservation and restoration science we often use archaeometrical analysis, or mechanical material testing for the characterisation of materials – their structure, physical and mechanical properties, the degree of alteration or ageing – as well as the simulation of treatments – consolidation, bonding, filling, etc. – by using dummy samples or other representative material samples. The main aim is to understand the object and our treatments, characterise them by this kind of forecast, to minimise risks and optimise the result – or to evaluate and compare them, in general. We do not need too much equipment to fulfil this aim of a scientific approach. Not every conservator has testing machines for tensile tearing, shear, peel, compression or bending tests. Not every conservator needs to do ageing tests on conservation materials before using them, evaluate the materials, or understand the object and its technical composition to the core, and so on. But everyone can keep the idea of scientific versus empiric working in their mind. Ask the right questions and look for sources where, and how, we can find answers. That is why it is so important that some others do this kind of basic fundamental research. Especially material testing is quite underrepresented in conservation literature and [current] research fields. However, we need to professionalise. We need to cooperate with other disciplines, like physics or chemistry. We have lots of documented case studies, we have lots of empiric conclusions, but we need scientific truths for deeper understanding. Scientific analyses and research like material testing is not the answer to all of our questions. Of course, we still need case studies and the feeling for every individual art work. But we want to establish our profession as conservation science. We need to confine us from craft. We still need to develop. We are not out of the woods yet. This is why we should ask ourselves more often, “How can we improve by using scientific analysers and research to enhance the conservation practice?”

Giovanna di Pietro: Thank you very much Hannah, for these insights in the field of material testing and faith in scientific truth. Let's now proceed to the last speaker who is Stefan Brüggerhoff. Stefan Brüggerhoff has a PhD in analytical chemistry and is the director of the Mining Museum in Bochum, Germany. And also, since 2013, professor of conservation-restoration at the University of Applied Sciences for Engineering and Economics in Berlin. His field of research is material science in conservation of ancient monuments, especially under the influence of environmental impact and testing of conservation media for iron and steel, as well as for elastomers and plastic. He will talk about which requirements are needed for a conservator to become a conservation scientist.

Which requirements are needed for a conservator to become a conservation scientist?

Stefan Brüggerhoff: Thank you Giovanna for this kind introduction. Thanks to the people here, to all the people here listening and especially to the people organising the conference. I think my talk will be much shorter than both of yours because a little bit everything is done. Everything is talked about now. Give me a short chance to reply to both talks, after 32 years of experience on the job. Now as a director of the museum starting as a PhD young researcher, coming from analytical chemistry with no idea of conservation and entering into a laboratory which is dealing with conservation of building materials. So, as Velson said, conservators and conservation scientists, there is a big difference. Especially in 1985, you had conservation scientists coming from physics, from chemistry, from engineering, talking with restorers and conservators and, in many cases, without understanding each other. The one is telling something about his object, the other – as Velson said – is talking about his method, about his, let's say, his model. In many cases you get an answer for the conservator that is not really an answer to the question that he has. But it was a question about the technique applied to the problem. I think this has changed a lot. But of course, there is still a problem. And now I'm coming to my question, "Which requirements are needed for a conservator to become a conservation scientist?" So the first thing I have to do is really to define what is a conservation scientist? Is it a scientist doing conservation work? Or is it a scientist from another discipline helping conservators to answer questions coming from conservation? Maybe it seems to be the same, but it is not the same. It's still a big discussion also in the field. If you talk to the different disciplines, or to the people coming from chemistry, physics or engineering, they feel like specialists in their techniques – as, let's say, the real scientists – giving an answer to the conservators with a question that these conservators can explain coming from the object. And for me it's now a first step – Hannah is a very good example for this – that we have an exchange between both disciplines. So, a conservator is dealing more and more with a special topic of, I think it's mechanics. Now, you will become a specialist who is able to, not to answer a question, but to be the one who can [ask] the question, and now, what is really the content of the question. And this is for me the main thing with regard to answering this question. How to come from a conservator to conservation scientist. There is a need to understand the problem of the object and I fully accept what Velson said, that this is the most important thing. The conservator knows his object. The conservator knows the problem. The natural scientist can answer questions, which are given in [the following] way, "Please analyse this sample" or "Please analyse it, give me mechanical parameters." But translating these results to the question of the object is again the task of the conservator – of the competent conservator. So nowadays [what] I'm trying to do in my professorship at the University of Applied Sciences in Berlin, is to train this. Conservators which are really willing to become specialists in special techniques. That they are able, on the one hand, to understand their objects and on the other hand, to understand the techniques. So maybe they do not need these translations, these explanations, which is so very important, between both. [What] I have seen in my career, was in many cases the link, really the deep hole, that causes a lot of failure in the different cooperations of both. So, going from a conservator to [becoming] a competent conservator, and then maybe [becoming] a conservation scientist is really to be specialists in those fields. A specialist in understanding the object, understanding the individual aspect of the object. And on the other hand, to understand the techniques, to understand the models, to understand the restrictions of these models and thus to

find a solution really for the object, a solution which may improve some techniques for the next step. To understand that this improvement is still something which is based on a model and has to in [work] in reality. That's it, thank you.

Giovanna di Pietro: Thank you very much, Stefan. So now it's time for the discussion and questions. Of course, I've done my diligent work of preparing questions to the speaker, but I invite you to ask questions and this is really your conference, students. I know that we all spend lots of time studying science and this is really the possibility, the opportunity to ask whatever you want to ask about conservation science. Also, not related to the topics have been presented. If you have further questions or if you want to give comments, please speak up, [tweet], or send a post on our blog and we have directly a question.

Eleonore Bernard: So I have a question. I think that conservation science and applied conservation science come together very nicely, maybe even easily, when you have the case study focus, when you have material analysis of a specific object that helps you to understand the object better as a conservator and find maybe a more adequate treatment, or just understand what the damage is. So I think that is very clear. My question for you is, “How do you reunite the more abstract, or at least a standardised method, of finding conservation science treatments within the always unique and non-standardised realities of objects that are not models?” That I think is my question maybe.

Giovanna di Pietro: Thank you very much, Eleonore. That was really the contradiction we saw in the different talks between the individuality of the objects and the general validity of models, lets say, or the striving for the general validity of models. So who would like to respond to this question?

Velson Horie: We construct models in our heads all the time about what our treatments are going to be. We then apply those treatments, or have seen them applied, to objects in the past. We then we revise our models over time. And that process of improvement is part of the process we have to go through which means there will be failures. Science learns a lot by the outliers, the ones that don't fit the models. And those are the things that we need to concentrate on in order to improve our treatments. There will be plenty of situations where apparently success has been achieved but we have to concentrate on the failures and learn from those. The medical analogy is quite good for conservation. Doctors kill patients all the time, and they learn from that. We've got to learn from our failures even better than they do. Because we will have failures and that is how we will learn.

Stefan Brüggerhoff: Maybe just to add, it is not black or white. It is something in-between. So what is said is that you need some information of modelling, but don't believe that this is reality. So take it, take the thing with skepticism, but take it because you get some answers. It's difficult, it doesn't help you to say, “Oh, I can not apply this kind of testing.” I would say this is the task of a competent conservator to understand how far from his reality his model is, and if you are able to really apply it in your mind, then you are on the right way.

Hannah Flock: I could try to add something, but I think it has already come out quite clear. I tried to show in my speech that of course material testing, and those abstract models, are not the [answer] to everything, we need case studies, but we need the other part as well. Because all we learn from the objects is empirical and we need to find those patterns, really true patterns in believable data, that is working scientifically. Of course you can be a great conservator just by experience over years and you have totally the right feeling for all things that are going on with the objects. But then, you don't realise that you are asking those questions, meanwhile you are already doing it in your head. That is what I've tried to explain.

Giovanna di Pietro: I would also like to ask the public what do you think about models? Do you think they are just abstract, useless, something you need to learn in school and then never use again, or do you have experiences or successes of [applying] scientific models to your practice? You can also [tweet] the answer.

Velson Horie: One of the things we put together for the UK accreditation system is reflectance, a reflecting conservator. So whenever you do something, learn – just as I explained from my experience with the exhaust system – you have to learn from your experience, reflect upon it, think what you did right and what you did wrong or what you did right, but what could be better. The reflectance on practice is really important and going back to your point about what an individual conservator has learnt. I think we must grow beyond the individual conservator, we must be a profession and professions are more than just a lump of individuals.

Giovanna di Pietro: So staying with reflection, what do you feel? Do you feel we have enough practice of reflection during your education? Do you think you have the possibility to reflect on the scientific successes or failures you have in your practice?

Piotr Popławski: Hello, my name is Piotr Popławski, I'm from the Academy of Fine Arts in Warsaw. I want to answer the question from before, “Do we need models?” I think we need to start with something, so at first the model may not be perfect, but after that, thanks to our experience, we can go on and learn more, but but we need to start from somewhere. So we need some models, I think.

Giovanna di Pietro: So models do not completely describe the reality actually, but they just give directions.

Piotr Popławski: They help to understand something, I think.

Giovanna di Pietro: Do you have a practical experience? So would you like to share a story where you found it was useful for you to have a model?

Piotr Popławski: I think I can try during the lunch break, thank you so much.

Mariana Escamilla Martinez: Hi, thank you very much for your presentations, I found them very interesting. Well, I think answering to your question about scientific models, samples for analysis – I think they are a necessity for us to establish a base knowledge, to enable us to compare treatments or compare materials. For my master thesis I am comparing solvents. I am going to do hard core immersion tests on paint samples and of course it does not compare to a real technique or method which a conservator would use with solvents. It's only a base for us to understand and compare these different solvents, which are more aggressive ones etc. So I think scientific sampling is a good basis and a necessity for conservators which should always be made, that's my opinion on that question. I would also like to ask the speakers something. I was thinking, as you were saying, science and conservation need to be together. And I was wondering how to unite both of these topics in one program, during the studies. Because sometimes I feel a little overwhelmed of all the things I have to learn practically as a conservator. How to retouch perfectly, how to do tear mending, everything, and then on the other hand I also have to know how to work with FTIR, how to use a microscope, how to analyse materials, how to interpret curves and data and peaks. I find it really interesting and I think it's necessary, but the question is how is it possible to join all of this and make it perfect on both parts – the practical part and the scientific part?

Giovanna di Pietro: Yeah excellent, so this is really I think a question for Stefan who was expecting you to be competent scientists and competent conservators at the same time. So what would you answer?

Stefan Brüggerhoff: I think the only thing to get to this point you address, is to focus. If you want to be a broadly working conservator, it is impossible for you to be a specialist in conservation science. So I feel this is the most important difference. If you nowadays go into natural science you will do a PhD and work in a very, very special field. How can you combine conservation and science? I will always say conservation is also a science. So if you want to be a conservation scientist, you will not be able to do this in detail in each field and to have hand skills in a way. So I feel there must be a broad education and then a decision. I think 80-90% will go to the market and maybe 10% will look for a further development in the field of conservation science.

Jonas Roters: My name is Jonas Roters, I'm from Dresden, in Germany, in the East in a Valley. It's called the valley of the people that know nothing, years before. But I think my question isn't so stupid, it's more general. The second question is written here, which requirements are needed for a conservator to become a conservation scientist. I am a little bit confused, because we are in the year 2017 and it's about the words conservation scientists. What are you now, a scientist in conservation or a conservation scientist? Because I studied and I'm ready now and I feel like a conservation scientist. I'm not a scientist in conservation. So I'm absolutely confused about this question. Did you understand me?

Giovanna di Pietro: I would like to say something. So, Carl Sagan, who is an American astronomer, you might not have followed, but he wrote many books, he is a popular scientist and said there is no such thing as a stupid question. So I invite every one to ask whatever.

Jonas Roters: I know, it was a joke.

Stefan Brüggerhoff: So first of all I have to apologise. I was given this question, this is not done by me and I really agree with you, I think you are a conservation scientist. But if we look in a special way at what we have discussed now, that you have some specialists who deal with natural scientific techniques in conservation science, which are very, very detailed and with a lot of different knowledge in this. There is a difference between these scientists and the conservator, who is also a scientist, but a scientist dealing with his object. There is a difference between those.

Jonas Roters: But the question we discussed now was which requirements are needed for a conservator to become a scientist in conservation and this is not impossible. It's the same thing you just told us two minutes ago. I wanted to clarify this, that there is a big difference and I think restorers should not try to be something they can not be. Also with [regard] to professionalism, I think.

Hannah Flock: I would like to add something to this. Of course, we have this full program in our studies and it is of course, it can be possible to focus on a special question and then to ask the right further questions and do cooperations with chemistry, physics, engineers, to go deeper into a topic. You don't need to do it, but I can recommend it, because you will understand so much more. We shouldn't think that we need to become perfect in chemistry and physics, because of course our focus is conservation, but in case you have a special question you should think about the other fields which could help you.

Velson Horie: The wonderful thing about people is that they do more than one thing. On some days I'm a conservator, some days I'm a conservation scientist, sometimes I'm a treasurer of IIC, sometimes I'm a teacher and occasionally I'm all of those three things at the same moment. But usually, in order to achieve things properly, I specialise in one of those aspects at one time. So I can be a conservation scientist on Tuesday and the next day I'm a conservator. I will use what I've done from conservation science, from me and the people around me, to apply to conservation. It's a different thing I'm doing. But it all combines to the whole.

Giovanna di Pietro: So I felt in this question of Mariana this burden. And Jonas, what you said, we can't be what we are not. So we don't want to be a scientist, we want to be a conservator. And I heard in your voice this burden of the amount of, expectations there are about being such good scientist.

Elena Manco: I am Elena, from the HKB in Bern, I have a comment. I agree with what you are saying, Velson Horie, I think it's the beauty of our job that we can do all of these things together and we know all of these different skills and I think, it is why I have chosen this job, because we have to know a lot of things and we learn every day something more.

Naïma Gutknecht: Naïma Gutknecht from Neuchâtel University of Applied Sciences. My question is related to the formation we are doing. I'm in the second year master and this year, for the common courses with the other schools, we have to do a research project. For our master's thesis we are asked to do some research as well. The students are often not sure where our limit is when it comes to the sciences. It's actually difficult because during

the studies we are really pushed to our limits, and when it comes to the master's thesis, we don't know when we can say, "Okay, I can't do that, it's not my field" or when we have to fill the lack ourselves. It's really difficult as a student to know when it is not our field or when we have to do that. I would like to know what your opinion is about that, when we should stop with sciences and ask someone else, or when we have to do it ourselves.

Giovanna di Pietro: Very important, so when is it important to have a dialog with scientist and when it is important to master the techniques or the modelling yourselves, right? So what is your experience?

Hannah Flock: Yes, of course I was also pushed to my limits during my master's when I realised I wanted to go deeper into a topic and I needed the help of engineers, in that case. And that is totally fine, it's not that we all need to do it all by yourself, but you need to ask the right questions and think about where you can find the help you need and then of course, by applying this method you will learn something and go deeper into a topic which would actually not happen in your general studies. So that's the point and that's what I tried to say in my speech. That we don't need to do this kind of basic fundamental research all on our own. But if you need people to do it and in case you don't understand what they are doing, you need to ask them. The most important thing is to ask the right questions and not to focus on the empirical case studies and to think, 'oh ,there is a limit' and that's it.

Stefan Brüggerhoff: Just a short addition. I always tell my students when they are very proud or enthusiastic that they are doing research now, to be able to understand which question you would ask a specialist. Then you have done perfect research, then if you have then the time to accompany the specialist, to understand what he is doing maybe to do some first tests. In the meantime to understand how much time is necessary for this and not to be enthusiastic and to say, "Now I have three months and it is impossible to do the research." Understanding what the specialists are doing and being able to translate the results into your own question, this is important. The next step is really to get a specialist, but I think this is a real step for a PhD work or even more.

Giovanna di Pietro: So, do you think you now have an idea about when to ask a scientist for help? Kind of, right? I have also noticed in this interaction between the scientist and conservators that very often the scientists dominate. Because science is the dominant paradigm in our society. So I would really like to ask the conservators here, or the speaker on the podium, which are the suggestions to keep your priority as a conservator in the dialogue with scientists; how to do this while keeping your priorities?

Agnès Gelbert Miermon: Hello, I am Agnès Gelbert from Neuchâtel, I am the coordinator from the research team. This is just a remark answering your question. I am coordinating a team where we are trying very hard to make applied research. In the team most of the researchers are scientists. It is very difficult to find conservators who want to get involved in the research. And for me, it's a call to the students, even if you don't want to become conservator scientist, it's very important for the scientists to have conservators involved in the research, otherwise we cannot make really useful applied research for you.

Velson Horie: I've found that who controls the money controls the priorities. The conservator who gets the grant for a good question that has got support from the external examiners, is given the money and then has the control of any science that is happening as long as one keeps the focus on that question as it gradually evolves. Once you allow the scientist to grab the money and say, “This is really interesting to me, what would you like to do with your time?” you've lost it.

Stefan Brüggerhoff: I completely agree. Just think about the fact that you are asking the question and the scientist is a servant to solve that question. This is the right position, but of course, if you have someone with a lot of experience and someone who is trying to do research work in this field, sometimes it's difficult if you enter as a conservator into this team for three or four months, to be in the same position as the scientist. So, who is the one who is asking the question? Then there is a good [balance] between both.

Salomé García Bacallao: My name is Salomé and I'm studying art conservation in Havana. I just want to make a comment and a question. When you don't have the resources, as we don't have in Cuba most of the time, to do any scientific studies on an artwork, so during most of our studies we focus on the practical and more empirical processes, as Hannah was saying. What is your opinion on that kind of practise that is most extended in Cuba, as there are no resources, usually, or not even equipment to do advanced technological studies?

Giovanna di Pietro: And this is also the situation for conservators working in private practice.

Salomé García Bacallao: So you kind of rush into the treatment without experimenting much before.

Hannah Flock: Of course the first step is always to look for sources, which have already worked on a topic that can help you. The next step is really – you have your object – and not to think, “Oh, maybe I use sturgeon glue because I have always used sturgeon glue and I think it's a nice glue, it works so well.” Maybe you go deeper and think that we have lots of different adhesives and, of course I may not have a tensile testing machine, but maybe I could do some free [adhesive] films and let's have a look at the mechanical properties of those films, at what kind of object I have. Do I have a paint layer, for example, which is much more flexible? Then I wouldn't use a brittle film. That is already scientific thinking. And that is something that really every conservator could really do already in his or her own workshop.

Giovanna di Pietro: I would like to go back to Velson who gave this definition of science as the building of knowledge on testable hypotheses. So this means that you have to have a hypothesis, as possible explanation for something you are observing and then you have to devise experiments that test this hypothesis and, based on the results, make predictions. This can be done really with very few means, it's more of a procedure, it's more an attitude. I'm actually a fan of science with ten euros.

Astrid Chanfon: I am Astrid from Bern, this is more of a question than a comment. I think sometimes science is very theoretical if you speak of models and ways of thinking and hypotheses. For us conservators, we stand in front of the object, we have money and time problems, we need applied sciences. So when we study, we study physics or mathematics, or whatever, but this is this is just teaching a way of thinking. How do we come to the applied sciences? When do we learn to decide what is important? When do we learn this is physics, this is chemical physics, this is chemistry, and when [do we] need theory now, or to do experiments?

Giovanna di Pietro: A really, really crucial question, so I would like to ask all the public here, what is your feeling? Did you only learn theory or do you see the transfer to the objects, can you apply the theory you have learnt to the objects?

Marc Holly: Marc Holly, University of Applied Sciences Cologne. I think this goes into the direction what Hannah said. When you have a glue and you tense it it and you look how sticky it is and how long it needs to dry. You look at the glue at different temperatures. It's also very important to do this kind of work, when you have these scientific sources where you have tables full of data and you have hundreds of data but you don't know how this data looks in your practical work and your practical object. And you always have to check this data in your practical workshop, so that's very important to bring science back to the applied side. And it's also something you can do in Cuba and wherever you are. Check the data and see how the data is in real life.

Giovanna di Pietro: Astrid, did you have the impression in your education that you had theory but no application to real [case studies]?

Astrid Chanfon: I think it's really important to have a broad basis. It is really important to understand the basics in physics, the basics in biology, but sometimes we have other objects in the atelier where we don't find the bridge. And yes it would be cool, if we could have the theory applied while studying.

Giovanna di Pietro: So I take it as a strong suggestion to us teachers.

Stefan Brüggerhoff: I think you are still an applied scientist in this way. You don't know that you are doing it in this way. So I feel that if we look back to 60 years ago, a lot of things have been done schematically. So one glue was proved to be a good one, and was applied several times without looking for an alternative, because the object is different. Maybe this is a very direct way to address the problem, but maybe 60 years ago this wasn’t the case. Nowadays we have a lot of knowledge, maybe not direct knowledge, but under the surface of natural science. Natural science has entered into conservation science. Conservation science as build a combination with conservation techniques. So I feel that most of the students, most of the conservators today are already applied conservation scientists or competent conservators. So don't be so anxious that there is a big gab between the pure science and the conservation science. If you try to think in this way, to think systematically, to use literature and so on, I feel this is a very good step towards conservation science.

Velson Horie: You can't know it all and you certainly can't know it all at once. And so it is a question of find out what you need for this occasion and you'll then start using a larger base of knowledge. The same applies to the value judgements you make about conservation, about objects. Exactly the same thing, we come in with limited amount of knowledge, we hopefully come out with more knowledge and much more insight and it doesn't happen happen at training, it happens over a lifetime.

Agnès Gelbert Miermon: I was just wondering, listening to you, if there is not also a problem of communication. Maybe there are a lot of people in their workshop who are doing research experiments etc., but they never publish their work. Maybe that's the point, maybe we can encourage also the conservators to publish all the science they make in their workshop.

Mariana Escamilla Martinez: Yes, I totally agree and I think a very important thing is to publish in English, so that everyone understands. I study in Germany, but I come from Mexico and when I see the literature that arrives in Mexico, it's obviously the one that is written in Spanish, Italian and maybe English. But German literature, Russian literature, French literature, no. So I think that's very important.

Salomé García Bacallao: I think as well that there are many publications that you can't access for free. So it's very hard if you come from a country that doesn't have a lot of access to internet, and on top of that, you have to pay to have access to some publications. It's really hard to sometimes have access to knowledge, to compare. So it's important as well that scientist everywhere in the world use these kind of platforms for sharing knowledge or forums and be open to helping other people which is, of course, hard because it takes time. We all know that if you spend five years doing a research project, maybe you don't want to share that knowledge for free. But, yeah, it's just a comment.

Giovanna di Pietro: Open access to publications is very important today, but is has a price. So if you want to publish a paper and it is open access you need to pay something more and this is one of the reasons why scientists do not always publish open access. There are a lot of copyrights on publications, so that you can't simply publish on websites, but that would be maybe an encouragement also for you students, to communicate [by means of] open access, because this is possible for writing the master's thesis. Is there anybody from the German-speaking countries considering, to write their master's thesis in English and not in German? Yes, two of them, three of them! So I would like to ask you, what is motivating you to write in English?

Jennifer Braun: Hi, I'm Jennifer, I'm studying here in Bern. I totally agree, it's really important that everyone understands what is being said, what the research outcomes are. I find it's really selfish to just assume that everyone else knows your language. We are lucky that German is being spoken in at least three countries, but I want to contribute to worldwide research and knowledge, so that's why.

Giovanna di Pietro: Great, so the conservation community is larger. We are a small community dispersed in many countries, so it is important to involve all of us.

Isa von Lenthe: I would just like to add that we have received a great offer from Taylor & Francis, publishers of the IIC. You will find a list in your conference bag of ten papers, for which we have been given free access until April for all participants of the conference. So, a beginning.

Giovanna di Pietro: Okay, thank you. If there is a moment of silence, I would like to ask a question to Velson. So you have encouraged conservators to use both rational thinking or this testable hypothesis, which is scientific knowledge, and also intuition. So you say, that 40% of the decisions are taken with the gut. But I guess that most of the student conservators might not yet have strong intuitions. So what is your concrete suggestion to us, to improve our intuitions?

Velson Horie: It's interesting that, looking back at my career, a lot of the decisions I made about what direction I would go into conservation, either treatment or research, weren't made rationally. They were made with extraordinarily little information. But I allowed that to be recognised at a conscious level, and did it. So I think, as I say, looking at children as well doing this, they very often make the right decisions, because for them at that time it works and in general for the conservation treatments i've seen that conservation treatments rely far more on the willingness and the skill of the conservator than the method they use. Very often it is not the treatment they use, but how well it's done that makes the difference. If you are committed to something – there are mistakes and you hopefully learn from those – but in general if a person cares an awful lot about getting it right, it may not be the best, but it would more likely be right than not.

Eleonore Bernard: I would just like to add to that. I think it does also help us young conservators to use the method of applied sciences and making just tests for ourselves. It's one way to build our intuition slowly. To get to know the materials that we are using for the treatments. So like you said Hannah, this glue maybe is more brittle, this one less. So we are building on different information that maybe is not directly [stated] in the paper, but we can extract. And most importantly – I think it's the most important of all – that we can find out how we as a person with abilities can actually use this technique and method. How easy is it? Is it possible on this size of an object? And that you can only really know, once you have at least made a test. If it's not written on the paper, if you can use this type of aerosole on this size, or with this concentration, you have to figure out on your own if for your specific case and with your personal skills it will work. Maybe then the second best option is your best option. I think it's maybe also our [responsibility] to take back our decision power, is to have this external information, this scientific input, and then be smart about how we apply it. That's also being conscious of your own limits, of maybe your time and financial limits, all of this also comes into play when you make a decision. So what is the best treatment or solution in your scenario and that I think is really our question to answer. Nobody can do that for you.

Eva von Reumont: Hello, my name is Eva, I am also a former student of the HKB. I was wondering if science, if research has facilitated the use of synthetic adhesives because there have been all the tests and everything on them – I might leave it at that. Is it that scientific research is giving a green light to something that we don't actually know for so long but, I think, conservators might prefer to use a synthetic adhesive because it's because of its

qualities instead of just adding alcohol to a proteinaceous glue, and that would work just the same, but they would rather use a synthetic adhesive.

Velson Horie: I'll come to that point in the moment. Let me answer the first point. One of the things that you said, Hannah, is that we make some things work and that those that do work will publish. It's really important we publish the things that don't work. Conservators all over the place make the same mistakes all over again, and no one says it's a mistake doing that. Publish the things that don't work, it's really important to publish the things that don't work. It's really important that we find out. There should be a bell-curve. If you are doing things statistically. Things in the middle work really well, and all the way down to things that are disastrous, and all we've got is just one point, the top one. We don't learn anything from that. So we need to know the shape of that bell-curve. Going back to the polymers. The wonderful thing about the polymer scientist is that they get a polymer sample from the factory. Essentially, polymers you buy form the manufacturers are very variable. The polymers you get from the suppliers of natural materials are just as variable, if not more so. I once got in touch with a glue manufacturer and said, "Could I have a couple of samples of glue?" and they sent me a list of 50. 'Which glue do you want?' I was asked. And I said I'll have three of them. "Now, which glue do you use? Which are the ones that are easily available? Which are the traditional glues and have no specification?" My best example is dammar [resin]. In 1920, they were tested for solvents, for the solubility. And in 1946 they were tested for solubility again. Completely different solubilities, completely different materials. So the natural materials which we use are as variable and as uncharacterised as the synthetic ones. Which means, as I have said at various stages, keep a sample of the material that you use. Going back to a point I was making – we should be making polymers for our own use. Just in about every other industry in the world, none of them uses an adhesive off the shelve. They specify what they want and they get it made for them. There are only two or three of those in conservation. The materials we buy – different from year to year, from the manufacturers.

Stefan Brüggerhoff: Not to the polymers, but to the publications. We need to make clear, that you will deal mainly with individual objects. So you will have different conditions which make these objects special. So don't ask or argue that you will publish research work. Research work always looks like it must be very extraordinary. So a lot of knowledge and experience gets lost because we think, "No, this is not worth being published." So as Velson said, conservation is like a living body, with a lot of people. So if we find a solution to share experiences, to share experiences in a way that not only the extraordinary topics are published, but also the normal or the daily extraordinary things are published, in a simple way – in a way that this experience can be shared. This would be really a very perfect next step for conservation. I am a member of a board in an association which is called Salts in Cultural Heritage. We have a Salt-Wiki, and in this Salt-Wiki we always try to push people to bring in their experience. And it is so very difficult to get people to write something down. One [reason] for this is maybe that "This is my experience, my speciality, I can earn money with it," and the other thing is "Oh it's not worth being published." But this is not true. If you have something which is a bit extraordinary, don't hesitate, just write it down. I feel it is necessary to do so. As we are now in a community where you can share this information in a very simple way, I feel this will help a lot of others.

Giovanna di Pietro: Going back to the invitation to publish failures as well. I remember that Barbara Sommermeyer, who is a conservator at the Hamburger Kunsthalle, I believe. She organised a few years ago a conference on "Scheitern in Konservierung-Restaurierung" – "Failures in Conservation-Restoration," and it was extremely difficult to get conservators to share their failures. So it is extremely difficult to convince conservators to share failures, and it is extremely difficult for scientists to share their failures. So, I mean, you gave a list of failures in your talk, [Velson]. There is a problem here. It is difficult to talk about failures because, basically, you could get your career compromised, and because in the whole society and in this education, making mistakes is not always welcome. We try all the time to be right. So I wanted to ask you Velson, because you gave this list of failures in conservation science, do you think it's still the same? Do you think that it is still common to have big failures in conservation science research projects?

Velson Horie: I think we are getting better, but we are still dealing with many of the failures in the past. Polyethylene glycol is my favourite example, brought in during the 1950s for water-logged wood. It's dripping out of objects at the moment. And it was predictable, and it was seen, in the 1950s. We are living with those mistakes and fortunately we are learning. But I think we still have the image of the science riding in from the West with the guns all blazing, and we'll shot the outlaws and they'll go away, and all of a sudden we'll have a democratic judge-lead society. It doesn't happen in conservation either, because there is always the danger that someone comes along a subverts the system. It's still happening because we still can have, having found a solution that works for now, the hubris of thinking that is the right solution. Instead of saying it is only the next iteration of a possibly better solution, or possibly a bad solution. We do have a lot more knowledge nowadays available. We don't necessary have the people who can interpret that knowledge and evaluate whether there is something we've been missing. So there always has to be skepticism. We shouldn't accept any of the results of the research or of these proposals as being gospel.

Giovanna di Pietro: A comment? Comments are very welcome – you don't have to ask questions, you can just comment.

Piotr Popławski: I have two comments. One is about a failure. It's very difficult. In Poland I heard a joke about failure by conservation experts, "The failure of the doctor – a medical doctor – will be covered covered by earth. The failure of a conservator will be laughed at by generations." It's cruel, but that's what I heard. Also, a comment about theory and practice, because there is too much theory – what about applying science into practice? A colleague of mine working in a lab, he told me what is theory and what is practice. He said that "Theory is when we know how it works but it's not working. The practice is when it works, but we don't know how." And he said that in our lab we connect practice with theory, "Nothing works and we don't know how, or why." Thank you.

Anita Filli: I am Anita, I am also from the HKB. I have a question regarding intuition and also practical work. Do you think that if you have experience in the practical field, for example, because you learned another profession beforehand, if can this experience stay in your way when you are in contact with science, or does it help your intuition?

Hannah Flock: Does science help my intuition, that was the question, right? Yes it does, because you see so many case studies, and [if] you are lucky you understand a pattern, but you don't know what is happening, and you try to look for reasons. The way of thinking in science helps you to find patterns and to ask the questions about what is happening and so on. I am a conservator, I am not an engineer, but it is really helpful for me. Let's say, I saw so many things on paintings, I realised them but I didn't really understand what was really going on. And when I had a deeper look, into engineering science, and then it was like, "Oh, wow, it's like that!" And it's not standing in my way. I see myself as a conservator and it's not like, "Oh, material testing is the answer to everything" and every result I have and that is written down in literature has to be true, no. But it's really just supportive – it is. Did I answer your question?

Anita Filli: Yes, partly. My question was also regarding [the fact that] if you have learned a profession in the practical field, for example, you learned to paint or to work with wood, and then you start studying. Does this experience you have in the practical field help you with your intuition, or does it stand in the way to think scientifically?

Hannah Flock: Ok, no – I wouldn't say that it's standing in the way. Experience is never standing in the way, in case you accept that there are also many more other facts that you can add to your knowledge. Just don't see yourself at the final point, and then be open to everything else. And I don't think that. When you come from crafts, and then you do conservation science, and then you do engineering, or you do it just the other way around, it doesn't matter. At any time it is experience. Be open. See the difficulties. I really could say that anything from my practical experience was a disadvantage for modelling things in science, no.

Velson Horie: I would just add one thing. The important thing is how you can use that knowledge. I think you need to have critical thinking, being able to think what is important, and what isn't important. And so I think the early training in universities, or painting, or whatever, that you can actually think logically and clearly through the problem, the critical thinking – that can come from everywhere.

Margaux Genton: I'm Margaux, a former student from the HKB. I'm sorry, but I see the time running and my question has nothing to do with what we are talking about right now, but maybe it's time to ask. I've been now working for a few years, two years, and I was wondering if this was the place where we could talk also about what are the possibilities for a young research to get back into research, at some point in our working life? Because we know that as a PhD [student], or with some institutions – maybe you can give us some answers about that, instead of spending hours on the internet looking at possibilities to find grants, or institutions looking for young people, to go back into that field.

Stefan Brüggerhoff: Unfortunately I do not have a [USB] stick to hand over to you with all of these opportunities, especially with regard to Germany, it is difficult. I have to say, it is difficult because you have a few institutions who are really focused on it, some famous institutions like the Rathgen lab in Berlin, or some other big labs. They are looking for restorers. My idea, or my proposal for you, is to look for currently running research

work in this field. And then, ask people. Don't be shy, really ask and say that you are interested, and these engagements in many cases help to make the first step. So look for the actual running projects and ask there and ask the institution dealing with this project. This is, I think, a good chance.

Giovanna di Pietro: So, here in the public, we have Sarah Staniforth. May I ask you directly about the English perspective? What is the possibility for an emerging conservator – a conservator, who shortly finished her education – to have a PhD, or to go back to research in England?

Sarah Staniforth: Thank you for pointing that question at me. I think have to put my hat back on, to when I chaired the National Heritage Science Forum in the UK. Thanks to the invention by the UK House of Lords who decided to do a select committee enquiry in to Science and Heritage. A lot of money has found it's way into scientific research directed to heritage. Now this is broader than conservation science, because it includes archaeological science and building science, as well as science applied to artefacts and collections inside museums. But that funding which comes from the research councils in the UK is being used for collaborative PhDs which are partnerships between universities and the museums, or heritage organisations, that have questions they want answered both about the understanding of heritage, but also the conservation of heritage. Those PhDs were advertised for the first time, I think the first students started two years ago. They are having a conference to report about the results of their research. I mean, I'm not going to say that it's luck in the UK, because it started with lobbying – some of us going to the House of Lords and drawing attention to the issues about science and heritage – and luckily finding one of the lords, members of the House of Lords, who was prepared to advocate for science and heritage. So we sort of made our own luck in that sense. But those collaborative PhDs are open to both conservators and people who have no conservation experience, who have a straight science background. They're in progress at the moment. That, I think, has proven a good model. I think the important point – I didn't intervene when we were talking about the nature of applied research – but what has been accepted by research councils in the UK is that end-user driven research, so applied research, to answer a question from the user of the research is now accepted. It used to be that research councils would only fund what they would consider to be pure research for new techniques that were really pushing forward the boundaries of science. So end-user driven research, or applied research, is what we need in conservation and the funding of that is now accepted by the research councils in the UK.

Stefan Brüggerhoff: Just as an addition to this with regard to Germany, as I am also on the board of the Research Alliance of Cultural Heritage. We had a lot of discussions with the German Ministry of Research and Education in this field and we always addressed the example of the UK as something, “Look at the UK, there they have done the right thing.” It is very difficult, but I am now hopeful that we have made a step. I got some information that during the next year the ministry will try to bring together the different disciplines. On the one hand, the cultural [field] – where conservation is addressed – and chemistry, physics and natural sciences, on the other hand. Because in the cultural [field], always, there is one department with very rare amount of money. In chemistry and physics there is much more money, so they bring both of them together – they told me that they will do it. So maybe the funding, starting from next year, will be better in this field. I am hopeful.

Velson Horie: Question, “What can the conservator do about it as opposed to the politicians?” Certainly in Britain, a large number, a significant number of people, do part-time PhDs. They have a real fire in their belly to do something, and decide to start doing investigations. They establish, as you say, a reputation by talking to people, by bothering academics, who don't understand the questions properly. So they ask better questions, and then, build up a reputation good enough to convince the examination board that they are fit enough to go forward with a PhD project which is thought through. Now, that happens quite frequently. In Britain a PhD is three years, so they spend six years or eight years doing a PhD. And that is how many PhDs are done by people in the late 20s, early 30s. They have gone through the mill and decided that, actually, bench conservation is not all that they want to do.

Hannah Flock: I would like to add something. Of course we all wish that the government provides the possibilities to do more of a combination of science and conservation, but already now – it's a case study, actually – I would like to encourage you. I studies conservation science and at our university there is not a possibility to do a PhD. So in my topic, I thought I would like to cooperate with engineers, I organised it, I organised a scholarship so that I could follow the topic and I do not need those government decisions. So, in case you have something you burn for then, just do it, it's possible. I would really like to encourage you.

Eva von Reumont: I wanted to actually add a comment on that, to emphasis that on the one hand the master’s thesis is a good opportunity to open doors to institutions, that can help you. But also the question – this might be a question – how compatible is a master thesis on an international level in Europe? So could I do a master’s thesis here at the HKB, which is a university of arts, and could I now go to Amsterdam, for example, and apply for a research project over there? Here in Switzerland it's a bit different. There has to be a second master’s degree at the University for one year where you pretty much prepare your dissertation subject, and you then get the ability to apply for funding from the state. But doing a PhD part-time is actually a wonderful [opportunity] for conservators. In Warsaw we also spoke about the responsibility for us to take that step, to receive more acknowledgement from a wider public, but also to never forget the link to the practical part. So we had speakers telling us, don't actually go for your PhD directly after you’ve done your master’s thesis. Remember that we want to learn from the material we are using, and building up intuition really also means to learn more about the scientific research in a practical way. I think that is a wonderful idea.

Giovanna di Pietro: In the audience we also have Sebastian Dobrusskin who leads the research division in materiality and culture. Sebastian, could you say something about the possibilities for a conservator to follow a PhD in Switzerland?

Sebastian Dobruskin: Well, I can only speak for our school here, [for HKB]. We have a GSA, the Graduate School of the Arts. This is a collaboration with the University of Bern and there we have the possibility for the second master’s which Eva already mentioned. This is because the University of Bern does not accept our master’s degree. After that you can start a research project for a PhD. We are working with other universities here in Switzerland that accept our masters’s degree. You have in any case to study there in addition because it is

always a change of your study topic. Because there is no university level education in Switzerland on conservation-restoration. But we have several students, former students from conservation-restoration in research, and one example is Johanna, who is working together with Giovanna on a research project. But I think [she] will talk about it.

Giovanna di Pietro: It is possible. In Switzerland there is not a possibility to get a PhD in conservation. But it is possible, for example here in Bern, to do a further master's which is called a Master of Research, and then to change your subject and work with the Faculty of Art History, or the Faculty of Archeology and get a PhD there. It is possible, of course, but it is always a question of how to get funding, which in Switzerland are mainly from the Swiss National Foundation [SNF]. There has been a lot of lobbying in Switzerland, from NIKE and different institutions, to get a special program at the SNF focused on cultural heritage. So we are lobbying in this direction, definitely.

Agnès Gelbert Miermon: I would like to say again that you can also make research without a PhD, for example, by getting a position as a research assistant. We regularly open a position as a research assistant and usually we do not get very many applications. There are not many restorers applying for those positions, it is often chemists. I would like to say, you can apply for those positions, even if you do not have a PhD. To be a research assistant for four years, it is also a good opportunity for doing research. So do not hesitate.

Giovanna di Pietro: Do you mean research assistants in the conservation schools?

Agnès Gelbert Miermon: Yes, I say this for Neuchâtel. I do not know if this is the same for Bern, but in Neuchâtel it's quite difficult to get restorers in the research team, usually there are a lot of chemists, scientists, applying for those positions as research assistant. We want to push restorers to apply for those positions. It is not often, but regularly, we open positions.

Giovanna di Pietro: So we have now only about five minutes for discussion. Later there will be some closing remarks of the [Local] Organising Committee. I don't think we had many [tweets], right? Please, [tweet]! Or I just encourage you to think about a question, you can say a comment, complain, you can ask whatever you want from to the speakers or your colleagues.

Mona Konietzny: My name is Mona Konietzny, also from the HKB. I have some doubts about the long lasting time of the PhD. I mean, there is like a boom in conservation science at the moment. There are lots of positions, there are lots of possibilities to go further in that field. But there are also some conservators, mainly practically working conservators, who are complaining about that. They are not willing to pay for a PhD. And I think that this might be a problem. What are your thoughts on that? Is it recommendable? It is a long lasting position or an opportunity for us?

Giovanna di Pietro: Very good, so how many positions are open for conservators with a PhD? On the long term, what happens after the PhD, eventually?

Stefan Brüggerhoff: A very difficult question. I think the PhD, if you just think that it will help you in your career, forget it. If you are interested in research work and you think that it is something that will help you bring new skills for yourself, just do it. It will help in any way. But, of course, I think the number of positions, the top scoring positions, is very rare. So, I'm a director of a research museum, one of a few [people] that come to this position. So I think you really have to burn for it, and it will help. But if you just think about your career, it is not a real [option] to do it.

Giovanna di Pietro: Quite a bitter reality.

Christian Müller-Staten: My name is Christian Müller-Straten. I am by my profession an art historian and a publisher. I would like to direct the attention to one thing and would like to add some remarks. One thing is – don't forget the humanities! Here in this discussion I have heard too much about natural sciences, which are very important of course, and I love them, of course. I always pledge for the cooperation between both kinds of sciences. But most questions in conservation-restoration are raised by the humanities. This is one thing I would like to remark. And the other thing, something which is more important than a PhD – although I have one by myself – more important than a PhD is publishing, because if you intend to make a career in the institutions, only in the institutions – not as a craftsman, with your own studio, but in the institutions – you will be asked for your publications list. And if you have nothing published, you are listed far below in the list of people who want to work in that institution. Therefore, it is very important for conservator-restorers to publish. And I think it is very important for them to know exactly what is a scientific approach, and what is not a scientific approach. We are just talking here about science as something which falls from heavens, but in practice, I have realised that many people writing contributions to magazines and books – with a PhD – and they were not approaching the topic scientifically. Therefore, I would say, if you know very well what you have to do, if you take a scientific approach, then you don't need any academic title. In the UK, for example, there is a long tradition for people without academic careers to publish scientifically. This tradition does not exist in the German speaking countries. Here you are always being asked what kind of title you have. This is not the case in the UK. In the UK there are many publications existing with excellent contributions by people without any university studies.

Giovanna di Pietro: Thank you. I think there are many different journals in conservation which really also encourage conservators to publish. I'm thinking, for example, about the Journal of Paper Conservation that explicitly invites conservators to publish their results.

Renate Poggendorf: I would like to make a comment on that. My name is Renate Poggendorf, and I am going to speak about salaries tomorrow, so I guess we will return to that topic tomorrow afternoon. But I at this point I would like to mention that it is tricky. I think, for the conservation, for the objects, it's great to to have people who really make in-depth studies, who do a PhD on something to improve their personal level of understanding that is

then maybe also applicable to other fields. But be aware that the job market is not necessarily looking for you. And there are little positions in research. The universities have assistant positions maybe, but in the public sector – and I can only speak for Germany – the museums are not prepared for that. And I will give details tomorrow. I think it is important to, for some time, you can maybe afford to work for your heart and to do what you really want to do, and train yourself, and go like that. But you have to think about how you want to live and what the job market is looking for is someone to solve the jobs, who do conservation work in the museums. I think people should be standing one several feet. And maybe that is why it is a smart idea to say, do both. Maybe you do your PhD, but you also work as a conservator because, at some point, you are also going to want to make a living on conservation.

Giovanna di Pietro: Absolutely important. Is there anyone here in the public considering to specialise in conservation science, part time or full time? Nobody? Exactly, so I guess we need to go back to the question. In this case we mean the application of natural sciences in conservation. Is there anybody? The fact that there is nobody I think is quite important. This gives the idea, as you say, of the difficulty in getting a job in this field. With this sad note I would like to ask the speakers if they would like to give a concluding remark and then pass the microphone to the [Local] Organising Committee.

Closing remarks

Stefan Brüggerhof: Just to give it back to the audience. I was very fascinated by the questions. I feel that it is very important to stay in this exchange of knowledge between experienced people and people staring their career. Because it is not only a living body in conservation science, it is also a living network of conservators. And my last reflection, my last advice to you, is really to try to build your network. Try to build a broad network of people you are together with, institutions you know, this will help a lot in a field where you are not able to understand all, to know all. But if you have someone who knows it, and he or she will help you, this will bring you more than one step further.

Hannah Flock: I would also like to thank you all for this nice discussion. My final statement maybe would be that, please just keep in mind not to think in too small boxes, as a picture. Feel free to have a look at other fields and other sciences and feel also free to get into these fields. It's never a good idea to think, “Oh, I'm a conservator, maybe I am not able to do all this chemistry, or physics, or whatever.” Because so many other people can do it, therefore you can do it as well.

Velson Horie: I benefitted enormously by going to meetings like this when I was young, and I still benefit from them now. It is a way I made the networks, the contacts and learned, being pushed up against people with completely different views from me, and it made an enormous difference – to go back to the reflectance bit – you've got to analyse what you do all the time. And in order to do that, IIC give a reduce rate for the membership for students and I really recommend, as treasurer, that you join.

Giovanna di Pietro: I thank you very much Stefan Brüggerhoff, Hannah Flock and Velson Horie for speaking to us here and I thank everyone in the public for listening and contributing with your questions. I will pass now the microphone to the organising committee.