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The International Institute for Conservation of Historic and Artistic Works

Panellists:

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Moderator: Jerry Podany, President IIC

A note to the reader: Those not familiar with seismic engineering, or the terms normally used in mount making, might find these definitions useful.

Seismic Mounts: The term "mount" means a great many things in the lexicon of conservation, it can mean a matte surround for a print or drawing, a cradle for a book, a wire and hook assembly to hang a painting, or a manufactured support for an object. In the context of preventing damage from earthquakes, the term "mounts" refers to any fixture or restraint that either adds strength to an object or restrains the motion of that object so that when earthquake forces are transferred those forces will have less dynamic effect upon the object than would otherwise be the case. That is to say, mounts safely keep an object from sliding, falling, tipping, turning over or colliding with other objects or with the object's surroundings. A measured amount of wax on the bottom of a small object such as a vase, or a length of monofilament which allows an object to be tied down, are the simplest forms of restraint. Still further the term "mount" is most often applied to a manufactured fixture which is designed and made to hold an object safely in place. Contour mounts (also referred to as *form fit mounts* or *spine mounts*) are good examples of this. These mounts are intimately fitting supports that follow the exact contour of an object and are attached to both the object (usually with monofilament ties) and to the deck of the exhibition case, to a pedestal or to the floor. Contour mounts can be made of metal, wood or plastic. Designing a mount must take into consideration the inherent vice and fragility of an object, the object's structural condition, the exhibition design requirements, and a need for discretion balanced with safety and functionality. A good mount is never obvious and always effective. A seismic mount is all that as well as being one that takes into consideration the forces that might be imposed by a probable seismic event.

Base isolation: the term is used to define a wide range of energy-absorbing and/or decoupling mechanisms placed between the ground and the object (or building) being isolated. Columns of visco-elastic rubber, interleaved with lead sheets, are often used as isolators under building foundations. While some buildings, a few exhibition cases, objects and a variety of electronic, scientific and medical pieces of equipment have been protected by multistage isolators (whose individual stages travel freely on bearings within a predetermined distance), there are very few examples of works of art or artifacts isolated in this manner. The purpose of the base isolators is to absorb a percentage of the earthquake energy by essentially allowing the earth to move under the object or building with less of an effect upon the objects or buildings themselves.

Panellists (clockwise from upper left): Kimio Kawaguchi (Japan), Bilgen Sungay (Turkey), Constantine Spyrakos (Greece), Paul Somerville (USA), Ugo Nizza (Sicily), Vlassis Koumousis (Greece), Charlie Kircher (USA), Roberto Garufi (Sicily)

Welcome and Introduction

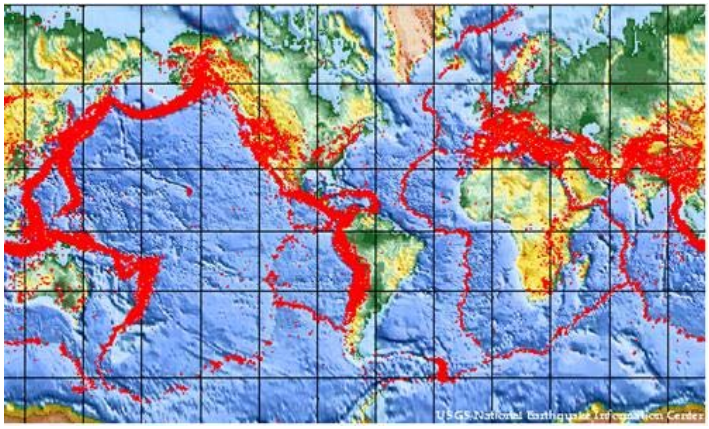
Jerry Podany, President, IIC

On behalf of the Officers, the Council and the entire membership of the International Institute for Conservation (IIC), welcome to this roundtable discussion focused on the issues surrounding the protection of cultural heritage from earthquake damage.

Before I describe the topic of this roundtable in more detail, allow me to express the IIC's gratitude to the National Museum of Western Art, here in Tokyo, and its director Dr. Masanori Aoyagi, for the generous support they have given in hosting this event. Our thanks also go to Kimio Kawaguchi, chief conservator for the NMWA, for his leadership and to Ms. Kaori Uchida and Ms. Mie Ishii for their organizational skills. Thank you as well to the speakers who have agreed to share their insights and considerable experience during this discussion.

This event is part of the larger IIC initiative: ***Dialogues for the New Century:*** *roundtable discussions on the conservation of cultural heritage in a changing world.*
These roundtable dialogues are meant to encourage the exploration of contemporary topics and their relationship to the preservation of cultural heritage. The goal is to raise the awareness of that relationship among relevant professions and the public sector. Each event benefits from a variety of experts from a broad spectrum of disciplines who contribute unique perspectives on a specific topic. The events are open to all but are also targeted to create productive collaborations among a variety of professions. Edited transcripts of each event are available to all on the IIC website (iiconservation.org).

Our unsettled earth
If one glances at a seismic event map (Podany figure 1) that records earthquake locations with small red dots of varying sizes depending upon the intensity of the earthquakes, it is clear that the surface of our world moves quite a bit. One cannot ignore the magnitude of the threat such movement presents to cultural heritage in all countries across our world.



Podany Fig.1: A map of earthquakes around the world.
(source: USGS, geomaps.wr.usgs.gov).

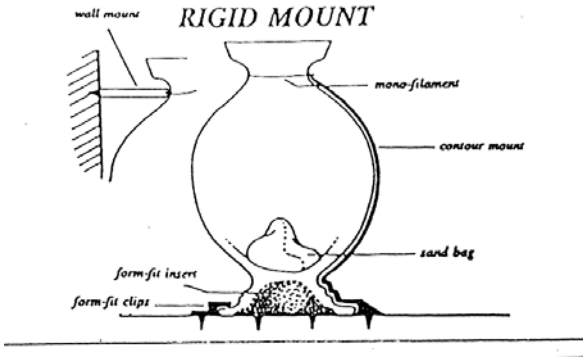
It should also be clear that these red dots appear to congregate more densely at certain locations, such as Japan. Indeed the records are so dense around Tokyo that they can obscure the exact location of the city on such a map. It seems fitting then that we gather here in Tokyo to discuss how engineers, seismologists, conservators, mount-makers, collections care specialists, architects, and numerous other professionals might come together to protect cultural heritage from the threat of earthquakes. It is no coincidence that we meet in a country where 10% of the world's earthquakes occur, as the Pacific plate relentlessly slides below the Eurasian plate and makes the ground tremble.

This event is about vulnerability reduction. It is about reducing the risk to which our shared heritage, whether collections, archives, monuments or buildings, is exposed in areas of significant seismic activity. And there are many such regions across the world. The challenge vulnerability reduction presents is quite significant since the focus of most seismic mitigation to date has been, appropriately enough, on life safety, the protection of essential services (power, water, roads, bridges, etc) and on built structures. The effective protection of cultural property has lagged behind. Monuments, archives, and collections of works of art as well as historical and natural science materials, remain at great risk whether on exhibition or in storage. Research and implementation to protect "contents" is an area in great need of development. Such developments are complex in

nature since artefacts do not always fit specific engineering categories. And the aesthetic concerns of presentation often restrict the degree to which restraints can be applied.

It is easy to forget, as we sit here among colleagues who have given so much of their lives to this topic of mitigation, that heritage professionals are often both uninformed and misinformed about what can be done to protect collections from earthquake damage (Podany figure 2). This is particularly unfortunate since so much that is both simple and inexpensive can be applied to avoid the significant loss of material experienced every year around the world (Podany figure 3). In every country, in every region, in every museum, site and storeroom one can see evidence of high vulnerability due to lack of information or denial. And after each earthquake one can witness significant damage (Podany figure 4). Yet so much could be done, and could be done now.

Podany Fig. 2: In museums all around the world one finds collections at risk from earthquake damage. Unstable configurations and mountings, such as seen on the left, are common. Solutions can be simple and relatively inexpensive but must also be elegant and discreet if they are to be sustainable and acceptable in the museum context. The example on the right surely protects the object but is visually disruptive and serves to only raise barriers to future efforts of seismic mitigation. (photos: J. Podany)



Podany Fig. 3: several ways of securing an object are illustrated in this one drawing. The object might be secured with clips along its base; secured with small amounts of wax under its foot; the centre of gravity of the object might be lowered by placing weight inside the object (such as a sealed cloth bag of sand or lead pellets); a “contour” mount might be manufactured to support and restrain the object; a rigid foam insert might be cut to fit a cavity in the base of the object; or monofilament might be used to tie the object down. While all of these approaches are simple and inexpensive, they require sensitivity to the condition of the object, basic understanding of the seismic threat, and the necessary skill to achieve an effective yet discreet support. (Drawing: J. Podany)

Podany Fig. 4: Protecting individual objects within a collection also involves the design of exhibition and storage furniture (display cases, shelves, etc) that are stable and secure. The collapse or distortion of exhibition cases can cause significant damage to collections, as can be seen in the photograph. (Photograph provided by C. Spyrakos)

Why then, if all of these simple and effective approaches are available, do our collections remain at such risk? How can mitigation information be shared more effectively? How can awareness of the threat and solutions be raised among individuals, government agencies and international bodies? These and other questions have brought us here today to explore needed answers and possible directions.

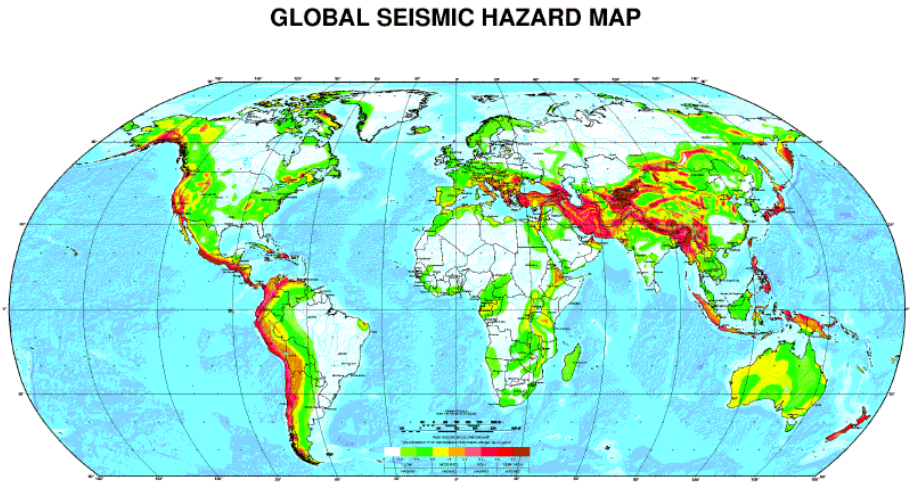
Eight colleagues from five countries that regularly experience significant earthquakes have agreed to consider a series of questions and to discuss with each other, and with you, the way forward. They have produced some of the best international research in seismology, engineering, education, policy and mitigation implementation to date and they lead the field with their knowledge and commitment.

If statistics are correct, many of the world's cultural centres will experience major earthquakes this decade and many have already suffered the effects of recent significant seismic events (the Abruzzo earthquake in Italy being only one). Time is therefore not in preservation's favour and immediate action is paramount. The needs for collaborative efforts in research and implementation, policy development and outreach are clear, and nothing less than the survival of much of the world's cultural treasures is at stake.

It is with these critical needs in mind that the IIC has convened this roundtable. It is our hope that awareness will be raised, connections and agreements will be made, and efforts will be advanced to address the threat of earthquakes. There is much to do, let us agree to begin. And let's begin with this first question:

> *Vulnerability reduction of cultural collections is a significant world challenge. Although seismic risk maps have been drawn up over large areas of the world, district by district, city by city, and region by region, most museums and indeed many historical districts find it difficult to know the level of threat they are facing. Specificity as to the exact nature of the threat aside, how can we do more to make such information available to these cultural institutions so that they might plan their mitigation efforts more effectively? Take a museum without the means to hire engineers, seismologists or geologists to undertake a specific site study and to develop a design spectra or a worse case statistical threat… how can they more effectively know the kind of earthquake threat they might face?*

Paul Somerville: At the moment there is a global seismic hazard map, called the GSHAP map http://www.seismo.ethz.ch/GSHAP/, which is good in some countries, and not so good in other countries (Somerville figure 1). Now there is a new plan to build what is called the *Global Earthquake Model* *www.globalquakemodel.org* sponsored by a number of organizations within the insurance industry and some universities. This project will provide a much better seismic hazard map, but will also provide a seismic risk map. Some preliminary results might be available in about a year (from GEM1) and then over the next few years the maps will be improved a great deal. So I think we should all look to the *Global Earthquake Model Project* (GEM) as a resource for new and solid information.



Somerville Fig. 1: GSHAP Global Seismic Hazard Map showing peak acceleration having a 10% probability of exceedance in 50 years. Source: http://www.seismo.ethz.ch/GSHAP

Charles A. Kircher: First of all Jerry said “risk maps” and I would like to explore that word “*risk.*” We have heard a lot about risk management, particularly financial risk. I believe what was really being referred to is earthquake "hazard," and Paul Somervile just mentioned hazard maps. There is a big difference between “risk” and “hazard” mapping. Hazard mapping addresses the intensity of the ground motion in any given location. Risk, on the other hand, requires us to also understand the vulnerability of works of art and historical artefacts. For example, if it is a metal vase, as opposed to a porcelain vase, and it falls over, it may just be a small problem because the metal vase is less brittle and less likely to be damaged. If on the other hand the vase is porcelain, it may be a much larger problem because of the fragile nature of porcelain. Other issues to be considered are the relative values of the objects and this includes not only the monetary value but the religious, cultural, historical value. So when we say “risk” and consider the risk that these objects face, we have to consider both the vulnerability and the value of the objects, as well has the earthquake hazard. Seismologists and engineers can tell museums about the earthquake hazard (that is to say the character and potential of earthquake ground shaking) but not about the risk (without also incorporating additional information on museum vulnerability, collection value, etc.).

Vlasis Koumousis: Usually in seismic prone areas when we are considering the risk of structures to earthquakes, we assign a life span to the structures. This helps us to estimate the risk that corresponds to the particular hazard in a given location. For buildings we assume 50 or 80 years as a reasonable life span. For works of art or artefacts it turns out that the life span, or the desired life span, is infinite. So in that sense the threat is always there and the probability of damage to vulnerable objects of our cultural heritage rises to certainty. That gives us grounds to encourage decision makers to pursue protection of these objects from earthquakes and to enforce mitigation measures of the kind we are going to discuss.

Bilgen Sungay: A loss scenario developed through engineering studies would be an effective tool and a good incentive to influence governments as well as funding agencies. However if an institution has the intention of mitigating its risks, specific information is not a must to understand the threat they face. We have been speaking with some of our colleagues, including mount makers, and it is clear from international research how categories of objects react to earthquake forces. And the possible mitigation methods to reduce risk are available in several printed and online resources such as www.eqprotection-museums.org and "Advances in the Protection of Museum Collections from Earthquake Damage" www.getty.edu/bookstore/titles/earthquake.html. We can start doing something now. We have examples from several museums in Turkey who have undertaken mitigation measures. It is not necessarily a must to hire engineers to undertake simple mitigation measures. Of course it would be more accurate to have consultancy that is specific to a collection, building and site, but institutions can at least begin the process immediately. And we should.

Jerry Podany: Bilgen, I think we understand what you mean when you say "we do not need to hire an engineer," since collections care professionals can, by instinct and common sense, understand what might fall over and what might remain in place during an earthquake. But are you suggesting that there is another way to get the information that engineers have and that collections professionals need so that this information becomes more widely available and more widely understood?

Bilgen Sungay: It would, of course, be ideal to have an engineer as part of the team. It is good to have as much accuracy as possible. However we don't necessarily need to wait for that if we would like to do something immediately. As an example, the museum professionals can begin with the storage areas where using padding between objects, adding simple restraints across open shelving (Sungay figure 1) and securing cabinets and shelving to walls and floors could be adequate precautionary actions. I don't mean we should set scientific studies aside, especially for those objects or group of objects that would need specific solutions and in cases where more technical applications such as base isolation are needed. But we can start with published results and use them and build on them. And then, when we have the possibilities of supporting more research, specific to a museum building and collections, we can do that.

Sungay Fig. 1: On the left, inexpensive netting is secured across the front of these open-faced shelving units. The netting prevents vases on the shelves from falling to the floor during an earthquake. On the right, the use of thin ethafoam sheets to surround individual objects on shelves. The ethafoam prevents the objects from colliding into each other or rubbing against each other during an earthquake. The shelving units have also been secured to the wall and floor. (photos J. Podany)

Constantine Spyrakos: Hiring a specialist to develop site-specific spectra and contracting a structural engineer to assess the vulnerability of the artefacts and to cooperate with museum professionals to take the appropriate measures to protect the artefacts, is the recommended approach. The fact is that, in many countries with high seismicity, there are substantial seismological data and procedures to protect artefacts. Unfortunately, even in these countries, this knowledge is either not widely known or, as a rule, not included in curricula of technical schools and universities.

Kimio Kawaguchi: Across the world there are many major exhibitions, costing a great deal of money to produce, and of course promising to make a good deal of profit as well. Many of them have quite significant budget restrictions and often these budgets do not include sufficient protection of the objects from natural disasters. I think exhibition organizers should have a "manual" of sorts, a book that provides clear and simple guidelines for how to protect works of art. In Japan, our Gakegeiin (curator) must have a better understanding of how seismic mitigation can be effective so that they will accept these efforts. The explanation of these concepts must be presented in a way that it is immediately understandable to a wide range of museum professionals, not just engineers, seismologists and a few conservators.

Roberto Garufi: When we complete the risk assessment map of Sicily we will be able to determine the number of artefacts throughout our territory. At that point we will come up with a document that outlines intervention guidelines meant to protect the collections and mitigate seismic risk. This will include not only the buildings and structures but the collections inside them as well. In other words we will have a sort of summary which will be drawn up by the Centro Regionale per la Progettazione e il Restauro in Palermo, Sicily. This will likely be ready by spring of 2010. The document will deal with earthquake mitigation, prevention protocols, disaster and emergency response and recovery, as well as safe environmental guidelines following a disaster. The document will be endorsed by our regional officials. The use of the guidelines by directors of museums, galleries and archives, once they will be made more aware of the problem, is going to be an important aspect of their work because the guidelines will be enforced by governmental offices. It is a must that political officials are made more aware then they already are of this problem and what can be done about it. Particularly important for them to understand is that although the safety of everyone is a priority, collections matter as well. Officials realize that the richness we have in terms of artefacts, which are our

culture, has to be protected and cared for. We cannot wait, doing nothing, until everything is destroyed. Once we have studied how we can mitigate the risks we have to take actions. And in order to do that we need funding and the support of officials to realize that funding. We also have to create priorities. We cannot do everything all at once, but we should get the ball rolling and I think we are prepared to do that.

Jerry Podany: Professor Garufi describes a situation where the government will enforce these precautions, a top down approach. Do you feel this is going to be effective?

Ugo Niza: Absolutely, once the rules are set and enforced by the regional officials. Those responsible for museums, galleries or archives will have to abide by them. Of course the necessary budgets will have to be available for them to meet those goals.

Kimio Kawaguchi: The National Museum of Western Art in Tokyo asks any institution that is requesting a loan what counter measures they will take to mitigate seismic damage. This way we not only protect our collections but encourage the advancement of mitigation efforts. Worldwide many museums use the facility report forms that the American Association of Museums has developed to gain more information or request certain conditions. I think it would be very helpful if that form also evaluated and included the degree of seismic mitigation effort in place at the borrowing institution if that institution was in a seismically active region. The NMWA provides institutions within Japan who are requesting loans from our collections with a seismic map of Japan, produced by the Earthquake Institute of the University of Tokyo, to help them evaluate what kind of threat they may be facing. We can also advise them on measures to protect the works of art.

Jerry Podany: I am going to ask the audience to join this conversation now. For those of you who work in heritage preservation and collections care, and who are not engineers, what do you need, what would you like to have, in order to begin this mitigation process? Or do you feel you can begin now? And if you do not feel ready to take action, why not?

Audience comment: My name is Tetsuhiko Aoki from the Aichi Technical University, civil engineering, and I am researching seismic engineering. At the time of the Hanshi Awaji Earthquake, there was a lot of seismic activity. As was just mentioned, the concept of risk management is applicable to works of art as well. A common factor between works of art and civil engineering is that they are both public. Risk is calculated by multiplying the cost of loss with the probability of the event. You must first recognize what the monetary value for each of the art works is. As was mentioned earlier, if an earthquake only occurs once in a 1000 years, than the total cost of loss is small. If they happen frequently, the cost of loss is high. It is important to firmly grasp this concept of risk management. I suppose that for the cost of loss, even insurance companies can give approximate evaluations. The approximate value of art work is not calculable, since works of art are considered priceless. The next problem is the scale of the earthquakes and their frequency. This is an extremely difficult matter and it is hard to predict. However, installing seismic isolation devices can reduce the cost of loss greatly. The problem is the price of the seismic isolation devices. For us engineers and seismologists, it is important to develop and provide these devices as cheaply as possible. That way we can lower the cost of loss and we can handle frequent earthquakes as well as large scale ones. That would depend on engineers and other people who are making the seismic isolation devices. As for the device used at a certain

company that Mr. Sato just talked about, if we could grasp the scale of the earthquake a little more accurately, the possibility of unexpected damage would be extremely low since we could do something about the risk.

Audience comment: I am Satoko Oaki from the National Earthquake Research Institute, University of Tokyo. Today, a new version of the Seismic Hazard Map that covers the entire country was released. While in the previous version, the site amplification factor was calculated on a 1 km square mesh, the new version has a 250 m square mesh. So it is 16 times more detailed than before and we can tell more accurately the place and scale of an earthquake. However, I think that even if a nationwide Seismic Hazard Map is released, there is still very little information on how to utilize that information at museums even if we are able to see the map ourselves. Additionally, even if information is released, the map itself is not well known. After the release of the map I talked to people at museums, they told me they didn't know about it, that they didn't know how big an earthquake would hit their museum, and that they would have liked to have had that information. I think that this is the kind of information that needs to go out first, and then also how to be ready and how to know what to do with the information once they receive it. The prediction of strong ground motion has been talked about. If it were possible to find out not only how big the waves are, but the shape of the waves as well, we would be able to figure out the motion ratio of individual buildings and we would be able to find out which buildings would be safe and which would not. However, we don't really know how to use this information, so I would like to ask the experts to explain, in a simple manner, how we should utilize the information that is available.

Audience comment: My name is Kaori Uchida from the Department of Conservation and Restoration, The National Museum of Western Art**.** I am a textile conservator. I trained in England and now I work in Japan, where we have many earthquakes. During my training we did not have classes or lectures on this topic of earthquakes. This is probably still the case in Europe and in the US where many conservators from all over the world get their education in conservation. We do not have any training in seismic mitigation here in Japan. I think that it is very important to introduce these concepts within the training programs and their curriculum. It seems to me that a large part of this effort is quite technical and mathematical. But I believe that the conservators do not necessarily have to know these technical aspects to such depth. What they must be aware of and understand are the basic issues, the basic theory and the possible methods of mitigation implementation. I would like to ask the panel what kind of training for students and professional conservators is available within your countries for this issue.

Jerry Podany: Let's start with Bilgen Sungay from Turkey. Is there training in seismic damage mitigation for young conservators, collections care professionals and students in your country?

Bilgen Sungay: I know from our colleague Dr. Erturk that in Yildiz Technical University's Museum Studies Graduate Program in Turkey, students receive some information on this topic within Collection Management, Maintenance and Conservation courses. A course titled Risk Management in Museums is being planned for the forthcoming semesters. Additionally, Bogazici University Kandilli Observatory & Earthquake Research Institute, Department of Earthquake Engineering together with Yildiz Technical University, Faculty of Art & Design, Museum Studies Graduate Program and in

cooperation with J. Paul Getty Museum, are working on developing a training package in Turkey targeting museum professionals and students from all related fields . We have compiled the initial training material containing visual resources from J. Paul Getty Museum, several museums in Turkey and in Japan. We will continue to improve these visual and written resources. This effort is intended to be widely available in accessible formats. We should sensitize our government officials. In Turkey we know that if we can gain government support on this topic, there will be a demand for implementation of risk reduction efforts and for the development of this expertise.

Jerry Podany: Professor Nizza and Prof. Garufi, do the training institutions in Italy have this topic in their curriculum? I am thinking of the Istituto Centrale in Rome and the Opificio delle Pietre Dure in Florence, and many other excellent programs including your own, the Centro Regionale per la Progettazione e il Restauro, in Palermo for example. Are the restorers and conservators who end up in museums aware of seismic mitigation? Are they aware of the possibilities? Or is it left to the engineers? And if it is left to other professions are they paying attention to heritage collections?

Ugo Nizza and **Roberto Garufi**: Not really, not yet. But our Institute has a program underway through an agreement with the Episcopal Conference, in Sicily, who own a great deal of religious artefacts of all sorts, kept in museums and churches. This project deals with training in the area of earthquake damage mitigation as well as preventive maintenance and management of cultural property. It will start very soon. The other museums, they do not have a budget to do such a program yet. But it is our thought that that they will be in a position to do that in the near future.

Audience member: My name is Okada and my specialty is the preservation and restoration of Buddhist statues. Many of Japan's cultural assets are not in museums, but rather in temples and shrines. This can be said for Buddhist statues. I believe that a similar situation exists for countries such as Italy and Turkey where there are many old churches. These countries are similar to Japan in that many of their cultural assets are in religious buildings. I was recently in Italy for a year-long training program but I did not see that many measures against earthquakes were being taken.

Constantine Spyrakos: An essential point was stated before, that this is a combination of hazard and vulnerability issues. Hazard is the highest in this case because the artefact will be there forever, or at least our goal is to preserve and protect it as long as possible. So the only way to minimize risk is to decrease vulnerability, which is the key. Vulnerability must be reduced as far as possible. It is apparent that the resolution of this problem requires the collaboration of certain professions; two of them are the curator and the conservator or restorer. But these museum professionals must cooperate with civil or mechanical engineers as well as with archaeologists and others to provide the best outcome. In Greece there are training materials prepared by the Greek Ministry of Culture containing simple techniques for seismic protection of museum artefacts. However, these techniques are not included in any curriculum.

Jerry Podany: Let me draw attention to Uggo Nizza's last comment and ask the audience a question regarding budget and action. How big of a budget do you need to do something about an unstable object? Let's say it's a heavy artefact loosely mounted to a tall slender pedestal that sways and wobbles when you simply walk by. Surely if there is an earthquake of even moderate size the object will topple over. How much money do you need to realize the problem and do something about it? Do you need to

undertake a study to determine just how unstable the assembly is? Do you need a budget line to determine whether another shape or dimension of pedestal would be more stable? I am emphasizing these questions because a lot of the effort we are trying to encourage is quite basic. It is not complex research but rather simple, common sense. Let me take just a moment to address the fifteen or so students who are in the audience. You will resolve the questions I just asked. You sit right on the cutting edge of the development of this effort. Now that you know there is a real threat, and that something can be done, it is really your responsibility to begin to address the problem, in stages, until it is resolved. You can do this, you must, and you have a lot of resources at your command including the help of those professionals who know the field of seismology the best. Reach out to them, but also engage your own common sense to address the threat.

Kimio Kawaguchi: As someone who works in a museum, I believe our first order of business, the most important effort we can make, is to communicate with all those responsible for the safety and care of cultural heritage and convince them that at some level everyone can do seismic damage mitigation, and should.

Jerry Podany: We have been talking about how to make preservation professionals and others more aware of the information that is already available so it can be used and implemented. Let's move on to another question, first for our professional colleagues in engineering and seismology. In the area of basic research and the generation of new information, what are the greatest needs and which of them should be pursued the soonest and in the most depth?

Paul Somerville: One of the greatest needs is to accurately record earthquake ground motion using strong motion instruments. This has improved dramatically in recent years but only in some countries. For example, after the 1995 Hanshin (Kobe) earthquake in Japan there has been a significant increase in useful information available from the NIED Kik-net, http://www.kik.bosai.go.jp/kik/index_en.shtml and K-net, http://www.k-net.bosai.go.jp/k-net/index_en.shtml networks. In Taiwan, China and Turkey there have also been big improvements. It is very important for countries to have records of strong ground motions so that they know what the hazard is. And I would also say that gathering this information at the museum sites is also of paramount importance. Knowing how the museum site and building moved during an earthquake could go a long way in helping us understand why damage to the collections occurred or did not occur.

Jerry Podany: The gathering of information is, as Paul Somerville has said, so essential to good research and solid conclusions. The field has gathered directly observed evidence regarding the way structures, roads, bridges, essential services, etc have responded to earthquake motions but there is almost a complete absence of any of this observed data regarding cultural heritage collections. The publication *Earthquake Spectra* (supplement to Vol. 6, May of 1990) reported on damage to museum collections after the Loma Prieta earthquake in California and I know there is a report from Kobe museums following the 1995 Hanshin earthquake that damaged Kobe, but to my knowledge that is it: two reports. And yet the engineering and architectural fields recognize this kind of reconnaissance as invaluable in understanding earthquakes and the future mitigation of damage due to earthquakes. Lack of such surveys in the preservation community is a significant failure since we could learn so much from them, including how to prevent damage to our collections in the future. Museums and

institutions with collections must follow this well established practice and be more generous and open with the information they should share after an earthquake has occurred. The preservation field needs to find ways of making that information more widely available.

Vlasis Koumousis: From the perspective of the structural engineer, I think many things have to be done. Of course simple things can be applied directly and they do not necessarily require any experimental or theoretical background. As you said, Jerry, common sense is a good tool. Thinking that any support may start shaking at any time can help the mount maker resolve the problem in cases where the mass, shape and strength of the object are accurately measured and understood. In that respect all the simple methods that combine the efficiency of seismic mounting, together with the aesthetic demands of exhibition display, can be applied directly and immediately. As for more sophisticated techniques, like the use of intermediate lightweight isolators under single artefacts or showcases, which is the next step, one needs specific designs and experimental verification to apply these approaches. At a medium cost, small scale isolators can provide adequate protection for single valuable objects or showcases (Koumousis figure 1). Then comes the question of unique and more massive pieces that require specific attention and efforts, such as Rodin's *Gates of Hell* here at the National Museum of Western Art (Koumousis figure 2), or the Hermes of Praxiteles at the new museum of Olympia in Greece (Koumousis figure 3). Descriptions of these projects can be found in "Advances in the Protection of Museum Collections from Earthquake Damage" www.getty.edu/bookstore/titles/earthquake.html. The ultimate protection of these objects should be based on seismic isolation, utilizing the maturing technology that exists for buildings and bridges, since isolation of entire buildings will offer the ultimate and safest approach. This is well understood in buildings like this one, the National Museum of Western Art in Tokyo (retrofitted with seismic isolation), and with new museum buildings we see around the world such as the recently inaugurated Museum of the Acropolis in Athens. Seismic isolation offers a solution.

Koumousis Fig. 1: a small scale Getty isolator placed under an exhibition show case at the Getty Museum. On the right, the isolator is shown is a displaced position with the protective panels removed.

Koumousis Fig. 2: The monumental bronze "Gates of Hell" by Rodin installed on its base isolator at the National Museum of Western Art in Tokyo.

Koumousis Fig. 3: The monumental marble statue of Hermes installed at the new Archaeological Museum in Olympia. The statue is isolated by a base isolation mechanism installed in a cavity built into the floor. On the right the supporting platform, on which the statue and its pedestal rest, is shown. Note the sufficient space between the edges of the platform and the protective rail that surrounds the exhibition assembly to accommodate the lateral displacement of the base isolation unit (and sculpture).

Ugo Nizza: A study in Palermo has been conducted at the historical centre where the geologists and the civil engineers interested in seismology throughout the territory have looked at the historical seismicity of the Palermo's historical centre closely. Basically the

study looked at the earthquake response of the same groups of buildings over a long time. How were they damaged and then how were they repaired and, finally, how did this repair affect their later response to earthquakes? They have come up with a model which is quite useful and provides a way of setting rules in order to enact mitigation measures. This model can be applied to other locations in Sicily and nearby regions.

Roberto Garufi: I think it is important to apply data that has already been gathered. It is time to take this data collection seriously and to start doing something and quickly. Why are we waiting? We have seen in l' Aquila, where we have had earthquakes continually for some time, the kind of damage that can occur without precautions in place. We are confident that Sicily will do something in the near future. I would say about base isolation of buildings that most of our museums are historical buildings and so it is not easy to install base isolation without presenting a threat to the integrity of the historical building itself. But, in terms of mitigation of collections, it can be done more easily and this is what Sicily will follow up on.

Jerry Podany: Our experience in speaking with institutions and university engineering departments internationally is that a simple mount, a piece of monofilament used as a tie-down for an object, a bit of wax to stick a small object down, all work quite well if made and applied properly. But such simple approaches do not seem to engender much interest in most audiences, especially engineers. What has interested the engineering community is the discussion and development of base isolators. The complexities and technical challenges presented are much more of a draw to them. As long as this is the case, the very basic underlying issues of collections protection are going to lag behind. With reference to protecting individual objects or exhibition cases I must say that I have a sense from this discussion and others that there isn't really an agreement about what works and what doesn't in the area of isolators. Perhaps we should consider clarifying what constitutes effective base isolators (under an object or showcase) versus what may introduce new or greater problems. Let me ask our panellists what direction we should take to better understand base isolation.

Charles A. Kircher: You are absolutely right. We spend a lot of time talking about base isolation because it is very attractive to the technically minded professionals. And it's a dramatic approach for those less technically informed. But most of the time the problem can be solved using much simpler methods and these methods need to get out there among museums around the world. As for isolation of buildings and objects, well, it's not rocket science. We put a man on the moon 40 years ago, and 50 years ago we couldn't even shoot a rocket into space. Here we are 50 years later still debating isolation mechanisms…it's a bit of a joke really. Although we do have the technology to isolate buildings and their contents, I think we can get the simpler stuff out there right away. Isolation will work for some objects, when the resources are there, but most objects can be handled with simple approaches. We need a curator/conservator-friendly guide to tell museums what works and what doesn't. And we need museum standards that describe this. Most of the time, protection of collections can be handled in this way.

Audience comment: My name is Kanda from the Tokyo National Museum. Jerry Podany and Charles Kircher just said that we can do a lot with just simple mounts and materials. I feel the same way in my daily work. However, just to mention the situation in Japan, mount makers are not employed at the museums themselves. Everything must be outsourced. We cannot indiscriminately allow external people to touch the precious cultural assets. If we do not have accurate training, we cannot give accurate and safe

directions. This is something we need to work on. Another area in which new research is necessary is the 3D configuration of cultural assets (modelling and mapping of objects), which is something we do not adequately have yet. This is the basic data that we need next in order to establish safety. For example, if we have 3D configurations, it would be rather easy to calculate the speed of acceleration of a falling object. If we had the data, mount making would be more effective. If we have 3D configurations, there would be various possibilities in packaging for shipping, or even for packaging in storage.

Constantine Spyrakos: If I can say something about research, every country has developed approaches and methodologies. All of these can be enhanced by disseminating information, and this can be easily done. But evaluation that can lead to research is also important. Many laboratories and universities, like the Technical University of Athens and the Getty Museum, have done important research and developed innovative techniques. I think it would be very useful and would have a significant impact on the problems of seismic mitigation, if central laboratories that have shake table facilities could test these techniques directly. It would go a long way in solving deficiencies if these mounts could be adapted according to the results of the shake table tests. What we can see in the literature is that the protection of collections and individual artefacts is much neglected. For example, at the World Conference on Earthquake Engineering in Beijing, there were perhaps one or two papers out of all those presented that addressed the issue of protecting artefacts and museum objects. There is a lot to be done in this area.

Jerry Podany: I could not agree more strongly Professor Spyrakos. At a recent congress in Rome I presented one of only three papers related to protecting museum collections from seismic damage and this was three among 277 published papers at an international congress on the topic of seismic research and mitigation. Let me ask a question of our Japanese colleagues: What do you think is the role of the university research centres in relation to the problem of seismic damage mitigation for cultural heritage? Dr. Spyrakos mentioned the need to do more shake table tests. I agree. But at the same time my institution does not own a shake table, and it is unlikely that it ever will. Contracting a shake table is, as we all know and relative to the typical museum budget, quite expensive and is therefore restrictive for most cultural institutions. How can we resolve this need?

Kimio Kawaguchi: In Japan, a great deal of the work regarding seismic mitigation for museum collections has been done by private companies. I think it would be very advantageous if we could create more interest among the university and government researchers.

Audience comment: My name Teshioki from the Univeristy of the Arts. We collaborate with other educational institutions and centres that specialize in the preservation and restoration of cultural property to educate and preserve cultural assets in the community. We are located in the north of Japan and we conduct community-based research and education. There are many individuals who privately own works of art who can benefit from this research. Seismic isolation is an extremely important area of research. One thing that needs to be made very clear is, as was said by a panel member, is that simpler, more effective, and more advanced research is needed in damage mitigation. I think that cultural assets are not something that only specialists handle. Museums and universities should play a central role and advance research in a way that is more community oriented and will broaden the base of research.

Audience comment: My name is Kanaba and I believe we must consider a minimum limit for each cultural asset, how much we want to preserve, as an expectation value. Therefore, one method is to take these cultural assets to places where earthquakes don't occur. If you're thinking in terms of say, 500 years, then you need an isolator that will protect them from an earthquake that happens once in 500 years. Or, you may want to concentrate on protecting the environment. It is important to think about the balance of the whole and consider how much we should do for disaster measures and if necessary, put more effort into it or use an alternative method for research.

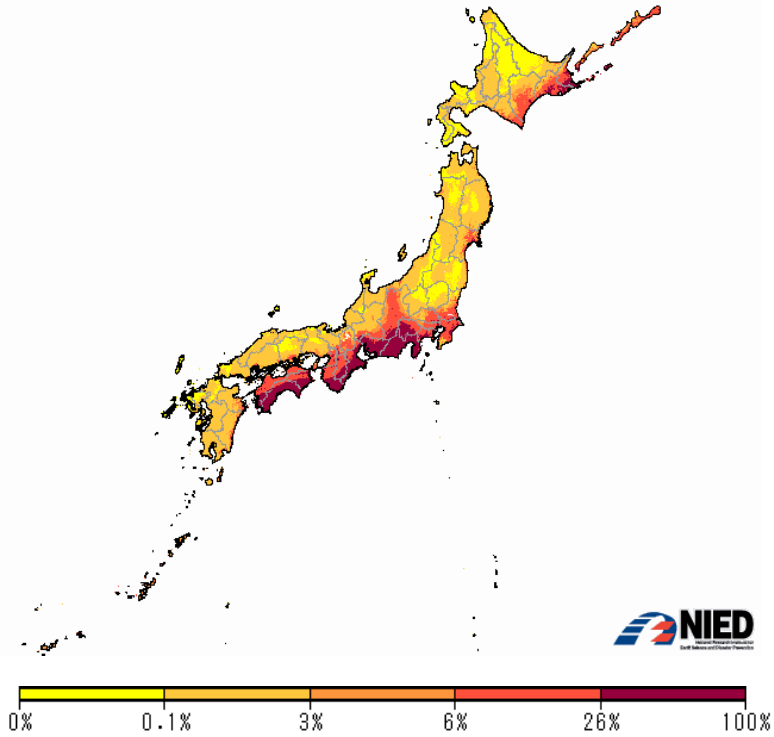
Jerry Podany: It seems that there is agreement among the audience members that we in the cultural community don't know enough about the degree of threat presented by earthquakes nor do we know enough about what to do in order to reduce the damage earthquakes cause. There also seems to be a consensus that you, members of the engineering and seismology professions, have the answers. Do you have the answers? How can we increase the communication and the collaboration between the worlds of seismology, engineering, research universities and museums (which may or may not have staff to implement the solutions)?

Vlasis Koumousis: Coming back to the role of the university, apart from the systematic production of new knowledge, there is the question of how to disseminate this knowledge. You mentioned this before, Jerry. Eventually we have to encourage the development of a relevant database. Meanwhile we can start something immediately, on a smaller basis. Every one of us, who has particular experience in seismic protection of artefacts and has applied a specific solution, should publish this information on a web site following a specific format and set of guidelines. A bigger program has been developed under the Earthquake Engineering Research Institute (EERI) and on the web there is the so called "world housing encyclopaedia" (www.world-housing.net). On this site, subject to a review process and a specific format, many case studies have been published concerning different typologies of buildings made from concrete, wood, adobe, brick, etc., reporting their response to major earthquakes and the strengthening measures taken. Perhaps we could contact them and see if they could help. Of course funding is needed to start and maintain this database. But if we agree upon a format and start presenting at least a couple dozen cases every year, we can start something useful and perhaps it will eventually attract more people and provide more information.

Bilgen Sungay: I agree that the internet would be a good way of disseminating this type of information. As I mentioned earlier we already have an effort to disseminate such knowledge using the web address www.eqprotection-museums.org. What we are further planning is to define the limitations of the local seismicity for the typology of the objects. Putting aside the works of art that need special attention, we can categorize the objects and make a study of these categories. From that we can then create a kind of guide book so that objects that fall into specific groups could be stabilized according to the characteristics and research done on that group. In Turkey (perhaps it is the same in all countries), museum buildings themselves also need to be structurally examined.

Constantine Spyrakos: Developing videos that show the basics of seismic vulnerability assessment and artefact protection techniques would be very useful to museum professionals. Such introductory training material could also become available through the internet for easy access.

Paul Somerville: It is relatively easy to find the seismic hazard map for Japan online (Somerville figure 2) http://wwwold.j-shis.bosai.go.jp/j-shis/index_en.html, and this of also true in the United States as well (Somerville figure 3) http://earthquake.usgs.gov/research/hazmaps/. A lot of information on seismic hazards is now becoming available online. And, as I said, the GSHAP map was a first crude start and the GEM map will be much better. I think the way forward is to find this information online and promote it in a way that helps people know what it is and how to use it.



Somerville Fig. 2: Map of probability of ground motion in Japan exceeding JMA Intensity 6 Lower in 30 years starting January 1, 2008.
Source: http://wwwold.j-shis.bosai.go.jp/j-shis/index_en.html

Somerville Fig. 3: Map of peak acceleration on soft rock in the United States having a 2% probability of exceedence in 50 years. Design ground motion values are typically 2/3 of these values in the United States.
Source: http://earthquake.usgs.gov/research/hazmaps/

Jerry Podany: So, the engineer and engineering seismologist as interpreter and guide?

Paul Somerville: Yes.

Charles A. Kircher: I would like to follow up on Bilgen's comment. Whether it is a guideline or, even better, a standard, the document we are envisioning should identify the seismic hazard sources and some basic criteria to evaluate and mitigate the threat. It should have examples that illustrate the concepts and it should somehow be sanctioned so that it is an official document. In this way, other museums will recognize its authority and other countries might consider using it. The information needs to get into a guide or a set of standards in some official way to make the information useful.

Roberto Garufi: The approach Charles Kircher was describing applies to Sicilian cultural heritage. In the past and in conjunction with other Mediterranean countries, we have developed guidelines for the repair and preservation of ancient theatres. These requirements are enforced by political institutions and apply to all the provinces of the region and their superintendents. We could do the same with methods of seismic mitigation. May I also add that In Palermo we have a shake table at the University and I think we could undertake the mount evaluations mentioned earlier.

Jerry Podany: Thank you, I think we all should keep your offer in mind. It is unfortunately the case for all of these roundtables that about the time we get warmed up…it is time to stop. I am going to ask each of the panellists, who have so generously given of their time, experience and wisdom, to make a brief concluding remark.

Charles A. Kircher (USA): This has been a great experience; I will just repeat that we need some sort of standard or guideline that presents the information that is already available in a "museum-friendly" format. In this way, the information can be immediately used. We should not get bogged down in researchers' differences of opinion. We know enough to get this started in an effective and helpful way. We need to make the information that is already available "implementable."

Paul Somerville (USA): Today, seismic hazard information is more reliable and more available around the world online than in the recent past, and this will help in the future. We should use it now.

Kimio Kawaguchi (Japan): It seems to me that right now what is most important is communication. We need to be sure that all heritage professionals (conservators, curators, directors of museums, etc) are aware that we can do something to protect our collections now. While more research is needed and while we can always improve our methodologies, there is no reason not to implement what we know works. I think a guidebook outlining all of these concepts is the next step. It is very much needed.

Vlasis Koumousis (Greece): From a purely structural point of view, the simpler a method or an approach is the better. This concept of simplicity has to be combined with the recognition that every artefact is a unique piece and needs special attention.

Roberto Garufi (Italy): We are taking the right steps toward the drawing up of these rules, standards or guidelines. These will enable us to actually act in order to save our culture heritage and collections. It is a must for all of us.

Ugo Nizza (Italy): Sicily is experiencing this now, it can be done. These are not theoretical ideas; we are doing it now. At the end of this work there will be a set of rules that need to be decided upon and applied as soon as possible.

Constantine Spyrakos (Greece): While I agree that there are simple measures available to museums today, I think the involvement of engineers at some level is important for success. We need to share information and improve our communication. The internet will be very helpful, as will training videos. We should disseminate available information through effective use of the internet; prepare guidelines that could be easily modified to satisfy local seismic hazard and artifact vulnerability; inform the public and officials about the great loss of valuable and irreplaceable artifacts, a part of cultural heritage, during earthquakes; and we should encourage the organization of conferences, such as the present series initiated by the J. Paul Getty museum.

Bilgen Sungay (Turkey): We should keep this format, meetings like this roundtable and the seismic conferences that have been focused on collections. They allow us a very productive way of raising awareness as well as sharing information and developments…they allow us to network in a productive way. They also help us to advance ideas about training. We need to have an effort to put this subject on the agendas of governments and funding agencies. They will have the power to impose rules and sanctions through policies and codes, and to assist with financial support.

Jerry Podany (IIC): Thank you. My last comment is also about sharing information and realizing the importance and power of that information…how it enables us to reach our mission of preservation and responsible stewardship of cultural heritage. I am aware of only two cases where cultural heritage collections were surveyed after a major earthquake; Kobe 1995 and the 1989 Loma Prieta earthquake. The latter survey was published as a short report in the Earthquake Engineering Research Institute's publication *Earthquake Spectra* (supplement to Vol. 6, May of 1990). To my knowledge surveys such as these have never been done since, despite the many earthquakes that have occurred in countries all around the world and despite the significant loss to cultural property. Museums, with or without engineering assistance, need to start directly sharing information about what happened to their collections and to their buildings during an earthquake. They need to openly share information about what was damaged and what was not, so we can use that information to develop more effective preventive measures. Museums must overcome embarrassment and defensiveness, and start sharing this information for the greater good of preservation. We can learn a great deal from our mistakes and from the surprises that occur. These will allow us to do a better job at saving cultural heritage.

This IIC roundtable had the purpose of raising awareness among the various professions whose future work will make it possible to share a deeper understanding of earthquakes and will make earthquake damage mitigation for cultural property a common reality. This event was also meant to raise the awareness in museums, administrative offices and the public sector about the possibilities of damage mitigation and the significant need to start the application of these approaches immediately. Our discussions have ranged widely. We have heard that while the fields of seismology and

seismic engineering are always advancing, there is still a great deal we do not know about earthquakes, and a great deal we do know that is also widely available. We in the heritage preservation sector simply need to learn where to look and we need to be tutored in how to interpret and apply that information. Ambitious projects have been described to map the world's seismic activity and hazards. But too little in this discussion was heard with regard to the area of assessing the seismic risks to our cultural heritage. Given the devastating effects of earthquakes on collections worldwide this lack of risk evaluation is surprising. We cannot ask the engineering field why we lack this resource since such assessments cannot be undertaken solely by engineers. The development of partnerships between heritage professionals, engineers and seismologists is essential.

Perhaps some would say that any effort to address earthquake threats is impossible, since we cannot, it seems, accurately predict earthquakes. But this is not, in fact, the case at all. We can predict earthquakes. In regions of moderate to high seismicity…they will happen. And in the end, isn't that all we, who struggle to preserve our cultural treasures, really need to know to take action? Shouldn't the awareness of this fact be enough for us to take the appropriate actions to prepare and protect our collections for the inevitable? Inexpensive and simple methods that have been proven to dramatically reduce earthquake damage to collections are available now. We simply need to increase awareness, invest in training and build the commitment as well as the will to apply them. More complex approaches have also been discussed, but even in these applications there has been a call for advancements that should already be in place but have been neglected. Several suggestions have been brought forward regarding a shared database of mitigation efforts, available to all and contributed to by anyone who has undertaken research, developed mitigation approaches, or applied damage mitigation measures. Since earthquakes are a global threat, it makes good sense that the solution should come from a worldwide effort. Some have suggested policies and regulations to enforce standards and guidelines as a way to achieve the goal of damage reduction and to gain a place on the agenda of funding priorities. Others have suggested that training, whether in the conservation educational programs or in venues like this roundtable or focused congresses, is a way forward. But all agree there is little reason to wait--for legislation, databases, or curriculum development--to begin implementing mitigation measures.

Those of us who have experienced the destructive power of earthquakes and who have stewardship responsibilities for cultural heritage in regions prone to seismicity, know that earthquakes are complex phenomena. And we know that the devastating results that earthquakes bring are complex challenges. But we have colleagues in engineering, seismology, architecture and geology that can help us face these challenges, understand them better and develop methodologies that will reduce the damage and loss. If we work together we can achieve a great deal. There is nothing less than the survival of a large percentage of the world's cultural heritage at stake.

Let us resolve to start today.

I want to thank the panel members for their insights and willingness to share their expertise. Thank you again to our host the National Museum of Western Art, and the museum staff who lent us their significant organizational skills. And a heartfelt thanks you to you, the audience, for participating in this IIC roundtable.

Addendum: It is a particular pleasure to welcome ten new members to the IIC. They are all students or recent graduates from the Tokyo Geijutsu Daigako (Tokyo University of the Arts) who have been sponsored by Mr. Noriyoshi Horiuchi to attend this roundtable and join the international conservation community through the IIC. We also thank Akiyo Maeda for managing Mr. Horiuchi's generous gift. When we speak of our responsibility to mitigate the challenges presented by natural threats such as earthquakes, we must turn to young conservators and heritage professionals such as this group to apply their enthusiasm and commitment. They are, after all, the ones who will seek future solutions.

The new IIC members are pictured left to right: Satoko Taguchi, Aiko Seta, Keiko Kida, Akira Fujisawa, Kang Lee, Natsuko Kugiya, Kanako Sanei, Yukari Kai, Manako Tanaka, Jincheng Xie and their instructor Professor Masamitsu Inaba.