Report on the 31th Seminar

"International Cooperation in Cultural Heritage from the viewpoint of technologies"

JCIC-Heritage

Japan Consortium for International Cooperation in Cultural Heritage

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Explanatory note

This report includes presentations and discussions at the JCIC-Heritage's 31st Seminar (Webinar) "International Cooperation in Cultural Heritage from the viewpoint of technologies" held on August 28, 2022 under the sponsorship of the Japan Consortium for International Cooperation in Cultural Heritage and Agency for Cultural Affairs. This report consists of transcripts of voice recordings, which have been slightly edited into a report format. All photographs of unknown sources and used in presentations are provided by the presenters.

Organizer：JCIC-Heritage Secretariat, Agency for Cultural Affairs

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Program

Purpose of the Seminar

In the field of cultural heritage protection, the introduction of new equipment and technologies has made ducumentation and preservation work more efficient and accurate in research and surveys, and at the same time, the introduction of various technologies has brought dynamic changes in research and survey methods and international cooperation itself.

In this seminar, we will introduce specific examples of international cooperation on cultural heritage in which Japan has been involved to consider how we should deal with new technologies in the context of activities conducted in diverse social and cultural backgrounds.

● 15:00—15:05

Opening Remarks/Briefing on the Purpose of the Seminar

AOKI Shigeo (Vice Chairperson, Japan Consortium for International Cooperation in Cultural Heritage)

● 15:05-15:25

"The Changes of Technologies in Societies: How We Should Work with New Technologies"

KAMEI Osamu (Adviser, Center of the History of Japanese Industrial Technology, National Museum of Nature and Science)

● 15:25-15:45

"Multilateral Cooperation for Adapting New Technology: Research and Protection of Cultural Heritage by Cambodian Archaeological LiDAR Initiative"

SHIMODA Ichita (Associate Professor, Faculty of Art and Design, University of Tsukuba)

● 15:45-16:05

"Extending Cultural Heritage Protection Using the Latest Technologies at Hand: Towards Documentation which Anyone can Work together"

NOGUCHI Atsushi (Visiting Fellow, Kanazawa University Institute for the Study of Ancient Civilizations and Cultural Resources)

● 16:05-16:50

Panel Discussion

Moderator: TOMODA Masahiko (Secretary General, Japan Consortium for International Cooperation in Cultural Heritage), KAMEI Osamu

Panelists: SHIMODA Ichita, NOGUCHI Atsushi

● 16:50-17:00

Closing Remarks

TOMODA Masahiko

Opening Remarks/Briefing on the Purpose of the Seminar

My name is AOKI Shigeo and I serve as Vice Chairperson of the Japan Consortium for International Cooperation in Cultural Heritage. Thank you all for joining us today at the 31st JCIC-Heritage Seminar. In light of today's seminar title, "International Cooperation in Cultural Heritage from the Viewpoint of Technologies," I will be discussing surveying technologies in the field of the conservation of cultural heritage. Such technologies are making great strides.

Let us look back on the history of photographic surveying, or photogrammetry, in Japan. In the field of cultural heritage, the first example is probably the 1954 creation of a 1:1000 map of the remains of the Heijo-kyu imperial residence, using aerial surveying. Photogrammetry of the Kamakura Daibutsu (The Great Buddha of Kamakura) was the first example concerning statues of the Buddha. In the Great Kanto Earthquake of 1923, the platform of the Kamakura Daibutsu collapsed and tilted, leaving the statue with a cracked neck. In order to reconstruct the platform with earthquake-resistant mechanisms and repair the neck, data on the Daibutsu such as its weight, center of gravity, and surface area was required; the first photogrammetry of a Buddhist statue concerned with cultural heritage thus took place in 1959. In 1970, a Central Asia research team from Kyoto University conducted photogrammetry of the Buddhas of Bamiyan and their cliff wall. Their records now constitute precious 3-dimensional data of the state of the Bamiyan ruins and the Eastern and Western Buddhas before their destruction.

Overseas, we are all familiar with the transfer through UNESCO support of the Abu Simbel temples and other Nubian monuments, which would have been submerged during construction of Egypt's Aswan High Dam. The transfer began in 1964 and was completed in 1968. In order to shift and reconstruct the removed stones to the correct positions, as well as to recreate the phenomenon in which, on specific days, the sunlight shines in from the temple entrance on the gods within the sanctuary, accurate 3-dimensional survey data was required and obtained by photogrammetry. These examples all belong to the era of photogrammetry when a stereoplotter was used to plot 3D images from analog stereo photographs.

Thereafter, as computers became available, they were first used to digitalize and plot analog photographs via scanners. From that time on, laser survey technology development began. Thereafter, as digital cameras appeared, photogrammetry entered its full-scale digital era. Today, thanks to the rapid advance of technologies like SfM (Structure-from-Motion) multiview stereo photogrammetry and laser surveying such as LiDAR, recording and application of 3D data has become common in the field of preservation of cultural heritage. This

AOKI Shigeo
(Vice Chairperson, Japan Consortium for International Cooperation in Cultural Heritage)

kind of use of technology enhances the efficiency and precision of survey research records and conservation work, as well as changing the nature of international cooperation itself. In particular, it is extremely important in areas affected by natural disasters and conflict.

Today we will hear about specific examples of the use of new technologies on the ground of international cooperation in cultural heritage. As there are issues raised by the fact that 3D surveying is now possible for anyone in itself, I hope that the subsequent discussion will address the significance and issues of the introduction of this technology. I hope this will become an opportunity to consider how we are to handle new technologies amid efforts at international cooperation conducted in a diverse social and cultural context.

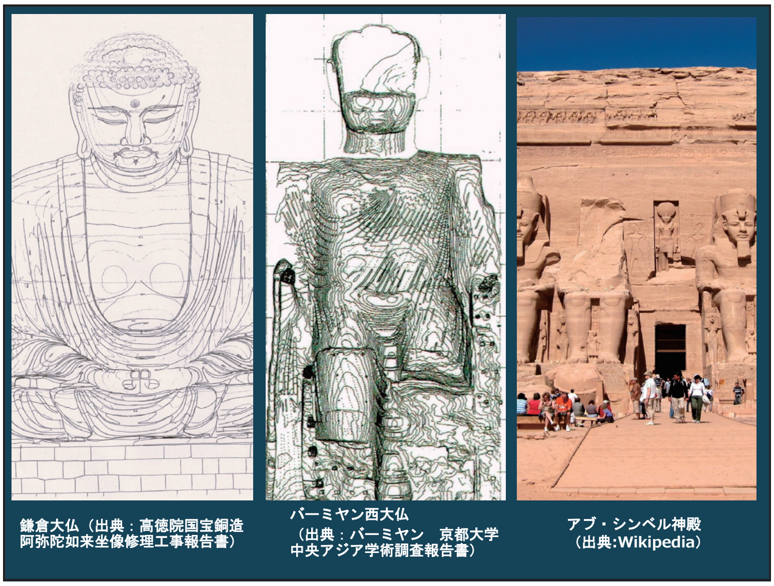


Figure 1

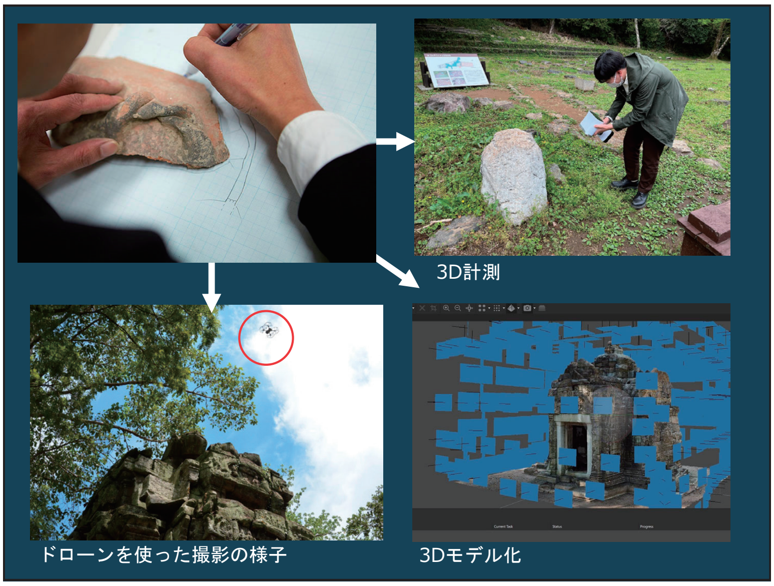


Figure 2

"The Changes of Technologies in Societies: How We Should Work with New Technologies"

KAMEI Osamu
(Adviser, Center of the History of Japanese Industrial Technology, National Museum of Nature and Science)

KAMEI Osamu is based in Chiba Prefecture. He has a Ph.D (Engineering), with a focus on industrial chemistry (organic resources/energy/environmental science). He has worked establishing public libraries and museums as well as research positions before present position. His research on the history of industrial technology explores the past and future of humanity and nature, considering technology as "the totality of the skill and knowledge needed for humanity to survive," and industry as "economic activity for the enrichment of humanity." He enjoys various research activities in cooperation with Japanese and overseas researchers, from sociological perspectives such as museum studies and science communication, to natural history perspectives such as the Anthropocene, awareness of human activity on a global scale, and ICOM-NATHIST.

My name is KAMEI Osamu and I work at the National Museum of Nature and Science. The title of my talk today is "The Changes of Technologies in Societies: How We Should Work with New Technologies." SOCIETY, in Japanese, I am aware that the term can represent a narrow field, such as local communities, each region or profession, to a large category, such as human society, culture or civilization. While my place of work brings to mind images of dinosaurs and biodiversity these days, it was first established in the early Meiji era in the late 19th century as a museum engaging in education on science and industrial technology for the *shokusan kogyo* (promotion of industry) policy、, which formed a part of *fukoku kyohei*, creating a rich country with a strong military, and was the policy, intended to bring Japan onto equal terms with the Western powers. Research on botany, zoology, geology and so on at that time was heavily slanted toward the practical -- does this have a medical use? could it be made into leather? are there better minerals available? and so on. In accordance with the progress of technology and the changing face of the world, the museum has a history of growth and contraction, sometimes barely surviving, while finding new social roles amid the changes and thus changing its role and format. As its 150th anniversary draws near, the museum

Figure 1

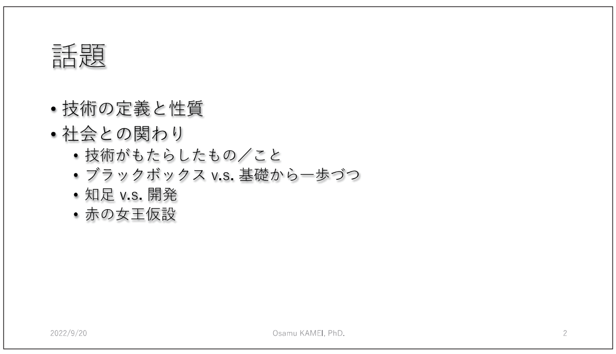


Figure 2

functions as a repository of natural history, human history, the history of technology, and the history of science; however, the latter two -- the industrial technology which is my field -- are now “endangered species” within the museum. (**Figure 1**)

Figure 2 shows the topics of my discussion today. I will focus mainly on the definition and properties of technology as well as its involvement with society.

First, the world is full of things we don’t know. The large square on the outside in **Figure 3** represents all the things we don’t know in the world. The circle within it is the things we do know. The borderline of these two things is where “things we don’t understand” are. These “things we don’t understand” are the questions posed to science and technology, as well as being the scope of science and technology, or as we say in Japanese *kagaku gijutsu.*

Next, here is a diagram visualizing the applicable range of technology. The horizontal axis is time, with the present at the right end and the beginning of modern humanity at the left, covering approximately 200,000 years. The vertical axis is the range of the use of technology. The range becomes wider toward the top. Technology is defined as “the totality of the skill and knowledge needed for humanity to survive.” This suggests that the range in which technology is applied extends throughout the entire range of human activity, from the time humanity emerged until now. The light-colored lines show politics, sorcery, religion and so on, all forms of social technology. In comparison, “science” developed rather recently; while its history may be short, it is a form of technology which serves as a versatile tool with a sharp cutting edge. The green square represents research, covering a slightly different range from that of science. Although this figure shows science expanding beyond politics, doubts do exist. Technology, including science, is -- as I will mention later -- affected by conventional wisdom and existing paradigms.

Incidentally, here I have written “kagaku gijutsu” in romanized Japanese. This phrase is the Japanese term used to refer to technology integrated with science at a high level, differing from the English “science and technology.” To express its particular characteristics, the Japanese term is sometimes used, with explanations, at international conferences and so on. (**Figure 4**)

In addition, we must also note that “predicting the future is difficult.” For example, when dealing with the simple harmonic motion which comes up early in school physics classes, the future position and speed of the pendulum can be accurately predicted with a simple equation. Predicting the future seems easy for science. However, when another pendulum is added to create a double pendulum, the future position and speed become impossible to predict. Research on complex systems and chaos is taking place in order to address phenomena like these, but we are not likely to find simple, accurate ways to predict the future any time soon. (**Figure 5**)In short, simulations are no more than simulations. Widely varying interpretations of the same data are often produced.

For example, climate change is one good

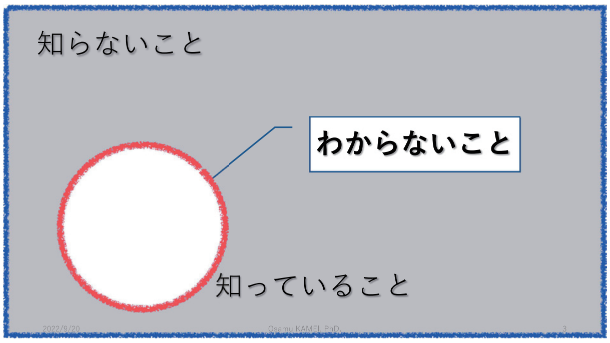


Figure 3

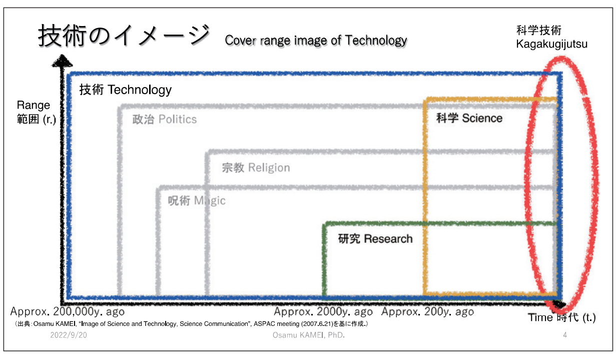


Figure 4

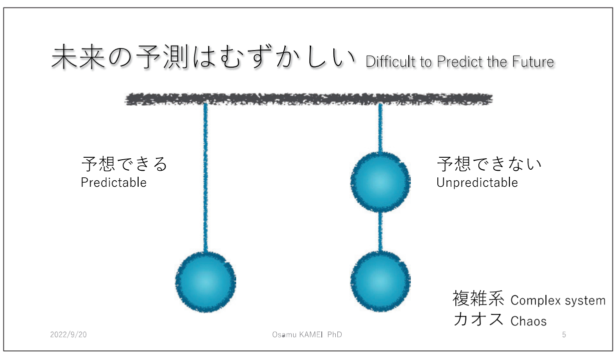


Figure 5

example, as a topic involving the future of the earth. Simulations of climate change produce entirely different conclusions based on the same measurement data, depending on the calculation conditions set. At left is a site full of threatening climate change-related photos. At right is a site insisting, based on data analysis, that there is no crisis. Many world-famous scientists are involved with topics such as these. While I have provided sites at the extremes for illustration, many different stories arise from the same measurement data on the same earth, the same planet. In short, entirely different interpretations of the same phenomena are possible. This is a reflection of the difficulty for science in grasping an image of the whole that extends to parts with no measurement values, or of predicting the status of the future, a complex system. A future “told through science,” using science where it might be effective, might look like one in which bold hypotheses based on human ideas and engineering methods are accompanied by practical use as something scientific in some way. This is where we find that simulations are only simulations. The desired conclusions can always be reached by changing the algorithms or the conditions set.

Science is of greatest use within the range that can be scientifically understood. The term “unexpected” when used by experts indicates “what we are not thinking about.” Rather than meaning “something we did not think to expect,” it is used to mean “something our expectations are deliberately not addressing.” “Extrapolation” sometimes employs science to address the unexpected. It must be used in expectation of wrong answers as well as right ones.

You would think the truth is unique, but it's not unique in the real world. Given normal-sized space and time, we may admit that facts are unique. But the truth is the application of human interpretation to facts. We are hardly in need of KUHN Thomas’s view of paradigm shifts to understand that human interpretation is affected by emotion. This means that there are as many truths as human beings want to see. The phenomenon arising, to misquote that young detective, is one in which each fact is accompanied by many truths. The truth changes according to the eye of the beholder -- their beliefs and what they take as common sense. (**Figure 7**)

I imagine that similar difficulties arise when considering the past and future in the context of international cooperation in cultural heritage, our topic for today. As we work, we keep in mind the fact that the figures constituting measurement results may have been attained through new technologies,

Figure 6

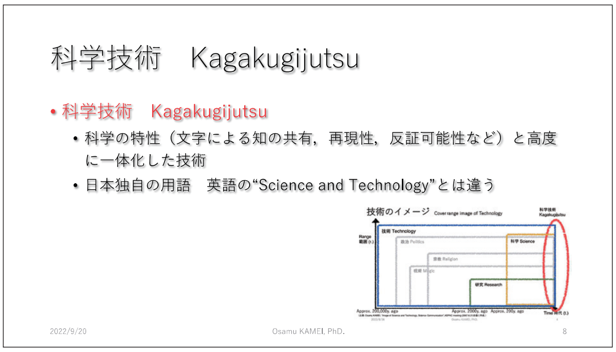


Figure 8

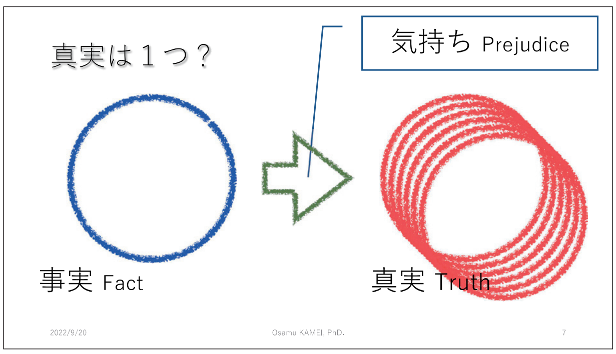


Figure 7

Figure 9

old ones, or any at all, that no matter how accurate they are, they depict only a "hypothesis" of the time in question based on our current perspectives. In my main area as well, the world of industrial technology, we tend to assess past living environments, the use of technology and materials and so on, based on current perspectives; we must also, however, remain aware that this may not be appropriate. We must not eliminate the possibility that we are seeing what we want to see, making assumptions about how people should be acting, or being led to focus on a specific direction. Falsifiability is the most important, most essential point in science as technology.

Accordingly, let me share my definitions. **Figure 8** confirms that the word kagaku gijutsu indicates technology integrated with science at a high level. The properties of science include the sharing of knowledge via text, reproducibility, and falsifiability. As shown in **Figure 9**, science is a systematization and theorization of knowledge extracted via technology, making it one aspect of technology. **Figure 10** confirms that technology is the totality of the skill and knowledge needed for humanity to live. Characteristic properties of technology include the resolution of human issues, being request-driven, and handling unknowns. I will omit here the explanation of industrial technology in **Figure 11**. Industry as represented in **Figure 12** is a general term for the activities which enrich humanity materially, economically, and spiritually.

Figure 13 shows the request-driven nature of technology. Human requests are fundamentally for the resolution of issues. Technological development proceeds to work on these issues as society, when permitted the use of the necessary resources such as the time and budget needed to find solutions. The history of technology is the practical handling even of things which science does not understand. When an issue exists and is then resolved, the next issue arises; this repetition is also the history of technology. **Figure 14** is a familiar example in the field of the history of industrial technology. In a time when people wanted to conduct industrial activity, to

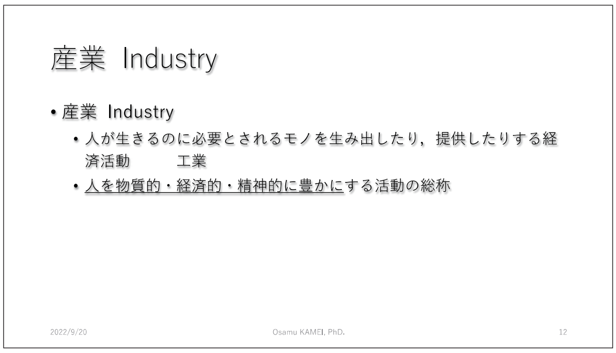


Figure 12

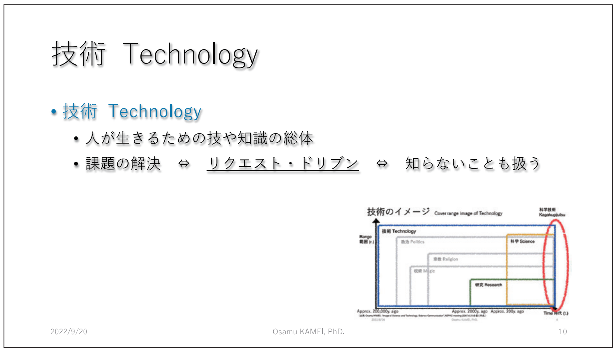


Figure 10

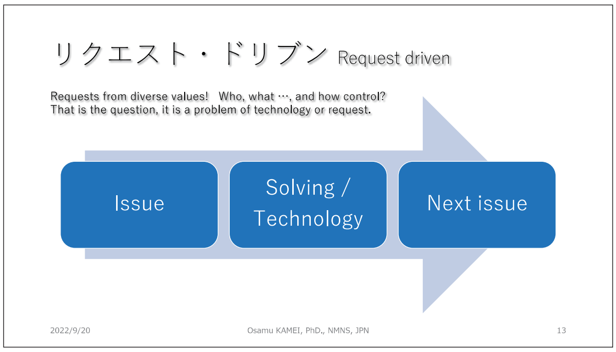


Figure 13

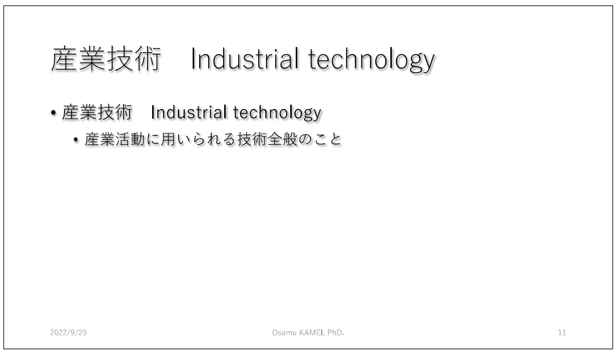


Figure 11

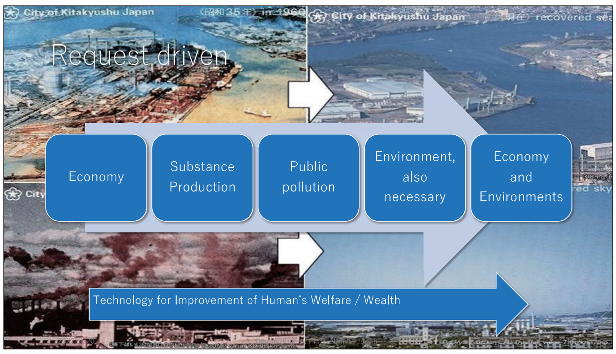


Figure 14

make things, to get things, to get money, in a certain area around Kita-Kyushu, society was in favor of making as much as possible. The left background of the photograph shows the multicolored appearing on the ocean and the sky at the time when these wishes came true. Now an infamous sign of pollution, at the time it was considered a symbol of regional pride, like coal mining folk songs. As a result of protests and calls for technological development for the environment as well, along with the arrival of economic conditions permitting money to be used for this technology, the blue sea and sky in the right photograph came about through a combination of economic and environmental improvement. This example is a simple description of the properties of technology in industry.

Figure 15 shows the importance of balance, that is compromise, in the application of technology. Realistic solutions appear by moving forward selectively with technology while paying close attention to the balance and compromises between the environment, everyday life, and economics. There are multiple solutions. The reasons the current technologies are widely used from among the many other options, can be explained after the fact, but more often than not the reason is "by chance." Humanity has multiplied and found success while solving problems with this kind of random selection of technology.

The graph in **Figure 16** is used to explain the Anthropocene, showing that the history of population increase does not follow a consistent line, but rather shows a sharp increase in recent times. This major turning point was the full-scale use of fossil fuels for industrialization, also called the Industrial Revolution. An even more essential turning point came in the 1950s, with the extension of large-scale consumption to the masses. This was supported by the dollar-a-barrel crude oil produced in the Middle East and supplied effectively bottomlessly after World War II. This oil enabled the masses around the world to take up mass production and material consumption, realizing a modern world in which no one would starve and everyone could live long, healthy lives. While it may run against our instincts to say so, economic inequity is clearly being reduced as well.

I was born at the end of the 1950s. The image most people have, in particular my contemporaries, is of a world divided into affluence and poverty, like the two lumps in the **Figure 17** graph. But the reality is different. Viewing the facts through recent figures, we find that, as shown in the **Figure 18** graph, the number of people in the poverty category is clearly

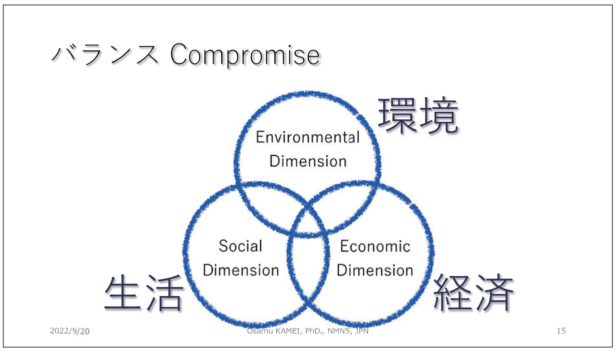


Figure 15

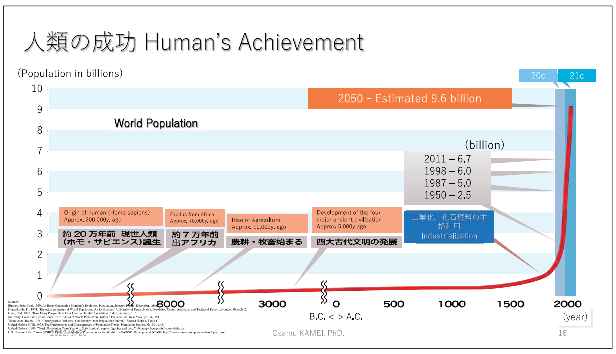


Figure 16

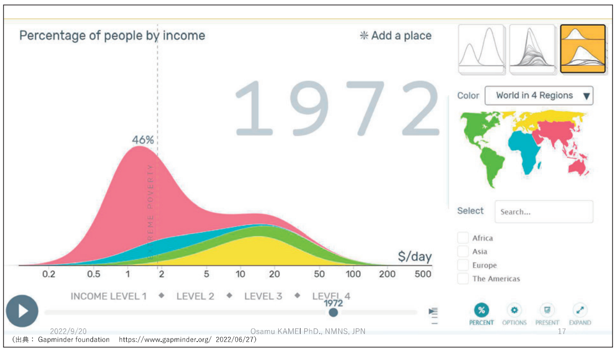


Figure 17

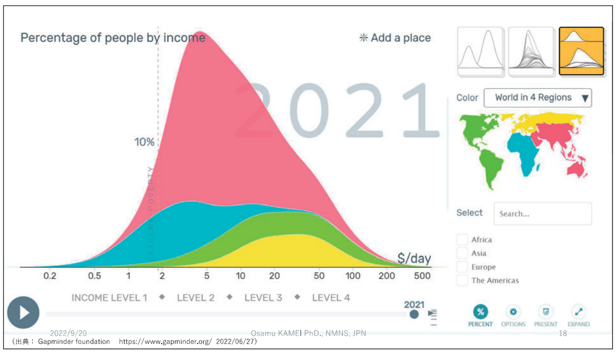


Figure 18

decreasing. The middle class has vastly increased, and those in the affluent category are increasing as well. While we tend to think that people starving or suffering in poverty are increasing, based on video images of war and natural disasters, in fact their ratio is continuing to decrease, currently reaching a low never before experienced by the human race. If anything, we now have problems like an excess of food production, and the use thereby of food such as agricultural products for non-food purposes, trading, and so on in order to prevent food prices from falling (**Figures 19** and **20**). For the first time in history, we have reached a stage where, in terms of humanity as a whole, more people die of overeating than of starvation. I will skip over my discussion of the evidence that fossil fuels and oil are not going to run out, but the figures show that we may consider ourselves at a stage where the absolute quantity of energy, as well as food, will not run short. (**Figures 21** and **22**)

Figure 23 shows the sustainable development goals (SDGs). The individual goals are no different from humanity's approaches over the last 2000 years, let alone the previous UN millennium development goals (MDGs). The only major difference is the clear awareness of methods which realize "leaving no one behind." The MDGs were goals for developing countries alone. The SDGs are a declaration on the part of the UN, as an engine for sustainable activities rendering people around the world, including developing countries, better off, to use economic activities involving developed countries. Sustainable development is economic development. This is a statement of determination that, rather than relying on aid from developed countries and rich philanthropists, the resolution of issues must take place through the growth of both developing and developed countries based on economic activities. The UN has established economic activities as a sustainable method of achieving its goals.

I have already demonstrated that the era prevailing until now of human poverty and inequity is approaching its end. When there is no longer

Figure 21

Figure 19

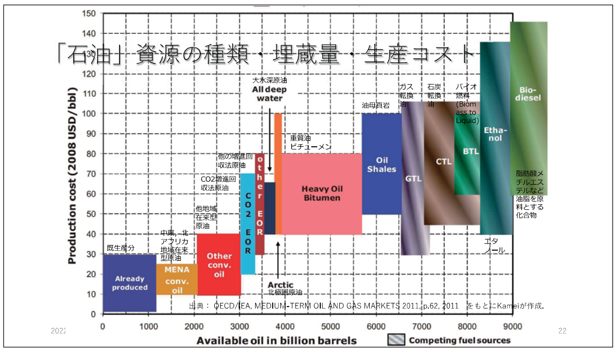


Figure 22

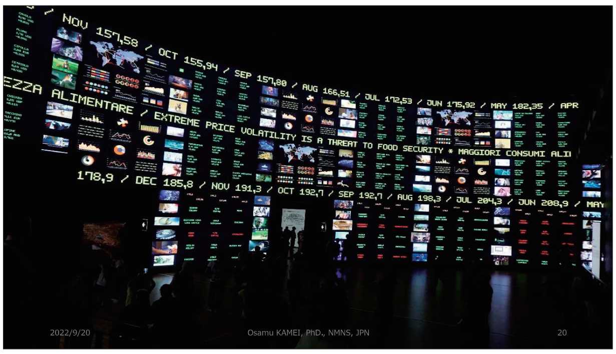


Figure 20

Figure 23

any clear economic inequity, the method of taking from the rich countries to give to the poor ones will no longer work. If developed countries do not use economic activities supporting wealth as well, they will no longer be able to guarantee sustainability. The human race has no experience, at least within the history of modern and contemporary nation, of sustaining mutual aid without inequity. I believe that a new era is beginning; however, we have no way of knowing how it will unfold. Past experience may not serve to resolve future issues. We must recognize that we are living in the age of uncertainty (VUCA). (**Figure 25**)

Next, let me discuss the understanding and use of technology. We were once taught that we must understand the content of technology, that it must not be used as a black box. I was taught this way myself. However, black-box technologies will only increase from now on. When a technology comes into everyday use, with no need to be aware of its existence, the technology starts to become a black box. Or perhaps it is at that moment that it completes the process of becoming a black box.

In the past, when social and technological change was more gradual and the range and quantity of necessary knowledge were limited, steady study from the basics up would enable mastering knowledge, succeeding in academia. But the mountain of knowledge has grown taller and keeps on growing, so that reaching its height step by step is ill-advised now. **Figure 26** shows a learning method comparable to using a helicopter to approach the goal. This method involves beginning with study of the necessary technology, picking up its principles and fundaments later on. Practical study requires an awareness of this method as mainstream practice.

Figure 27 is a reference example from industrial technology. JES was a prewar industrial standard. After World War II, it was aligned with the United States Military Standard (MIL) to become JIS. As JIS was created through a transplant of the inch-standard MIL, it involves a number of complicated decimals. Lengthy figures were established as the standard, based not on scientific reasoning but through the simple conversion of engineering data from inches to millimeters. Japanese industry, called on for compliance with standards involving three and four numbers after the decimal point, responded by increasing its precision to reach top global standards. When our faraway descendants excavate modern-day objects, measure them, and examine the figures, they may decide that the Japanese manufacturing industry aimed and succeeded deliberately to reach a high standard of precision at some point.

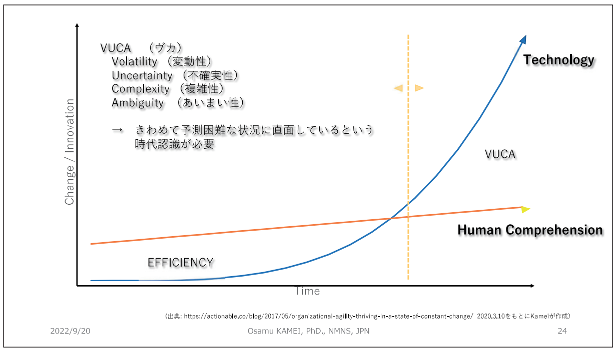


Figure 24

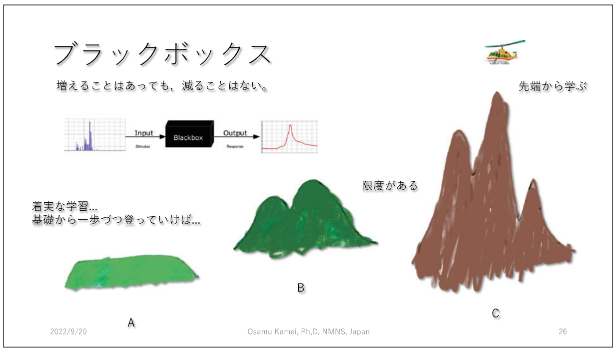


Figure 26

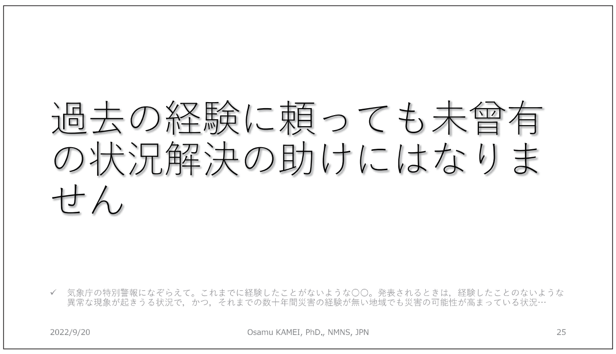


Figure 25

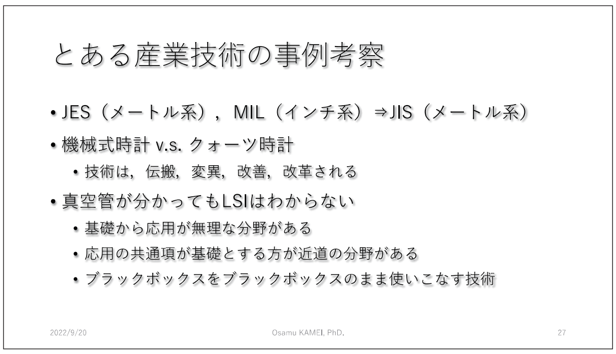


Figure 27

Another example is mechanical and quartz watches. We no longer have the technology to mass-produce accurate mechanical watches. Mechanical watches cannot be produced with the technology used to produce far more accurate quartz watches. The two technologies are not the same. In this way, for good or ill, one technology replaces another. Technology is possessed of the properties of transmission, mutation, improvement, and reform.

Myself included, we are seriously hidebound by the attitude that we can climb the mountain step by step from its base and eventually understand everything. However, take the field of electric circuitry, for instance; it would be no easy task to start by studying vacuum tubes and eventually come to understand LSI (large-scale integration). The electron tube technology which has played such a major role historically is effectively useless when it comes to LSI. In this way, there are many fields where studying from the basics of science to its application is difficult; in reality, we extract theory from application and call it science. There are an ever-increasing number of fields where we find ourselves at the top of the mountain and must continue using the technologies at its foot as black boxes. Science is a systematization of the common points of application. While there are still some fields where science can be learned from the ground up, there will be more and more where we must enter from application and configure the basics therefrom.

I mentioned the need for technology education enabling these black boxes to be used as black boxes. While we need to consider how to handle the technologies of the past and what characteristics these boxes possess, let me also confirm the need for education which teaches the use of most of these black boxes as black boxes.

Figure 28 shows a perspective on the affluence of the people shaping the background of technology. Upon self-reflection, I find that around the beginning of the 21st century, I believed that we had entered an era of chisoku, or "awareness of sufficiency." I thought that if humanity were to continue with the level of abundance that it had attained thus far, this would be sufficient. The UN SDGs showed me that this was a lazy attitude. For all humanity to live in abundance, we need a sustainable framework for moving forward together. Maintaining the status quo, all enduring together, is not a sustainable framework. In this context, rather than chisoku, awareness of sufficiency, I have the Red Queen hypothesis on my mind. It is a hypothesis in biology, that species must constantly adapt, evolve, and proliferate in order to survive.

Figure 29 is an illustration from Lewis Carroll's *Alice Through the Looking Glass*. In this illustration, Alice and the Red Queen are running. They have to do all they can do just to stay in one place. The Queen kept crying "Faster! Faster!".

"Now here, you see, it takes all the running you can do, to keep in the same place," says the Queen.

In response, Alice asks, "Then how would I get somewhere else?"

The queen answers, "If you want to get somewhere else, you must run at least twice as fast as that!"

This is the world we find ourselves in now, and with this I end my talk.

Thank you.

Figure 28

Figure 29

"Multilateral Cooperation for Adapting New Technology: Research and Protection of Cultural Heritage by Cambodian Archaeological LiDAR Initiative"

SHIMODA Ichita
(Associate Professor, Faculty of Art and Design, University of Tsukuba)

SHIMODA Ichita is an Associate Professor at Tsukuba University, with a Ph.D (architecture). He was born in Tokyo in 1976. He worked in Cambodia from 2007 to 2013, as technical advisor to the Japanese Government Team for Safeguarding Angkor. As well as working on the Angkor Wat and Bayon Temple restoration projects, he was involved in numerous architectural and archaeological surveys among the monuments. Along with a survey intended to clarify the full scope of the ancient city at the Sambor Prei Kuk site, which was registered as a World Heritage site in 2017, he has worked on projects including protecting monuments across the entire region, conserving and restoring remains, and nurturing human resource in these areas. From 2016 to 2019 he worked in World Heritage conservation management and registration applications as a Senior Cultural Properties Specialist at the Agency for Cultural Affairs, handling World Heritage site nomination of the Mozu and Furuichi kofun sites. He is a member of the Japan Consortium for International Cooperation in Cultural Heritage, Subcommittee for Southeast and South Asia and of the Japan Geopark Committee.

To begin with, let me introduce myself. I have worked as a member of the Japanese Government Team for Safeguarding Angkor (JSA), which is engaged in the restoration of the Angkor Wat and Bayon Temple monuments as well as nurturing human resource for conservation work and architectural/archaeological research in this context. (Note 1) Launched in 1994, the JSA has already been active for over a quarter-century. It is a pioneering and flagship project, as one of Japan's oldest endeavors in the field of international cooperation on cultural heritage. Professor NAKAGAWA Takeshi has served as director since its beginnings, while the first site director was Mr TOMODA Masahiko, now the Secretary-General of JCIC-Heritage. (Figures 1and 2)

I myself have participated in this project since my student days in 1998, working roles including site manager for onsite restoration work at the Northern Library of Angkor Wat from 2006 to 2013. Experts from a wide variety of academic fields participate in this project; as shown here, there are roughly ten specialist teams, which collaborate while carrying out their work.

Figure 1

Figure 2

Various types of technology for research and restoration work

A list of the main technologies used by each team would look something like this table. (Figure 3) For example, the architecture team at the top, applies various surveying technologies for recording, analyzing and designing the restoration plan. In recent years, emerging technologies include point surveying, 3D surveys and models using 3D data, AR, VR are also becoming familiar in this field.

These technologies are applied in order to conserve the cultural heritage of the Angkor monuments; they also serve to identify the value and characteristics of the heritage and to select and examine targets for protection. Other technologies are also needed to identify why and how the monuments are deteriorating or being damaged, and to develop the required restoration technique and material.

At the bottom of the table are the technologies used by the restoration design team. These are the technologies directly required for restoration work. An extremely wide range of technologies is incorporated comprehensively for each stage of the restoration work, from advance surveys to restoration planning, the restoration work itself, and monitoring and maintenance after the restoration work. These technologies are brought onsite by Japanese experts and sometimes cooperating specialists from other countries; we make every effort to share theoretical and practical knowledge with the Cambodian local staff and to work in concert with them onsite.

Technology Transfer in international cooperation

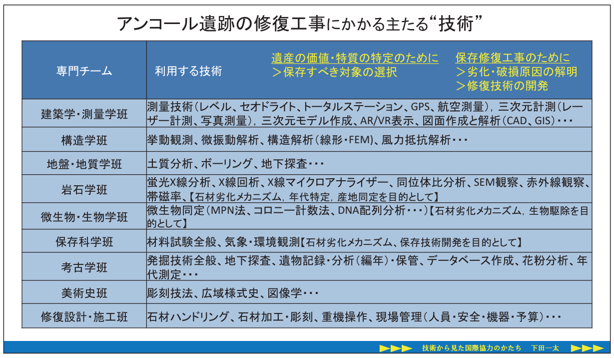
One of the significant aspects of international cooperation in this context is technology transfer; there are two general types of technology to be transferred. First, as shown at left, we have the technology composing elements intended for specific purposes, such as stone repair, surveying, operation of heavy machinery and so on. Within the JSA, the member known as technical staff learn these individual technologies.

Elsewhere, as shown at right, we have experts with a comprehensive understanding of the individual technologies involved in planningand managing restoration based on the required various research. Through long-term OJT (on-the-job training) of staff selected through training for Cambodian university students, the JSA has worked to develop these multi-talented specialists. They acquire experience in survey and restoration work alongside diverse Japanese experts.

In this way, the phrase "technology transfer" must be considered to include both elemental technologies which can be mastered in short-term training and those which require long-term education to develop applied technicians who can take a comprehensive approach to individual technologies. (Figure 4)

Technologies here include those at the cutting-edge as well as the analog and traditional. For example, what I'm showing you here comes from the onsite Cambodian university student training program held about a month ago in Cambodia. (Figure 5) Held as an International Contribution Project for Cultural Heritage funded by the Agency for Cultural Affairs, as techniques such as photogrammetry have recently become much easier, we introduce students to these technologies and instruct them in methods of drafting elevational views, ground plans, and cross-sections of the architectural heritage. (Note 2)

The students find these technologies very exciting; during training, they mainly learn practical methods of


アンコール遺跡の修復工事にかかる主たる"技術"

専門チーム	利用する技術　遺産の価値・特質の特定のために ＞保存すべき対象の選択　保存修復工事のために ＞劣化・破損原因の解明 ＞修復技術の開発
建築学・測量学班	測量技術（レベル、セオドライト、トータルステーション、GPS、航空測量），三次元計測（レーザー計測、写真測量），三次元モデル作成、AR/VR表示、図面作成と解析（CAD、GIS）・・・
構造学班	挙動観測、微振動解析、構造解析（線形・FEM)、風力抵抗解析・・・
地盤・地質学班	土質分析、ボーリング、地下探査・・・
岩石学班	蛍光X線分析、X線回析、X線マイクロアナライザー、同位体比分析、SEM観察、赤外線観察、帯磁率、【石材劣化メカニズム，年代特定，産地同定を目的として】
微生物・生物学班	微生物同定（MPN法、コロニー計数法、DNA配列分析・・・）【石材劣化メカニズム，生物駆除を目的として】
保存科学班	材料試験全般、気象・環境観測【石材劣化メカニズム、保存技術開発を目的として】
考古学班	発掘技術全般、地下探査、遺物記録・分析（編年）・保管、データベース作成、花粉分析、年代測定・・・
美術史班	彫刻技法、広域様式史、図像学・・・
修復設計・施工班	石材ハンドリング、石材加工・彫刻、重機操作、現場管理（人員・安全・機器・予算）・・・

▶▶▶ 技術から見た国際協力のかたち　下田一太 ▶▶▶

Figure 3

Figure 4

operating the technology. That is, while the students create these drawings, they are not engaged in the process of understanding architectural forms, styles, structures, and so on. Dr. KAMEI spoke previously about black boxes of technical process, and there are aspects in which this is becoming increasingly unavoidable. However, I consider it very important to understand the principles and the technical theory in combination with meaningful experience.

Therefore, I make sure during these training programs to have the students understand the basic technologies of surveying from the ground up, as well as actually seeing the target objects and drawing them by hand. Through this process, the students acquire enhanced understanding of the target buildings and also of their structure and state of deformation and damage. Working manually also enables them to understand the limits of the data precision available. I have tried various teaching procedures throughout training of this kind in the past, finding that when conventional technologies are explained in chronological order, the students tend to become bored, losing interest before the end. Therefore, I begin by having them work with the latest technology, without understanding its principles yet (treating the technology as a black box), and feel the excitement of doing so. I find that their interest is more sustainable if I use this experience to encourage them to understand the background principles or the target object in order. In this way, I consider it important in technology transfer to promote understanding of the technical principles to the greatest extent possible. (Figure 6)

Today's seminar is intended to foster discussion on technologies in international cooperation through cultural heritage; the restoration of the Angkor monuments alone involves a diverse range of technologies, which, as I have just pointed out, require equally diverse methods of transfer. In fact, the forms of international cooperation for cultural heritage are diverse in the extreme, including exhibits of artifacts, cooperation at research institutions, and so on for tangible and intangible cultural heritage. These approaches are not limited to surveys and conservation alone; therefore, discussion covering all of these diverse technologies is far from easy. Important points at the core of international cooperation include the hardware aspect of technology as well as the issue of how to transfer principles along with technology. (Figure 7)

LiDAR technology at the Angkor monuments

Here, let me discuss my main topic, the aerial surveys conducted at the Angkor monuments in Cambodia. This project took place via cooperation among seven countries and eight international organizations. (Note 3) The main movers were researchers from University of Sydney, École française d'Extrême-Orient, and the Cambodian governmental Authority for the Protection and Management of Angkor and the Region of Siem Reap (APSARA); in addition, private-sector organizations and countries such as Japan, Hungary, and the US took part.

As the use of aerial surveying has been increasing in Japan as well over the last few years, many people here may be familiar with it. In brief, it is a survey technology which uses the reflection of the earth's surface of multiple lasers, irradiated from above with highly precise position information, to grasp the overall topology of the ground surface height. Aerial surveying is an extremely helpful tool in Japanese cultural heritage as well, where it is put to use to

Figure 5

Figure 6

grasp the precise shapes of kofun tombs overgrown with trees, castles in the mountains, and so on. (Figure 8)

This is a satellite photo from Google Earth of the Angkor monuments. The main remains of the monuments cover an area of 25 kilometers east-west and 20 kilometers north-south. For example, this rectangle to the west is an artificial reservoir built in the 11th century, just one of many vast water supply constructions. (Figure 9) In recent years, we have come to understand that the area of the capital of the Angkor dynasty was very large, considered to have encompassed the entire area from the Phnom Kulen mountains to the north to Tonlé Sap Lake in the south.

The region slopes gradually from northeast to southwest, with an average gradient of about 0.1%. (Figure 10) The central area of the monuments is thickly forested: in particular, the area around Angkor Thom and Angkor Wat, which must have been the center of the capital as it was, is difficult terrain, now covered in weeds and forest, with poor visibility and dangerous footing. (Figure 11) Aerial surveying enables at least five or six measuring points per square meter. Point-cloud data of this kind provides a clear image of the shapes of the Angkor Wat temple architecture. In addition, high-resolution aerial photographs are also made available. (Figure 12)

The orange areas on the map are the results

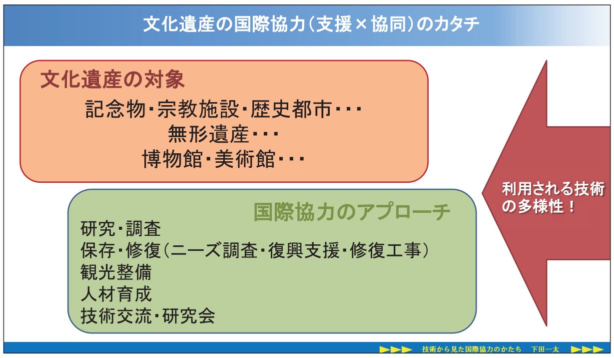


Figure 7

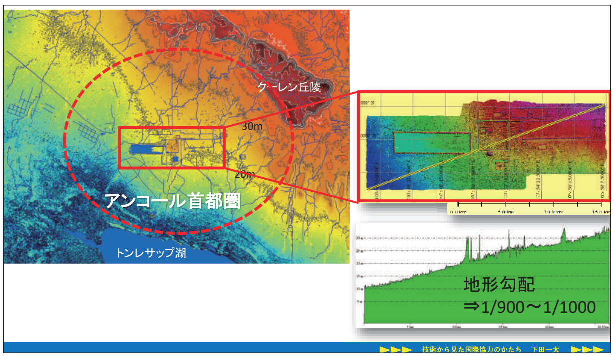


Figure 10

Figure 8

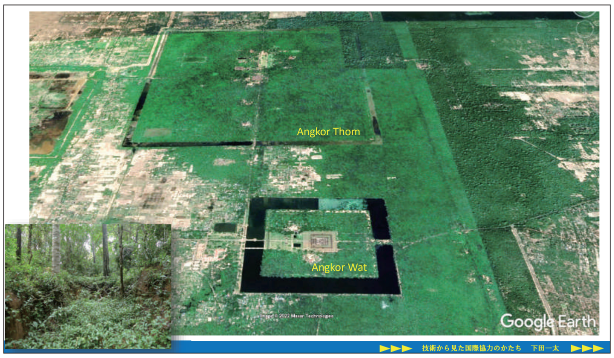


Figure 11

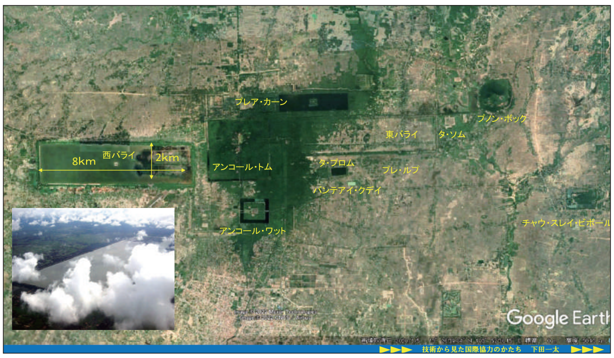


Figure 9

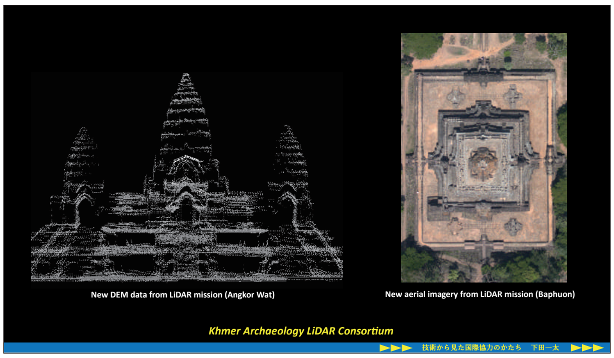


Figure 12

of a 2012 measurement project. (Note 4) As well as 180 square kilometers covering the central Angkor monuments area, this project included 90 square kilometers in the Phnom Kulen mountains, the putative location of the 9th-century kingdom's capital, and the Koh Ker archaeological site considered to be the 10th-century kingdom's capital, currently under application by the Cambodian government for inscribing to the World Heritage list. (Figure 13) Further, in 2015, additional surveying covered the major Cambodian sites of Banteay Chhmar, Preah Khan of Kompong Svay, Sambor Prei Kuk, and Longvek, through a new research organization mainly involving the École française d'Extrême-Orient and the Cambodian government. (Figure 14)

New insights of Angkor Thom and Angkor Wat from LiDAR survey

We at JSA acquired data on the central area of the Angkor monuments through this project. For example, multiple linear remains and reservoirs have been confirmed in this way within the Angkor Thom citadel, completed in the 12th century and surrounded by a 3-kilometer square moat. (Note 5) (Figure 15) This contour map, an enlargement of the central Angkor Thom area, enables clear confirmation of linear remains in an irregular grid as well as a great number of reservoirs of about 50 meters on each side. (Figure 16)

The Angkor monuments are sometimes called a hydraulic city; surveys have enabled the recreation of this grid-shaped irrigation network. The mechanism thought to have existed setting water drawn from the northeast corner of the walled city to flow along the natural topology of the area and reach everywhere within the citadel, eventually reaching the southwest corner and once again being discharged into the moat outside the walled city. The details of this structure need to be elucidated by future surveys. (Figures 17, 18 and 19)

The difference in elevation within the city is only about 5 meters per 3 square kilometers, so when the topographical data obtained is displayed as a normal elevation tinted hillshade map, visual confirmation of detailed shapes was found to be difficult. Here, with the cooperation of Dr. CHIBA Tatsuro of Asia Air Survey Co. (consultants on aerial information), who developed a technology representing diagrams based on topological displays with an improved red relief map, we were able to conduct detailed

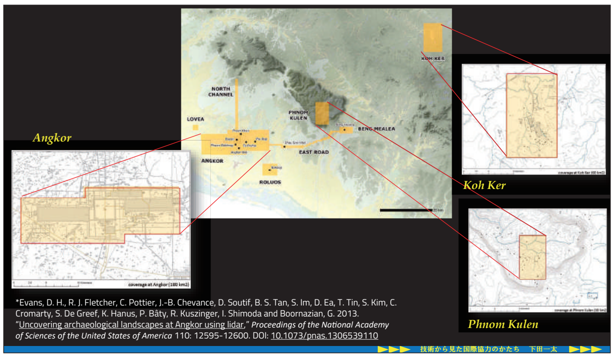


Figure 13

Figure 15

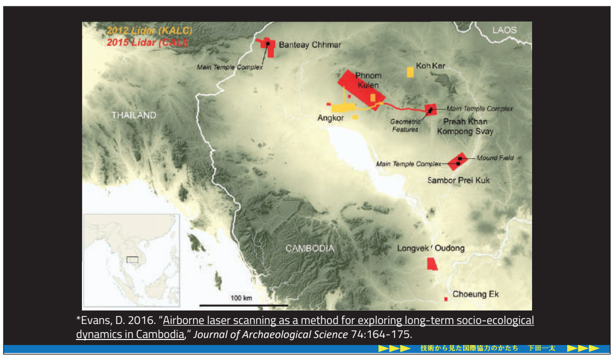


Figure 14

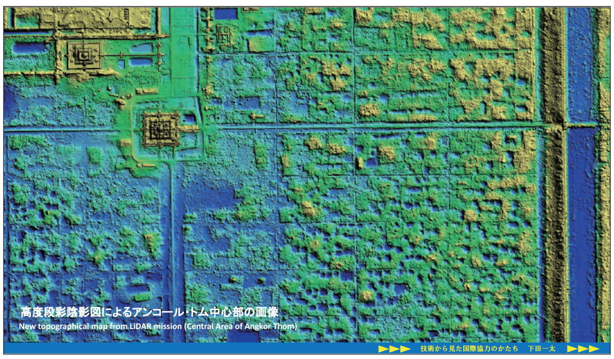


Figure 16

analyses. (Figure 20)

Using this, we were able to confirm the distribution of over 2000 reservoirs within the city. At this point it is not clear whether the ponds were there from the beginning of city or they were dug later period as needed by residents when the water supply network within the city failed to function. As the reservoirs are considered important element to elucidating the past environment and studying land use at the time, further survey should be highly interesting. (Figure 21)

We have been discussing Angkor Thom, but numerous interesting remains have been found around the moat in Angkor Wat as well. The area within the moat was divided into multiple districts by linear lines, in which the regular distribution of reservoirs has been confirmed. (Figure 22) This forms a contrast to the random distribution of the reservoirs in Angkor Thom, as we previously saw. The difference is suspected to derive from land use or from the different eras in which the reservoirs were constructed, an issue which must be analyzed in the future. (Figure 23)

Use of LiDAR data to various purposes

Through the combination of the topological data gleaned from aerial surveying and onsite underground surveys and excavations, we are working to clarify the history and structure of the Angkor monuments and other ancient cities in Cambodia. Currently,

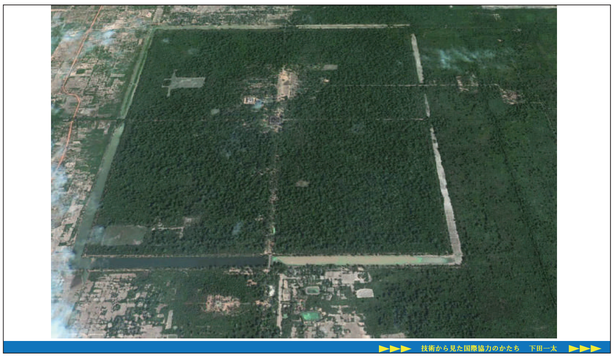


Figure 17

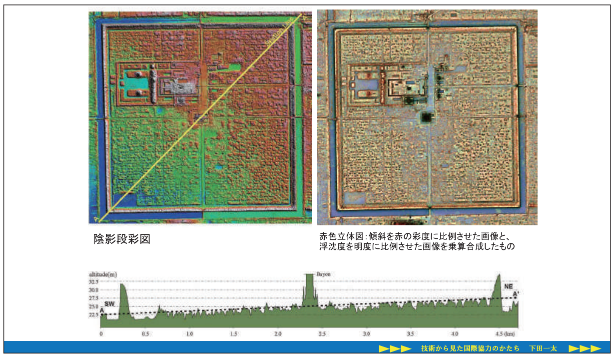


Figure 20

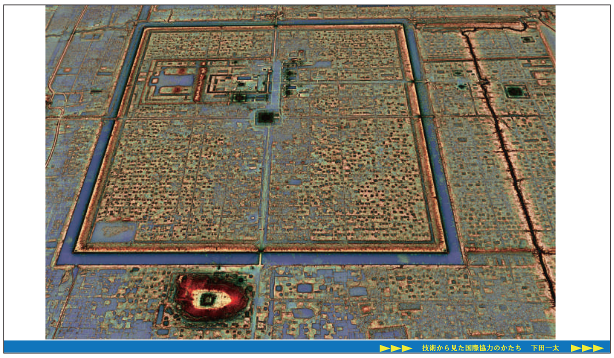


Figure 18

Figure 21

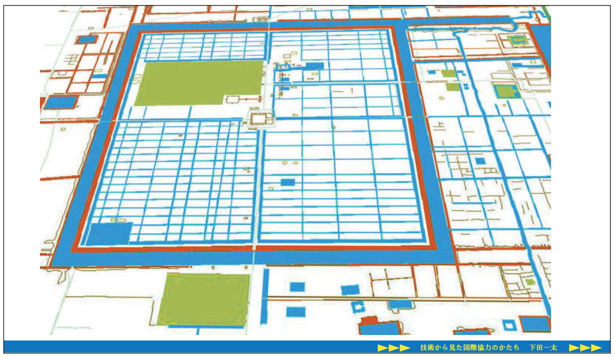


Figure 19

Figure 22

JSPS Grant-in-Aid-funded research is in progress in order to clarify the hydraulic systems, land division systems, land use, and environment of the ancient khmer cities. (Note 6) With overseas travel finally becoming possible again after the restriction by COVID-19, full-scale on-site research is once more feasible, and I hope to make good progress with the aid of various other researchers. (Figure 24)

With regard to aerial surveys conducted as international joint projects, various information is available online, and numerous academic papers based on these surveys have been published. While we do not have enough time to get into the individual research outcomes, topological data gained through aerial surveys is contributing significantly to archaeological research as well as monument conservation. (Figure 25)

With the new discoveries of relics over a wide area, our understanding of the monument groups has been dramatically upgraded. We have been able to analyze and verify questions such as those relating to the renovation of temple complexes and the process thereof; how multiple facilities were combined to form comprehensive water supply remains, and how these facilities fell into disrepair as the cities declined. The topological data gained from aerial surveys has also come into use for issues relating to protection of the monuments in the present day, such as more detailed reconfigurations based on the current status of conservation areas, new plans for water discharge and storage construction, land use within the remains, and management of land ownership. (Figure 26)

Significance and challenges of multinational cooperation

The last slide is a presentation of the significance and issues of multinational as opposed to bilateral cooperation on this project. First, the premise is that this project was realized as a collaboration among multiple organizations based on the foundation of heritage conservation through international collaboration developed after the Angkor monuments' World Heritage registration in 1992. The project also owes its realization in part to the hard work put into coordination by Dr. Damian EVANS, originally of the University of Sydney and subsequently moved to the École française d'Extrême-Orient.

The significance of cooperation among multiple countries lies in the diverse resources which can

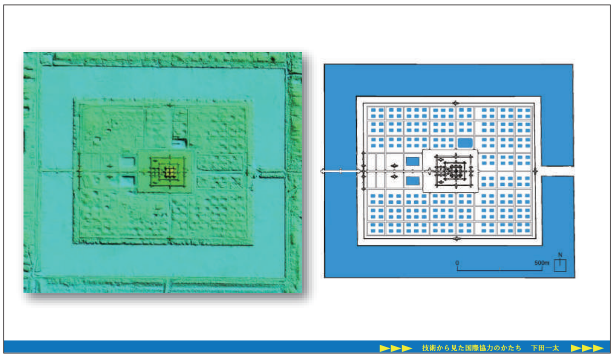


Figure 23

Figure 25

Figure 24

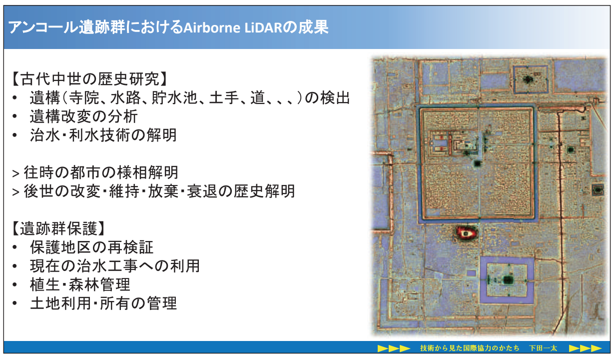


Figure 26

be shared for research. In particular, because this project required a large budget, a major advantage was the division of the monetary burden among multiple parties. The participation of experts affiliated with multiple organizations also led to the discovery and sharing of outcomes and data usage methods which had not initially been expected, a major benefit.

Elsewhere, issues included the question of how to share data. Options included the construction of a platform or interface that everyone could use. As of now, each organization analyzes the primary data, but there needs to be discussion on future methods of use in order to enable this data to be widely used by experts in addition to the initially participating organizations.

Multinational cooperation in cultural heritage was at one time fairly typical, centered on international organizations such as UNESCO. In the case of academic research, wide-ranging collaboration among experts from various countries remains typical; in the field of cultural heritage conservation, however, international cooperation has sometime become a matter of their national policy to some extent. Therefore, over the last twenty to thirty years, the dominant practice has been for each country to create its own organization which handles these projects.

In projects which can succeed by applying and introducing existing technologies to the field of cultural heritage, bilateral cooperation is likely to remain common. However, when more academic research is the objective, or when technology must be developed rather than introduced, more and more projects will find themselves in need of multinational cooperation.

In bilateral cooperation projects, the relationship of provision from the supporting country and acceptance from the supported country tends to show up clearly; in multinational support, however, equal relations between the supporting and supported countries can be created more easily, as they participate in discussion and carry out the project together. Moreover, by having the supported country also contribute an appropriate amount as the project is carried out, I believe that it becomes easier to create a project in which opinions from

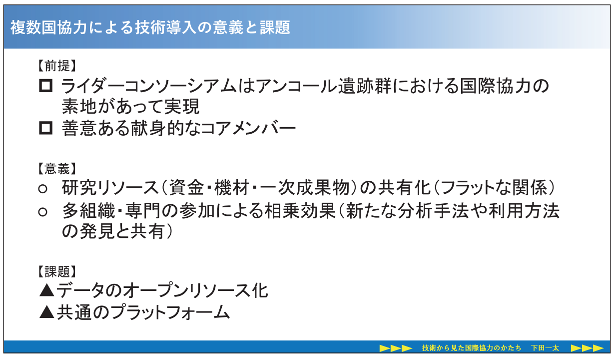


Figure 27

both sides and local technology are respected and made good use of, moving forward from international support to international cooperation, from support to cooperation.

Based on the examples discussed here, projects aimed at the conservation of cultural heritage can likewise benefit significantly from this kind of equal partnership among multiple countries in cooperation. My hope is that we will see major developments of this kind in the future. (Figure 27)

Thank you for your attention.

Note1: Japanese Government Team for Safeguarding Angkor website
（https://angkor-jsa.org/）

Note2: Sambor Prei Kuk Conservation Project
（https://www.shimoda-lab.org/spk-project/）

Note3: Cambodian Archaeological Lidar Initiative
（http://angkorlidar.org/）

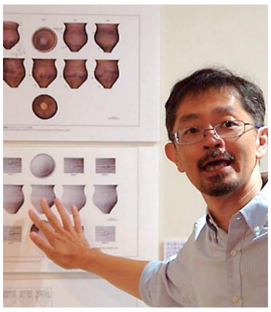
Note4: Evans, D., et al. (2013). Uncovering archaeological landscapes at Angkor using LiDAR. Proceedings of the National Academy of Sciences of the United States of America, 110(31), 12595-12600.

Note5: Shimoda, I., Haraguchi, T., Chiba, T., Shimoda, M. (2016). The Advanced Hydraulic City Structure of the Royal City of Angkor Thom and Vicinity Revealed through a High-resolution Red Relief Image Map, Archaeological Discovery, 4(1), 22-36.

Note6: Grant-in-Aid for Scientific Research(KAKENHI) "Research on the Urban Structure and Social Infrastructure of Ancient Khmer Dynasty: Archaeological Field Survey Using High-Precision Topographic Data" （21H04353, Principal Investigator: SHIMODA Ichita）

"Extending Cultural Heritage Protection Using the Latest Technologies at Hand: Towards Documentation which Anyone can Work together"

NOGUCHI Atsushi
(Visiting Fellow, Kanazawa University Institute for the Study of Ancient Civilizations and Cultural Resources)



NOGUCHI Atsushi was born in Tokyo in 1971.
He completed his graduate and undergraduate studies in archaeology at Meiji University. His area of specialism is paleolithic archaeology, and he had been involved in field surveys in Japan, South Asia, and the Arabian Peninsula. He also works to support cultural heritage conservation in Pakistan and the development and introduction of 3D surveying technology. From 2020 onward, he has held online workshops for Japanese and international participants.
He is currently working to introduce 3D surveying into cultural heritage preservation in Central America, as well as serving as an adjunct lecturer at the Tokai University School of Cultural and Social Studies.

Today's my topic is "Extending Cultural Heritage Protection Using the Latest Technologies at Hand." In previous session, Dr. Shimoda discussed aerial survey for cultural documentation. I'd like to talk about documentation of various cultural heritage on the ground, using compact and low-cost technology. (Figure 1)

I am an archaeologist, working in mainly hot and dry countries. (Figure 2) I am also working on 3D documentation and databases. If anyone is interested, please refer to the books shown here (Figure 3). Recently, I have also published articles on 3D documentation technology and application in the *Research Report of the Nara National Research Institute for Cultural Properties*, as well as in the *Current Awareness: a journal of the National Diet Library of Japan.* (Note 1). (Figure 4)

Here, I'd like to begin my discussion from the thought on "technology." (Figure 5) In my sense,

Figure 1

Figure 2

Figure 3

technology is somatic and extra-somatic operational means whichis created by human being to achieve their objectives. And modern and advanced technologies are aiming on extending physical skills and/ or overcoming physical limitations. In the context of cultural heritage conservation, the objective should be optimization of the outcomes of documentation, preservation and protection; beyond the limitations of human eyes, hands, feet and so on. (Figures 6 and 7)

I will focus particularly on 3D measurement and related technologies. Likely all cultural heritage are in form of arbitrary three-dimensional. Here, I present an example of head of Buddha statues excavated from Kalawan site in the World Heritage Site Taxila, Pakistan. Tremendous number of point-cloud covering the surface of object is recorded for reconstruction and representation of the original shape. On this Buddha head, about 10 cm by 10 cm by 20 cm in its size, 11.25 million points have been recorded. The data of 3D measurement is consisted of X-Y-Z three-dimensional coordinates as well as additional information such as vertex colors and so on. (Figures 8, 9 and 10)

The greatest advantage of 3D measurement is enabling record of the exact shape of object as it is, no matter how complex it is. Therefore, in the context of cultural heritage conservation, monitoring the status of remains and their protection becomes possible, along with ensuring masterpieces in reconstruction and restoration. A high level of performance in identifying individual artifacts and objects serves as the foundation of a catalog database, which should also enable monitoring issues of illegal distribution. In addition, as noted by Dr. Shimoda, this can also yield the basis of research data in archaeology, architecture, art history and so on. (Figure 11)

Another advantage is that data is created as

Figure 4

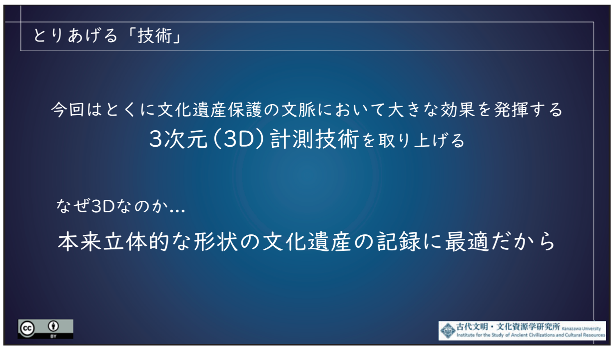


Figure 7

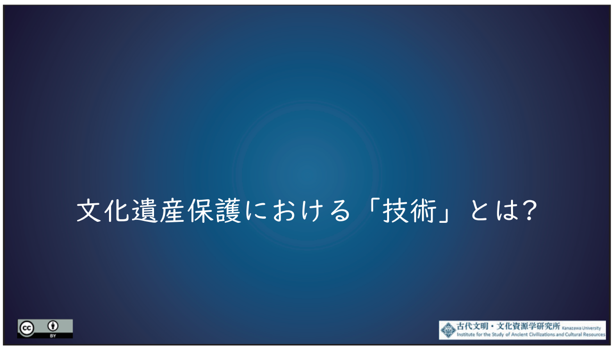


Figure 5

Figure 8

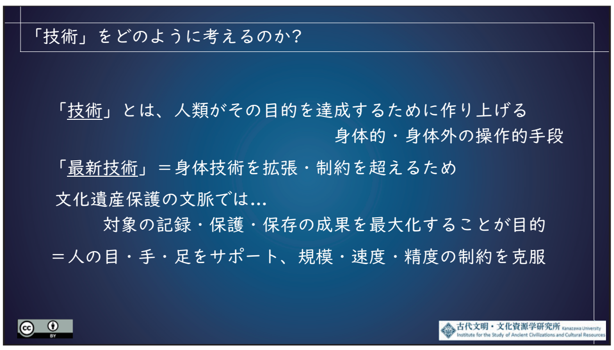


Figure 6

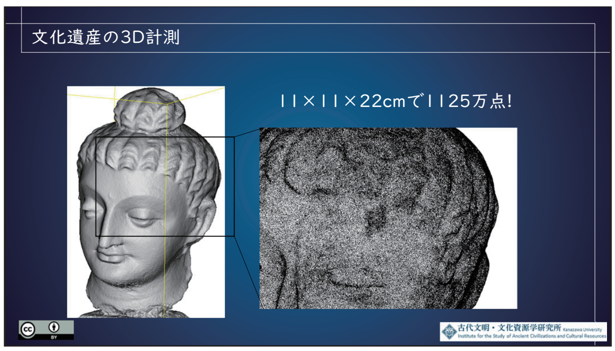


Figure 9

born-digital. Digital data does not deteriorate during reproducing process even in multiple times. Therefore, it produces highly robust backups and ensures easy redistribution. It also constitutes an improvement in terms of accessibility through online world-wide-web from anywhere in the world. In addition, with born-digital data, it can be compared, verified and managed authenticity retained through identification. It can also support various media and platforms. (Figure 12)

My first motivation of introducing 3D technology was for documentation for archaeological materials efficiently in a short time. As an archaeologist, I study the Paleolithic. I'm working on the sites in Pakistan which have yielded tremendous number of stone tools. It is almost impossible to document all of them manually with ordinary methods like as hand-drawings. Therefore, in 2012, I began to use desktop type 3D scanner for documenting materials. (Figures 13, 14 and 15)

This solved issues. With 3D scanner documentation work became semi-automated. Then, I was able to take photographs or conduct observation simultaneously during 3D scanner documented materials. In addition, because of digitalized data, I could bring them to Japan in form of digital data for further works without original material.

On the other hand, some issues remained. The device is relatively expensive, and not able to be permanently set up in Pakistan. Transportation is also difficult because it is sensitive precision equipment. In addition, the desktop laser scanner is very specific device which is only able to measure small artifacts but not for large monuments, site, topology, etc. More critical issue is that it demands consistently consistent electric power supply to work. However, in places like countryside of Pakistan, consistent work is difficult due to poor electricity supply which leads

Figure 10

Figure 13

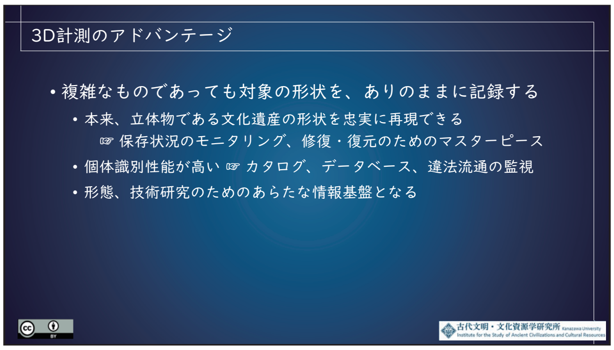


Figure 11

Figure 14

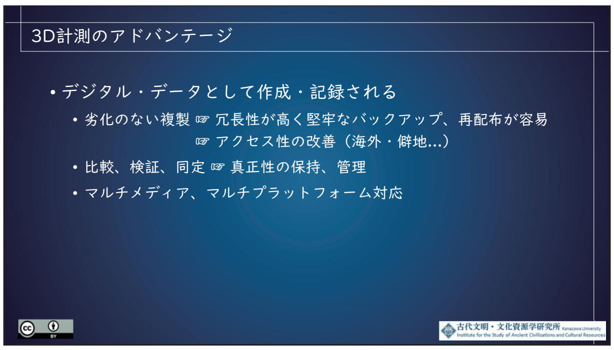


Figure 12

Figure 15

frequent interruption of work by blackout. (Figure 16)

In this context, I chose 3D photogrammetry as the next solution. In northern Pakistan, part of the ancient Silk Road linking the western China with South Asia, I was participating survey of cultural heritage jointly with Hazara University, Masehra, Pakistan. (Figures 17 and 18)

In the certain area, documentation of cultural heritage in detail is absolutely necessary due to lack of established documentation even on well-known sites registered as World Heritage. Only sketches, black-and white photographs, as well as rubbings obtained in past investigations are available. These records were not likely suitable either for the present work or future applications. (Figures 19 and 20) The field conditions in the area is severe. Long-distance travel by road is required, a return trip by car of over a thousand kilometers from the base camp in the university. Therefore, the equipment must be as light and minimal as possible. Furthermore, it is difficult to keep electric power in constant and stable condition due to poor condition of electricity supply in mountainous rural area. Therefore, battery powered equipment is only usable. The location was in the mountains, at 1200 to 1500 meters altitude or above. However, there is likely no vegetation covering the ground. Therefore, daytime temperature eceeds 40°C. in July and August. The high altitude, high temperature, and strong UV exposure conspired to create the worst environment for sensitive precision devices. Survey objects are various from small artifacts held in museums, to outdoor monuments and sites. In addition, geopolitical issues made it difficult to use laser equipment and drones (UAV). Actually, use of such equipment is prohibited or refused permission (Figure 21)

In this context, I chose 3D photogrammetry with compact digital camera and laptop computer

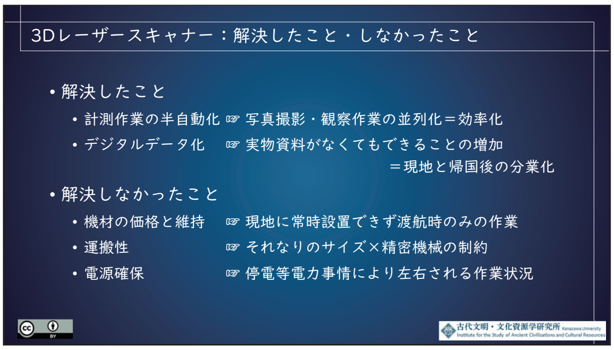


Figure 16

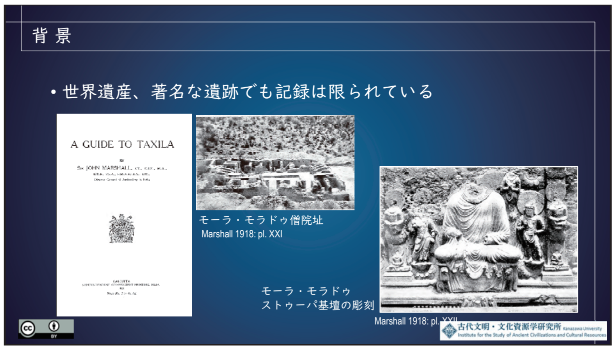


Figure 19

Figure 17

Figure 20

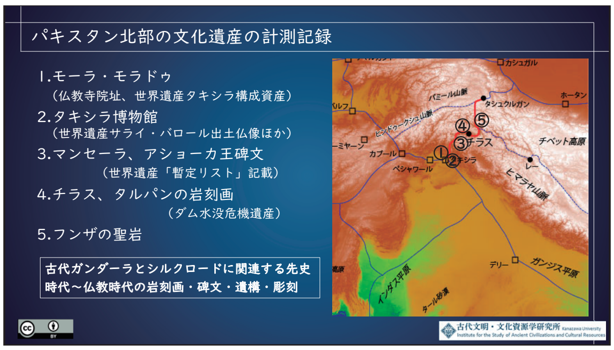


Figure 18

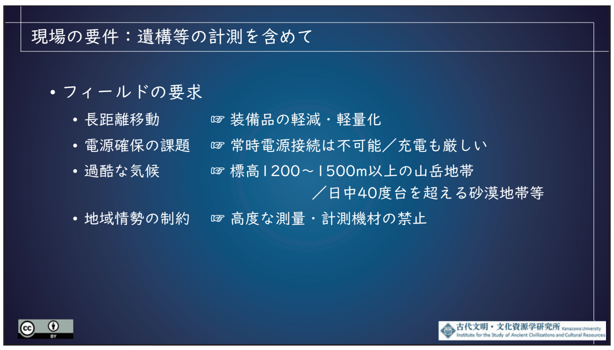


Figure 21

which installed a specific software. This achieves to minimize equipment. In the field, principal work is capturing photos of object form multiple direction. Processing those photos is carried out after back to camp, in evening, by laptop computer which can work either cable or battery. Full analysi is conducted after back to the base camp in the university while preliminary analysis is done during the travel. Equipment in 2014-15 season were as following: Olympus TG-4 compact digital camera and Agisoft Metashape 3D photogrammetry software (Photoscan in that time). This is relatively low-cost settings rather than terrestrial laser scanner or drone. (Figures 22 and 23)

The fundamental of photogrammetry is based on stereoscopy with 2 photos taken by two cameras or from two different points which are for reconstructing depth information by parallax. Modern and advanced 3D photogrammetry, so-called SfM-MVS: Structure-from-Motion and Multi-View-Stereo, can automatically render multiple photos taken from arbitrary positions into 3D. Proprietary software is improved to enable easy operability for anyone. (Figures 24 and 25)

Here are a several examples of the survey. The first example is the foundation of stupa with stucco statues in Mohra Moradu monastery in Taxila World Heritage site. With multiple photos, software outputs a 3D model. Further image processing brings out various visualizations. Taking 30 photos in the site takes less than five minutes. The software requires some time for processing, but total time required for documentation is reduced than conventional method. (Figures 26 and 27)

Another example is the Ashokan Rock Edicts in Mansehra, in the north of Taxila. The surface of the rock is severely weathered, but 3D documentation makes the text incised on the rock clearly visible. It appears more readable through image enhancement

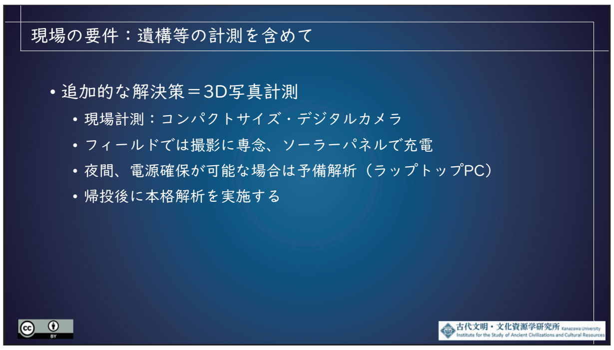


Figure 22

Figure 23

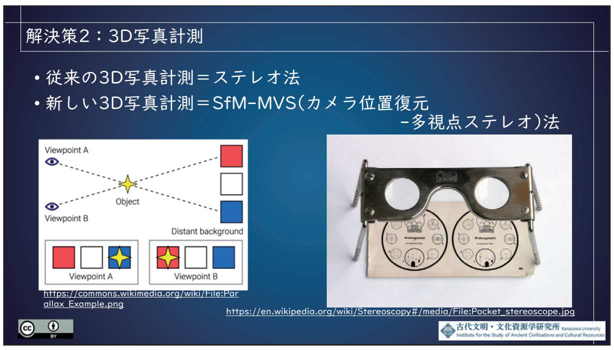


Figure 24

Figure 25

Figure 26

Figure 27

process than naked eye observation. (Figure 28)

Next examples are inscriptions and rock-carving art in the northern area (Gilgit-Baltistan) which are endangered to be submerged by construction of the Diamer-Bhasha Dam. The Sacred Rock of Hunza, a well-known cultural heritage in the north of Gilgit is documented as well. It bears rock-carving drawings of many long-horn ibexes. As same as the Ashokan Rock Edicts, the surface is significantly weathered and some parts are damaged. While protection from the progress of weathering and deterioration is difficult, 3D photogrammetry can preserve the detail condition in the form of digital data. (Figure 29)

The advantage of 3D photogrammetry is simple setting of equipment. Rather than expensive special devices, a digital camera, an LED light, and a computer for analysis are required. What we should do in the field is only taking photos of the objects by digital camera with references for scales. The quality of results basically depends on the quality of the photos.

The other advantage of 3D photogrammetry is low work force requirement. Capturing photos in the field can be done by a single person in minimum. For safety concerns and other conditions may require additional persons, but a large-scale teamwork is not required. Wroking time for field survey can also be reduced notably. Post field-survey process requires much time, but it can be done in later in different time and place. According to this advantage, it is possible to concentrate only on photo capturing in the field, then to conduct analysis after back to the base camp in the university. Furthermore, in some cases, post field-survey process can be done in Japan. This leads reduction of overseas staying period as well. (Figure 30)

After the practical experiment in the field, I have started transferring skill and knowledge to the locals to make them conducting the survey by themselves. Hands-on workshops on 3D photogrammetry are held at Hazara University for training of undergraduates and graduate students. (Figure 31)

Most important aim is the local procurement availability of equipment. At the time, Pakistan government led the prime-minister's initiative to provide laptop computer to students with high grades. This supports many students while only a few students have their own computer. Smartphones and low-price digital cameras can be used for capturing photos. So, there were sufficient provisions in place locally. The workshops alone would be ineffective if the students simply gained experience with borrowed equipment rather than their own. Conditions enabling continuous practice are extremely important. (Figures 32 and 33)

Next step is extending the project in collaboration with a federal bureau, the Department of Archaeology and Museums (DOAM), Pakistan. Together with Hazara University, practical work on the collection of Islamabad Museum in the capital city has been

Figure 28

Figure 29

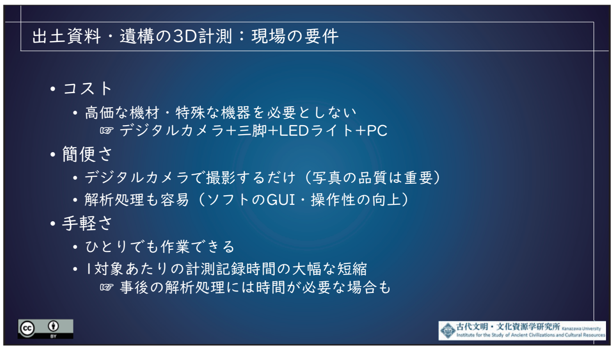


Figure 30

Figure 31

carried out. (Note 2). (Figure 34)

Unfortunately, the pandemic of COVID-19 makes travelling to Pakistan difficult. Instead, I am conducting capacity building workshops via online. (Figure 35)

In cooperation with the Tokyo National Research Institute for Cultural Properties, I held two workshops aimed at Asian countries in the 2020 and 2021 academic years, with participants from Cambodia, Nepal, Pakistan, Sri Lanka and so on. I also gave a lecture in the 2021 academic year based on a request from the Sri Lankan government’s Department of Archaeology. I have also committed to online training courses for Central American countries organized by the Institute for the Study of Ancient Civilizations and Cultural Resources, Kanazawa University, with which I am currently affiliated, I also offered in the academic years of 2020 and 2021. These were quite intensive sessions, held over eight to ten days per course. The first training session was for participants from Guatemala, Honduras, Mexico, El Salvador, and Costa Rica. Lectures were given in English with local interpretation into Spanish. This was well received in Latin American countries, then subsequently more participants from a wider range including Bolivia, Peru, Chile, and Argentina were joining to the course in later. (Figure 36)

Elsewhere, there are issues with online training. Internet connecting condition and computer performance in local contexts are most critical. Processing may not finish within the given time, so that participants may not be able to keep up with the work during the workshop. Because the workshop is not face-to-face, it is not easy for either side to grasp how far the work has progressed. This results incomplete operation in time and causes of reducing effectiveness of the workshop. Therefore, Kanazawa University plans to prepare video recording for on-demand self-practice which can be done at their own timing.

In September 2022, I was eventually able to hold a workshop on-site in Copán, Honduras (Note 3). The workshop was held from morning to evening every day for a week, including lectures and practices both in the classroom and in the field of Mayan archaeological site of Copán as a World Heritage. At the end of workshop, all participants gave presentation on their outcomes and perspectives on the usage of 3D technology. (Figure 37)

At the end of my talk, let me discuss on recent development on technologies and international assistance of cultural heritage conservation. Technologies are developed and changed rapidly in recent. Likely every year we recognize significant change of devices and technology in general. Therefore, I am focusing on how we can apply these latest technologies in accordance with the mission of cultural heritage conservation, sntead of taling about technological development itself.

Nowadays, Digital Shift or Digital Transformation is taking place throughout all fields among the society,

Figure 32

Figure 34

Figure 33

Figure 35

from industry to education, not only in developed countries but also in developing countries. The latest information reaches likely all countries through the Internet in same time. While those providing support and assistance to developing countries consider that less-developed technologies and devices are enough for recipient countries, those provided support and assistance in developing countries may feel complain that donors despise them.

Therefore, in terms of adopting new technologies, we must start with demonstrating and proposing updated system, providing enough information on the latest development and mutually exchanging opinions, rather than unilaterally decision making. It is important to share awareness of what technologies will be needed in the future, based on discussion of their applications, when and how this should be done, including a road map for the future work. (Figures 38 and 39)

At the same time, it is highly significant to make use of consumer products with the latest technologies. Elsewhere, a major issue is the costs of introducing and operating the equipment itself, as well as the costs of the education and training. Because of differences on price levels between countries, even consumer products with the latest technologies which are familiar in Japan may be considered extremely expensive in other countries especially in developing countries. Another issue is the infrastructure status, leading to problems with the power supply and communications environments on which the latest technologies depend.

However, infrastructure issues is rapidly improved. For example, in Pakistan, the power supply and communications status have both been rapidly improved over the past five years. Therefore, critical issues which we faced five years ago are now solved. In my experience, especially in developing countries, improvement of infrastructure seems faster than global development of technology. Anyway, problems will be solved faster than what we expect. So, it is not necessary to recognize the status in developing countries as behind of the present situation in developed countries. This is the reason why we must consider the latest technology for international cooperation and assistance in the field of cultural heritage conservation.

Data handling and management is another rising problem. Here I have an example in Japan with my experience, for which I have some supplementary material. (Figure 40)

While the pandemic of COVID-19 interrupting overseas travel, my activities are somehow shifted within Japan. The practice in Hida City, Gifu Prefecture, central Japan is the case. We organized workshops on 3D documentation of museum collection in Hida Miayaga Archaeology and Folklore Museum, which is located in the remote mountainous area and only open 30 days per year due to lack of resources. For promoting the museum under prevent of travelling

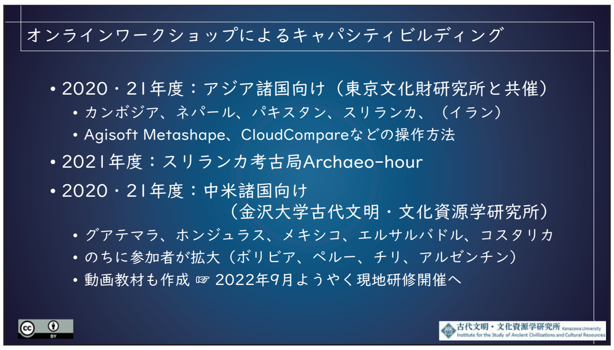


Figure 36

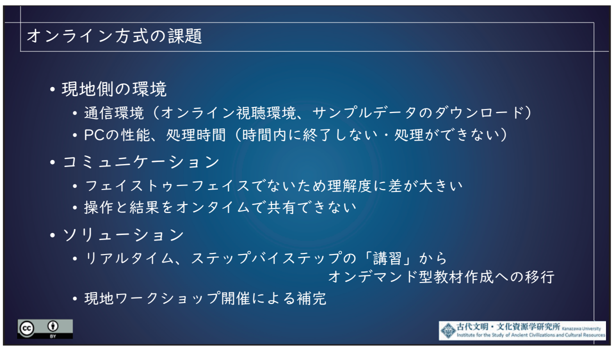


Figure 37

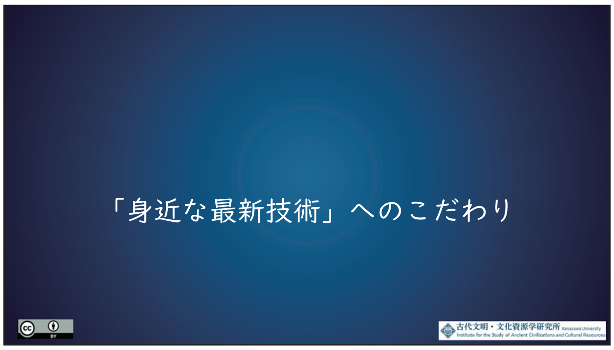


Figure 38

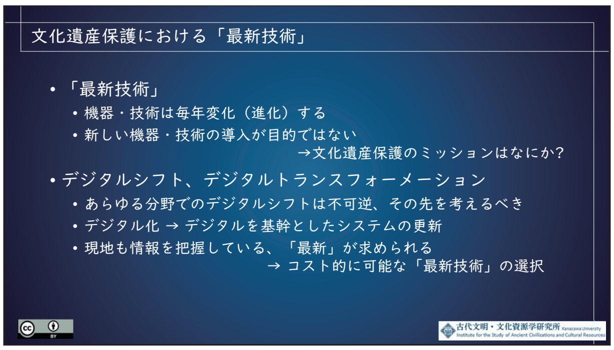


Figure 39

due to the pandemic, we call not only experts but also citizens for participating 3D documentation workshops. (Note 4). 3D models is better for online promotion of museum collection. And development of 3D documentation technology makes people available to work with their own digital camera and even with their smartphones. Apple iPhone LiDAR scanning apps are absolutely easy to handle so that even first-grade primary school student can make 3D model of Jomon pottery and obtain 3D printed model. Such easiness on 3D documentation makes people more familiar to museum collection. Mental barrier that people feel to cultural heritage is overcome when they touch and work on them together with experts. (Figures 41 and 42)

Rapid spreading of smartphone 3D documentation leads another change in protection and conservation of cultural heritage under conflict. Polycam, a company developing smartphone 3D documentation apps, is collaborating with UNESCO on the project called Backup Ukraine (Note 5). This project aims to record threaten cultural heritage in the conflict zone of Ukraine. (Figure 43)

The cutting-edge technologies I have discussed here is consisted with a significant number patented technology, which are not open but in black-box status. Sometime, this causes social problems, such as oligopoly, inequality to access products or services between different social classes or countries, etc. At the same time, those cutting-edge technologies can be the key for solving social problem. Therefore, it will be important to discuss what we can do with them, rather than what is problem to use them, together with overseas colleagues.

Regarding with this point of view, the task for experts is defining the mission and distributing manuals on the necessary precision and usage of methods and devices. For example, I am committing to the pro bono activities of Mobile Scan Association in collaboration with members form sectors of civil engineering and architecture industries to establish principle manual on how to use smartphone 3D scanning apps in practice (Note 6). Using smartphone on 3D documentation of cultural heritage is recognized effective and sufficient during the field practice in Honduras. (Figure 44)

These cutting-edge technologies are actually not easily affordable for people in developing countries by themselves. However, it is effective not only for reducing work force and time, but also for expanding opportunity of public engagement. Either rapid development of economy or cost-down of technologies and devices due to commonization among the market will be trigger of wide distribution of them in future, not so far but in near.

Generally speaking, when the resource is limited, it is necessary to concentrate upon priority object for optimizing the performance. This is same in the field of cultural heritage conservation. For instance, spending limited funding resource to high-end

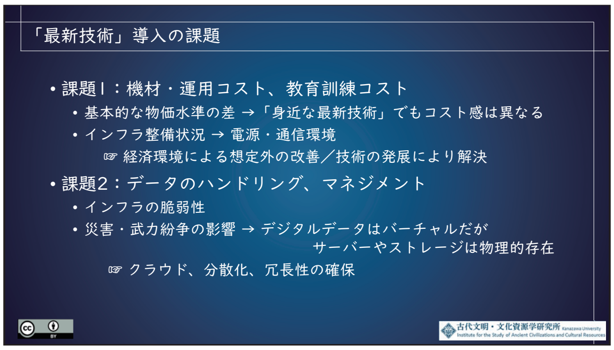


Figure 40

Figure 41

Figure 42

Figure 43

expensive equipment and use them at high priority site is appropriate decision. In the case, consumer products with cutting-edge technologies can cover others, and those who have such devices can engage project, of course not only experts but also non-expert citizens. Experience of actual engagement makes people aware of being stakeholder of cultural heritage with satisfaction to contribute to social activities. In this regard, we can gain both data as the result of 3D documentation and strong supporter or enthusiast who can work together. (Figure 45)

Working toward the future that everyone, not experts alone, can be participated in documentation of cultural heritage, we need to make more good practices on use of technology in order to preserve cultural heritage securely for the coming generations. For their experience in future we will work on and keep on it. (Figures 46 and 47)

Thank you for your attention.

Note 1: http://doi.org/10.24484/sitereports.69974-11964; https://current.ndl.go.jp/ca2017

Note 2: NOGUCHI Atsushi, “Bunka isan no sanjigen kiroku e no torikumi to kadai: Pakistan no jirei (Approaches and issues in 3D recording of cultural heritage: The example of Pakistan),” *Kikan kokogaku (Archaeology Quarterly)* 140, 2017
NOGUCHI Atsushi, “3D kiroku e no atsui manazashi (A passion for 3D recording),” *Archaeology Quarterly* 140, 2017

Note 3: https://isac.w3.kanazawa-u.ac.jp/report/mayaproject_20220914.html

Note 4: https://hidasuke.com/events/event/sekibou_3d_2022/

Note 5: https://poly.cam/ukraine

Note 6: https://mobilescan.jp/

Figure 44

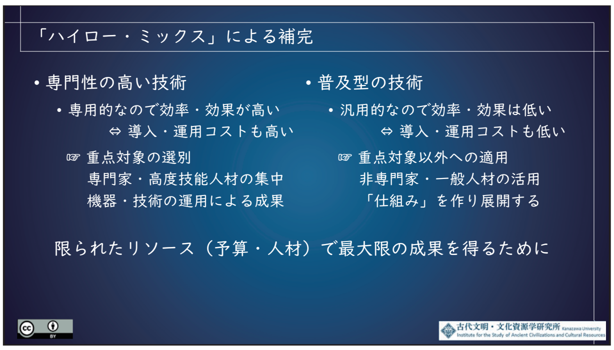


Figure 45

Figure 46

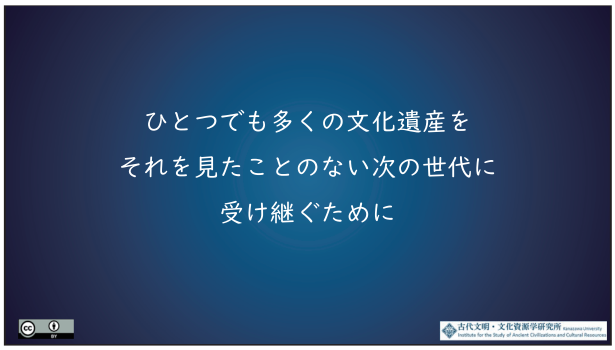


Figure 47

Panel Discussion

Moderator： **TOMODA Masahiko** (Secretary General, Japan Consortium for International Cooperation in Cultural Heritage)

KAMEI Osamu

Panelists： **SHIMODA Ichita, NOGUCHI Atsushi**

TOMODA Masahiko

(Secretary General, Japan Consortium for International Cooperation in Cultural Heritage)

TOMODA Masahiko was born in 1964. He is registered as a first-class architect, and a Professional Engineer (Discipline of Civil Engineering).

He specializes in architectural history and cultural heritage conservation. From 1994 on, he served as Field Director for the Japanese Government Team for Safeguarding Angkor, working mainly on the restoration of Northern Library of Bayon Temple in Cambodia.; thereafter he has been involved in planning, design, and supervision of numerous archaeological and architectural heritage conservation projects in Japan and overseas. From 2008 on he has been engaged in international cooperation projects for built cultural heritage at the Tokyo National Research Institute for Cultural Properties, working on survey research, conservation and repair support, and nurturing technical human resources in Indonesia, Vietnam, Cambodia, Thailand, Myanmar, Bhutan, Nepal and elsewhere.

Since 2019, He is placed in Director of the Japan Center for International Cooperation in Conservation, Tokyo National Research Institute for Cultural Properties. He also serves as a Board member of the ICOMOS Japan National Committee.

TOMODA

Thank you all very much for your presentations. My name is Tomoda Masahiko and I am Secretary General of the Japan Consortium for International Cooperation in Cultural Heritage. Along with Dr. Kamei, I will serve as moderator of the discussion.

To begin with, the thrust of today's seminar is "International Cooperation in Cultural Heritage from the Viewpoint of Technologies." This may have led some people to expect that technology itself would be the topic, but I hope we can focus more on how we approach and work with technology, in particular new technologies, within international cooperation in cultural heritage. In this sense, we have asked Dr. Kamei to join us today for hearing his opinion, including criticism, regarding what we do, from a perspective outside the field of cultural heritage.

Therefore, I'd like to start the discussion by asking Dr. Kamei to provide anything he wasn't able to discuss fully in his own presentation, as well as his reflections on all three presentations, including the two presenters who followed him, along with a rundown of the issues to be discussed in our debate today.

KAMEI：I apologize for my rushing presentation. I'm afraid it was not easy to follow, with insufficient explanation. Thank you very much, Mr. Tomoda. I was able to talk with peace of mind, leaving him responsible for moderation.

I'd like to begin with the point that technology is a means to achieve Objectives. While it is true that technology itself sometimes becomes the objective, groups taking this view are in the minority in society. We often hear about technological development but not about the feelings of the people using the technology. The same thing sometimes occurs in industrial technology: many people care little about how technology will be used as a means for ordinary people and society overall to realize something. Leaving aside any talk of science for the moment, the normal practice is to use existing technology to solve problems when it can be used, and otherwise to use or develop other technologies for the purpose. The preservation of technologies which are no longer in regular use in the form of artisanship, etc., must be understood as an exceptional and recondite practice.

The balance, or form of compromise, among the three circles in Figure 1, the economy, the environment, individual life, and so on, depends on what stage the individuals and societies have reached. Those with money will use expensive technologies, while those without money will use cheaper ones. Locations where labor is cheap can use labor-dependent technologies, while those where it is expensive must use technologies less reliant on human labor. Each case is different. The presiding rule is to use what comes to hand, existing things if possible, better still if they have a reliable record of use; if nothing is there to use, then come up with whatever takes the least trouble to develop.

I am entirely in agreement with Dr. Shimoda's argument that actual experience is necessary to understand something through the senses, and that making time for this experience is difficult. I'm reminded of the onsite saying that "experience is what you get after you need it." The difference between having experience and lacking it is significant. In order to retain technology which is no longer used on an everyday basis, simply experiencing it once is not enough, but it is still better than nothing. Craftsmanship must, after all, be passed on by a master over a long period of developing experience. In an era when labor costs -- lifestyle and personnel costs -- were socially cheap enough, it was also possible to pass on experience over time along with a master. In times like ours, when these costs can normally no longer be borne by the individual or society, and when there are alternatives available as well, it is important, as Dr. Shimoda says, to pass on the technologies that constitute a means to an end by other methods. This often means not passing on artisanal work but introducing new technologies. I was very struck by the reference to the importance of working with what you have, even if it is not enough, to the point that this does not mean passing on techniques of the past.

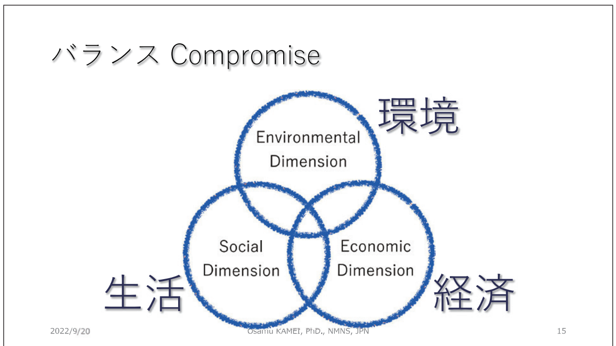


Figure 1

This is exactly what he means when he says that development in an international context will shift from "support" to "cooperation." The issue of cooperation is one in close discussion with the current international situation and the topic of today's seminar. Of the economic or technological gaps large enough to make a one-way declaration of support realistic, there are not as many left in the world as we old fellows think. If anything, there are more and more cases in which our full-fledged support is not even close to sufficient from the other side's perspective. I have also heard of cases in which fully economically developed parties are willing to accept any support being handed out.

In industry as well, Japanese manufacturing once had an overwhelming advantage over the rest of the world. And yet these days, when buying a factory, for instance, it is possible to acquire not just the technology of the manufacturing machinery but also that of the operation and management as a set on the spot, including some very high-quality information. People in the Japanese manufacturing industry were once convinced that the lack of know-how and operating technology made manufacturing overseas impossible. And yet, before they knew it, transfer of operation and management technologies has now become routine. These days, all you have to do is buy a "factory set" to manufacture a reasonable product almost anywhere in the world. While Japan's manufacturing industry is struggling with the principle of technology transfer standing up here as well, for humanity at large it is a blessing.

In terms of money as well, the gap in GDP per person is almost visibly shrinking. The world is no longer that of the two-peak distribution; everyone in the world is becoming affluent. The presentation brought to mind for me that the technological cooperation now becoming possible is suited to the situation in which many countries and regions are now economically capable of providing funding.

Mr. Noguchi's presentation enabled me to realize once again that familiar advanced technology is becoming immensely significant. Familiar here means that the technology is widespread enough to become a part of daily life. This widespread acceptance has its own reasons and significance. For example, the products that reach us are suited to how we operate them and the attitudes used in daily life, as well as being mass-produced, meaning that they are easily affordable and also have good cost-performance compared to products developed as one-offs. As in the examples provided, the method of using widespread technologies of this kind is likely to become more and more important in the future.

While I know I am preaching to the choir, the division of labor is among the most important technologies that has created modern society. This may involve the division of labor among regions, between people, in terms of tasks, or in terms of time. In any of these cases, the technology of grasping the entire process, analyzing it, dividing it accurately and moving on with the work is a tremendous invention.

Technologies with a shared objective will become a future issue in the sense of awareness of the technological development that keeps society running. I was very impressed with the stance focusing on the development not only of mechanical technologies but also of social technologies with shared objectives or involving social decision-making such as education systems.

There are many other points I want to emphasize as well, but I will yield to my colleague here.

TOMODA

I'd like to organize some of the many points of discussion that have arisen. While we tend to use the term "international cooperation in cultural heritage" unconsciously, in fact it has various meanings. As one point particularly relevant to our discussion today, while I'd like to hear Dr. Kamei's opinion on whether this is specific or not to the use of a given technology on cultural heritage, we first need to address the topic of how to work with new technologies in the context of the protection of cultural heritage.

Next, adding the context of international cooperation -- here, international cooperation in the field of cultural heritage in particular -- we must discuss the problem of using these technologies in various environments and with different partners. On this basis, we can relate these points to the prospects for the future of international cooperation in cultural heritage, the question of how we ought to move forward with the use of new technologies. I'd like to divide the discussion into these three stages.

First, regarding new technology in cultural heritage conservation, I'm sure everyone here has noticed that today's presentations focused on surveying technologies. While this owes something to chance as well, as Dr. Shimoda mentioned previously, the technologies used for cultural heritage conservation are extremely diverse; addressing them all separately might diffuse the discussion, and so my intent is as well to focus deliberately on topics related to the familiar issue of surveying technologies.

To that end, today's presentations have covered mainly surveying and recording technologies; I know everyone here is also very much interested in technologies for conservation. In almost all cases of surveying and recording, the cultural heritage itself is not physically affected. Conservation technologies are somewhat different, in the sense that they involve physical interaction with the cultural heritage. The presentations today have not yet touched on this point. I'd like to hear how our speakers feel about the issues calling for attention in conservation technologies, as different from survey and recording. Dr. Shimoda, will you start us off?

SHIMODA

As Mr. Tomoda pointed out just now, technology

usage in cultural heritage can be roughly divided into "technologies for surveys and research" and "technologies for conservation." We must note that both forms of technology are premised on the point that cultural heritage is not a venue for technological experiments and verification.

Surveying almost never involves the risk of damaging monuments, but one example whether it is sometimes necessary to use damaging methods in order to investigate the internal structure of buildings or monuments. However, even in that case, given that cultural heritage is the object, the intervention is required to be minimized.

Another issue often raised is the importance of reversibility. My sense is that much of the work we do is only technically reversible. Realistically, in terms of reversibility, we tend to proceed on the basis that execution should be possible.

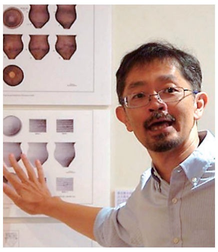
In any case, the application of new technology to cultural heritage requires a perspective willing to minimize the effects on objects; on the other hand, however, while cultural heritage is both unique and rare, it is also categorized, and each category has its own representativeness. Some types of cultural heritage are representative in themselves, while others include multiple categories.

In these cases, for example, when dealing with something which has not been registered as part of World Heritage or a national cultural property, it is also important to make active use of new technology, to some extent, in surveys and research or in conservation, toward the development of further surveys, conservation, and organization.

As it is very difficult to assign the relative merits of cultural heritage, the question of which objects can be permitted what degree of the active intervention of new technologies is very difficult to judge on a uniform basis, requiring case-by-case judgment. However, as, for example, surveys requiring disassembly or research involving partial destruction can make major contributions to a deeper understanding of the cultural heritage in question, we need to use new technologies with suitable judgment, based on the long-term prospects suited to the target within the overall scope of cultural heritage.

TOMODA

I'd like to hear from Mr. Noguchi as well. Your presentation referred to the division of special technology and general-use technology, using the term "high-low mix." I feel that to a certain extent, this applies both to the aspect of surveying and to that of conservation. I'd like to hear what you think about the combination of ready-made and made-to-order technology.



NOGUCHI

I myself am not in close proximity to the field of conservation, with almost no direct involvement in projects of this kind, so I am, as it were, taking an outsider's view in this case. The high-low mix format I discussed in my presentation can be addressed not only within conservation but also with regard to the combination of conservation with the surveying and measurement technologies discussed in this seminar.

For instance, while I agree that irreversible approaches to cultural heritage are difficult and that caution is thus required, if we are now capable of conducting advance surveying and recording with greater precision than ever before, we can thus attempt more challenging projects as, even if deformation or displacement of some kind takes place, we can guarantee conservation in the form of the existing records. This process also involves selecting the target carefully, as Dr. Shimoda pointed out. I feel that combination in this sense should also be feasible.

On this point, as the greatest advantage of the surveying technologies Dr. Shimoda and I have discussed today is that they are non-contact and non-invasive, with these as a premise, even when invasive technologies must inevitably be applied, we should be able to create records via non-contact, non-invasive surveying technology as a guarantee with regard to their impact.

TOMODA

These are all very important points. The issue which arises when using new technologies is how far the technology must be verified to become acceptable for use. As each individual object is different, when bringing a given technology to bear thereon, it is impossible to predict the results completely. Dr. Kamei's presentation also touched on the increasing difficulty of prediction, referring to the black box. In this sense, I'd like to hear from both of you about how technology stands up to verification.

SHIMODA

I find the issue of how far cutting-edge technology must be verified in order for adoption to be acceptable a very difficult one. The verification line which is the standard for judgment varies depending on the target, as well as the nature of the intervention to take place. If a given technology has been judged through various advance experimentation to be the best option, it will be put into use; thereafter, however, it will become the touchstone, so technologies must be put into practice through sufficiently cautious verification. We must not forget that doing nothing is also a valuable option: I feel that we must be aware of the fact that when judgment is impossible, deciding to hold back from intervening and wait and see is an extremely important option.

When making use of new technologies upon a given degree of verification, naturally the results thereof must be monitored long-term from a comprehensive perspective, and their helpful and harmful effects verified. Thereafter, the widespread sharing of the results of this verification will provide important resources for the subsequent use of technology as well as for development. In the case of cultural heritage, failure is not an option, but verification with the actual object can unquestionably also provide important data for subsequent work, monitoring post-application is as important as advance verification.

TOMODA

I'd like to hear from Mr. Noguchi as well. I believe your presentation discussed the handling of data gained from technology in particular; could you talk about this here?

NOGUCHI

In response to Dr. Kamei's presentation at the beginning as well, I've been drawn to reconsider various points; I believe that the black-boxification of technology as it develops is itself no longer reversible. Elsewhere, my reaction to the idea of using technology "as is," as a black box was that new roles and tasks will arise for us as experts; I addressed this a little in my own presentation as well.

The developers are working on general surveying technology, not special technology specifically intended for the cultural heritage industry. The catalog specs are presented as such and such. The use of background technologies is also indicated.

We experts examine, given a general level of knowledge of these background technologies, how the catalog specs will actually be applied and realized in the context of cultural heritage, and how they will be reflected in the outcomes. This is something the technology developers cannot do; it will, I believe, also come to be positioned as something pioneering experts need to carry out before the technology becomes widely accepted and used onsite by many people.

Therefore, I felt that rather than the two options of open or black-box, gradations may also come to exist. The format in use will shift from a total black box to one suited to each specialist field as experts, in tech terms, "hack" the technology to some extent. The role of experts will shift and expand to creating manuals and guidelines based on this process.

I was thinking as I listened to the presentation that the early 21st-century new form of overseas cooperation (allowing for some exaggeration!) may be for Japan, or any given country with a well-developed field, to expand it overseas through education, training, and transfer.

TOMODA

One of the key words in Mr. Noguchi's presentation was "the latest technologies at hand," which strikes me on reflection as an extremely contemporary expression.

I feel that cutting-edge technologies were once not so close at hand. Since that time, new technologies have made rapid progress, with smartphones as just one example; these days, they become widely accepted and used in no time. In this context, not a little of us in the field of cultural heritage are still cautious about the adoption of these new and untried technologies. Our two presenters today are rather progressive actively adopting new technologies, but others may not be.

I may be the one among old-fashioned; I'd like to hear from Dr. Kamei about how we in the field of cultural heritage should approach technology, in particular regarding the adoption of new technologies.

KAMEI

I get the sense that people are nervous about the adoption of new technologies. It seems to me that if issues arise, they can simply be solved with technology. Technology is improving and changing, including its usage methods. Any given technology remains in use while it is needed, and then falls out of use and become lost when another convenient technology, or a cheaper one, is developed -- that's just how it is.

The generation before mine took for granted that pencils were sharpened with a knife. My generation uses a pencil-sharpener. Some of people in our generation had been told when they started school to use a knife to sharpen their pencils, even though pencil-sharpeners were available. Today, not only the pencil, but the hand writing instrument itself is used only in limited situations as a work tool. In the larger scheme of things, we can see that it was something that was passed down from generation to generation in the belief that it was important in the past and would be useful someday, in other words, it was a fantasy of the one who passed it on.

Going out of our way to preserve old technologies which have fallen out of use alongside new technologies is a highly expensive proposition. Also, the expense only increases with time. To use the pencil example again, it would have been more rational to start using pencil-sharpeners right away, or to introduce mechanical pencils and concentrate on research and development of study methods within that system. Passing on technologies in order to resolve problems has ended up as an effort to conserve the technologies themselves, when they would otherwise have been lost. Myself included, we must make sure we are not doing the same thing now.

The use of general-purpose technological products is often a faster, more effective way to reach the goal than the development of technologies from scratch. For any widely accepted technology, an even newer successor technology will appear. There will also always be consideration regarding the transfer from old to new. Dedicated development does lead to purposive technologies, but their development, operation, and upgrading all involve significant costs. With fewer users, new technology development will lag, and with no users that will be the end. General-purpose products are in demand by definition. As long as demand exists, they will continue to be sold, even if the format and the sellers change. It is entirely natural to put them to use for specialist applications as well. Uniquely accumulated technology is important, but it has to be capable of upgrading with the times -- I want to emphasize this general point.

TOMODA

I had quite a shock recently. My field is architecture, and a little while ago, in industrial fields as well, everyone used a tool called a ruling pen to draw plans. There are still just a few people using it now, but first it gave way to the rOtring technical pen, and now the rOtrings are being discontinued too. I was made to realize we are now in an age where it's normal to produce drawings via computer.

While the conservation of traditional technologies is another topic again, which I will pass over lightly here, it struck me that careful thought is needed – for what purpose, even when we keep using what we always have, like when we adopt new technologies -- to make a conscious choice either way.

Dr. Kamei, I'm sure you have more to say.

KAMEI

I too came across instructors in industrial drawing who would say you were no good if you couldn't sharpen a ruling pen. My friends and I received instructions of this sort with a chilly lack of interest -- when would we ever use it? There was certainly a time when ruling pens ruled all. I remember being told by a senior colleague that official documents must always be written with a fountain pen, not a ballpoint pen. And I hardly need explain where matters stand now.

Incidentally, I think I was probably one of the first people to get the authorities to accept an approval document printed out from a computer. We won't even get into gathering up affixing one's seals event left as they were. I'm grateful to the older students and colleagues who taught me so much back then, but I do have a few things I'd like to say to them.

TOMODA

We could discuss this forever, but for now let us move on to the next topic. International cooperation is, of course, not a matter of cultural heritage alone, but cultural heritage as one of the many fields in which international cooperation takes place, is the position from which we work.

My impression of the main points of Dr. Shimoda's presentation today was the issue of what happens when new technology is adopted, as the subject using the technology. Elsewhere, Mr. Noguchi's presentation focused on the issues arising when conveying an in-use technology to others, especially to others overseas.

I'd like to hear about the difference between your use of new technology overseas, in a context of international cooperation, projects, et cetera, and your normal use in Japan. One characteristic is likely to be the diversity of the targets; I believe Dr.

Shimoda mentioned the distinction from traditional technologies that came up previously, as well as the importance of manual technology. I would like to hear your thoughts on the applicability of new technologies including this perspective, in particular in the overseas contexts. Dr. Shimoda, if you would.

SHIMODA

I don't usually keep technology especially in mind when working overseas, but this discussion has made me freshly aware of the important perspective technology constitutes. Regarding your questions, I have three points in mind, from varying perspectives.

The first is the point raised previously by Dr. Kamei, with regard to the need to select technologies based on the objective or the method, with which I agree. I'd like to go further and say that in the case of repair and conservation, it's important that the use of technology be closely suited to and shared with the principle, if you will, or theory of the work.

For example, we need occasions to consider the integrated relationship those providing support and those receiving support, and between principles and technology. The use of traditional technologies and of supplementary cutting-edge technologies are also important options. My first point is that traditional technologies can offer opportunities for new technological development to the providers of support, making it important to be actively prepared to learn about the traditional technologies used locally, as well as to be aware of the potentials for the creation of new technologies based on melding these traditional options with cutting-edge technologies.

My second point, pointed out by Mr. Noguchi in his presentation, is the adoption of the optimal technologies for the local environment, the targeted monuments, etc. A little more than ten years ago, I worked with Professor Aoki, who introduced today's event, in a JICA project selecting equipment for the Jordan Museum. While I was hardly more than an aide, it was an excellent learning opportunity. The mission was to conduct the necessary research on heritage required to establish this national museum in Jordan, and to select the conservation science equipment. We spent about a week talking with the local people and selecting equipment which could be managed locally and would be suitable for the targets. This experience enabled me to learn from Professor Aoki the importance of selecting equipment which was basically at the right level of specs, had the functions needed by the cultural heritage onsite, and could be managed locally. My second point regarding technology in international cooperation is the selection of suitable specs and the adoption of technologies that can be sustainably managed locally.

My third point, from a somewhat different perspective, is the reality that technologies are forged onsite. Cultural heritage sites sometimes involve extremely problematic conditions. With ordinary targets, a failure can be remedied with repeated efforts; you use technology, and if it doesn't work you find something new from there and try again. With cultural heritage, however, failure is not an option. The general stance is that pushing the envelope with the use of technology is a bad idea. However, the use of new technologies in difficult onsite conditions can also be extremely beneficial for new technological development.

It is extremely important to use technologies with potential of this kind onsite, and to aid their development along with that of their technicians, if Japan as a country is to continue and sustain its policies of technical cooperation in cultural heritage. Empirical results onsite come in useful at the next site, and are shared among experts. This point is important.

Therefore, my third point is that in order to carry out sustained international cooperation in cultural heritage, I feel we need to push the envelope to some extent with the use of technology to the cultural property which is not the highest state of significance.

TOMODA

You mentioned previously that the results gained from the adoption of LiDAR cannot be entirely predicted in advance, and that its results evolve new analysis methods and data usage methods. Then, they in turn will lead to new technological development as well.

SHIMODA

Yes, exactly.

TOMODA

I'd like to hear from Mr. Noguchi as well, bringing in the issue of technology transfer if you prefer. Particularly, I'd like to hear your opinion on appropriate methods of introducing technology, including the question of whether there is a gap between the receiver's perspective and that of those bringing in the technology.

NOGUCHI

While this may seem to contradict or conflict with what you and Dr. Shimoda have been saying, I feel that education and transfer have become much easier thanks to the introduction of new technologies close at hand, as I discussed earlier. Something that came to mind when considering why this might be so was that traditional methods are extremely physical. To some extent, we ourselves have muscle memory of the things learned over long training, which is a positive aspect in itself; conversely, however, it is very difficult to convey cultures of physical sensation and physical skill to people who do not share them. With regard to archaeological materials and survey drawings, we Japanese produce extremely precise drawings; it's come home to me that this is based not only in university education, but in a background going back to elementary school craftwork and subsequent technology classes.

Professors who never draw their own diagrams sometimes, in Pakistan for instance, see our drawings and say, we want to draw like this, teach us how. But say we start at ten in the morning with Japanese methods, no one comes back after lunch. They say it's impossible. Because they have never before manipulated a pencil or a set of dividers, the use of the Japanese method would involve starting from the elementary or secondary level.

However, when it comes to smartphones and computers, regardless of anything studied in school, most middle-class households have them these days; smartphones in particular are now widely available at very low prices, so that people who have not reached middle-class incomes know how to use them as well. This means that they already have the muscle memory, the physical manipulation skills I've been referring to. As I may seem to be presenting only the positive side, this point is showing much better results than traditional methods. Conversely, even when the Japanese method is not employed, in countries which teach various technologies at the elementary and secondary levels, education and training are possible along lines the same as or similar to our method. This suggests to me that widely accepted new technologies are being put to use in closing the gap of social contexts such as culture and education.

Another point is that, as Dr. Shimoda pointed out, the introduction and development of new technology have been changing rapidly, particularly in the last two or three years: the developers of smartphone apps are frantically searching for users and their feedback on social media. When talking with these people, I found that app downloads can be viewed by region, in Japan, although there are a lot of users who are posting about their 3D renderings on social media, there is almost no feedback for the developers. In the West, however, they are bombarded with comments about how hard the app is to use, even though users there are hardly making use of it at all. Therefore, we end up getting direct messages asking what the Japanese usage habits are.

The Mobile Scan Association members use Google Translate when their English is not up to the task, receiving one request after the next -- I want such-and-such a function, such-and-such area needs improvement, and so on. This leads to invitations from the developers for beta testers, asking them to use the product and provide their opinions, a process which is making notable progress recently.

I realized thereby that while experts in cultural heritage, archaeology, architecture and so on have done their share of joint technical development, they have made relatively few direct requests with regard to general-use, wide use, or consumer-use technology. Major development of new technologies has been possible in the context of massive research funding or government-level cooperation, between governments, but I feel we need, if anything, to commit actively to the new technologies beginning to develop at the grassroots level. We don't need to worry about how many users are involved with cultural properties or cultural heritage, or whether the technology will stand up as a business; we can leave that to the corporation in charge of marketing, and take the stance that we want such-and-such, we'd absolutely use this if it were available, if it comes into use such-and-such a product would also be commercially viable. We are going to need to work with the developers in future in this way to create technologies best suited to our use.

TOMODA

When considering technology transfer, the amount of technology which can be transferred within a limited time has to be narrowed down, which leads to the problem of whether the provider side can make the choice entirely on its own. What do you think here?

KAMEI

As you know, technology is influenced by location and climate. To give a representative example, stainless steel in England is not at all “stainless” at Okinawa in Japan. No matter how the provider argues that stainless steel is what it is, when it rusts in use, it can no longer be considered stainless. It depends on the receiver whether the technology considered good enough by the provider actually works. The evaluation of technology rests on whether it solves the receiver’s problem. This is the vital point of technical cooperation and technology transfer.

TOMODA

Technology once transferred must then have its effects verified and so on; to what extent should the transferring side take responsibility for how it develops thereafter, including sustainability?

KAMEI

It’s a difficult question. The historical facts of industrial technology show that bridges using new technology have fallen this way and that, while ships likewise have breached their hulls and sunk in droves. History also tells us that technological development has kept moving through failure. Regarding the assignment of responsibility, technical ethics struggles here as well, but basically I believe that the user of the technology ought to take responsibility for its results, improvement, and continued transfer.

In terms of actual phenomena, we know surprisingly little and must often try something out to understand it. The results of such attempts tend not to go well. Guarantees against failure tend to be “probatio diabolica,” the impossibility of proving a negative. In medieval Europe, groups of experts called alchemists or blacksmiths historically used their “secrecy” to adjust the level of the technologies they released. Nowadays, in the era of science which guarantees reproducibility and falsifiability through knowledge made public, the responsibility lies not only with those expert groups but also with users and the general populace.

While it may be hard to swallow for experts in cultural heritage, a certain degree of failure is inevitable in technological development. Cultural heritage is the same as general technological development. We need the technological, institutional, financial, and psychological support that will enable the people onsite to take risks through trial and error, assessing the degree and severity of risk without fear of failure. Where possible, I consider it important to share knowledge, including technology, with people, and thus to create empathy. I hope to have an opportunity to put into practice the method Mr. Noguchi mentioned of providing feedback for general-use products in order to bring them into the relevant field.

TOMODA

Mr. Noguchi was saying that culturally shared physical technology is difficult to transfer. Dr. Shimoda, do you have a view on this?

SHIMODA

I’d like to take a new tack here, including the previous discussion, and consider the targets and methods of technology transfer as well as the experts involved. In my presentation, I addressed the categories of elemental technologists and applied technologists, saying that the approach to cultivating the human resourcelatter was particularly important. I believe that it’s the most important with regard to various technologies to cultivate people like orchestra conductors, working out how they can acquire the capacity to select the appropriate technologies.

Elsewhere, the side providing support must collaborate with elemental technologists, technicians if you will, and regional scholars. In particular, the importance of regional scholars is their familiarity with the needs of cultural heritage, the area, and the country, as well as their awareness (even if at a generalized level) of elemental technologies. Further, collaboration between regional scholars and national policy-makers is also important. In part, it is important for both sides to have a deeper understanding of the effects brought about (other than cultural policy) by various cultural activities. Moreover, the companies developing technologies can also benefit from the admixture of a broader perspective on cultural heritage. To this end, I consider it important in order to select the technologies that meet existing needs for regional scholars to come in contact with private-sector companies developing technologies and constantly encounter new technologies. For the developers as well, although the field of cultural heritage is a small enough market to be short on profits, the use of equipment in cultural heritage is also the locus of technology developed to solve intractable issues; it can also contribute to brand image improvement and international name recognition. It is regional scholars who need to play the connecting role here to achieve these ends.

TOMODA

My impression is that both of you agree on the point that it's important for people involved in various capacities to share information while providing feedback working toward newer and better technologies.

As we have only a little time left, I'd like to start wrapping up our session. Based on the discussion so far, what else would you like to consider, and what expectations do you hold, in respect of international cooperation on our part in cultural heritage conservation, as well as ways to approach new technology and its use? Let's start with Mr. Noguchi.

NOGUCHI

In relation somewhat to Dr. Shimoda's previous comment, to the best of my knowledge the corporations developing new technology, particularly the developers themselves, are not so much focused on increasing profit; rather, they get extremely excited when their technologies are used for something new, something where technology has never been used before. I said before that marketing and monetizing can be left to the company; as Dr. Shimoda mentioned, in the field of cultural heritage, the issue is not just simple market economics but also, for instance, how to commit to policy. Conversely, if we experts can play the connecting role successfully, we should be able to provide a foundation from which the developers can take the next step.

In that sense, through today's discussion as a whole, one thing that stands out to me more clearly than before is, for instance, the importance of placing technologies at the core and creating a network connecting them. Experts will be called on to act as liaisons for the establishment and maintenance of communication connecting local experts, people involved as regional scholars, those involved as experts in various academic fields, technology developers, and so on; my feeling is that this is a real change from the roles and positions of experts as envisioned in the 20th century. At the same time, the process is still in its infancy; I am often called on to play multiple roles at once, and I think Dr. Shimoda may feel the same. Listening to the discussion, I felt that in the future the roles needed will be better organized, shifting to a division among those suited to each role, for instance with specific communicators, or with managers specializing in management. That's all I have to offer.

TOMODA

Dr. Shimoda, what about you?

SHIMODA

If we start from the incredible diversity of technology, it will be quite a task to determine a basic policy for the use of technology in international cooperation. That said, if Japan is to continue with the preservation of cultural heritage as one of its methods of international cooperation, we will need some kind of guidelines, as it were, organizing our basic stance.

If we could organize some kind of basic principles -- for instance, prioritizing the use of traditional technology where it is effective, or shifting to cutting-edge technology, or a hybrid thereof with traditional technology, when the monuments or materials have major damage from the start -- these may or may not be appropriate ideas, but it would be significant to be able to convey Japan's attitude concisely to the countries receiving support.

In addition, the conservation of cultural heritage in Japan has the major advantage of there being an established culture of retaining post-conservation reports. These reports are valuable assets as background for the verification and use of new technologies. Heritage conservation projects in developing countries and so on often take place in settings where the culture of making thorough reports is not a given, so we need to sharetransfer this practiceculture along with the technologies involved. At the same time, it would be immensely helpful if we had a framework within Japan for unified management and provision of the reports filed as part of international cooperation.

TOMODA

Dr. Kamei, may we hear from you? The discussion just now has come from perspectives within the field of cultural heritage; I'd like to hear your expectations from an outside point of view as well.

KAMEI

I have the impression that research can easily become dependent on individual capacities. Therefore, in the sense of passing on these individual abilities, the question of how to bring them into the public space is very important. In addition, while I think the other two speakers have covered the topic of the choice of technologies effectively, and I don't have much to add in that regard, I still had some questions about the approach to cultivating a social, or governmental, awareness regarding the use of technology to conserve cultural heritage.

The conservation of cultural heritage is a technology of sorts, when viewed broadly, and its use requires positioning in terms of "how do we want to affect society," "how do the people around here want to lead their lives" and so on; otherwise, it will end up at the surface level of "reports were written," "records were made using the correct methods," with no real sense of what the conservation actually means. It's not sustainable, in that case. In this context, I feel that cultural heritage conservation will attain a solid position within society if the people working with it can take sufficient care with regard to the position they want it to have.

Reference: Nara National Research Institute for Cultural Properties (2023) "Recording and Utilization of Cultural Property Information via Digital Technologies Vol.5" Nara National Research Institute for Cultural Properties Research report 37
http://doi.org/10.24484/sitereports.130529

Closing Remarks

Today's discussion has covered a number of very valuable points. The topics have ranged too widely to be summed up in few words but let me attempt at least to do so.

First, as the obvious premise, technology itself is not the end but the means to solving problems and resolving issues. Given the premise, to what ends do we use technology? This is the question the users of technology must be aware of -- beyond the level of "how it is used" to "what we need to do with it." For example, it has become clear here that based on this point, it is important in technology transfer as well to convey the context along with the technology.

Today's seminar has been conducted as a webinar with the new Webex technology. Although we began using this technology as a necessary measure in response to the coronavirus pandemic, it has already become everyday practice, with its various advantages along with, in comparison to face-to-face seminars, its limitations gradually becoming clear. This suggests that we constantly face the question of how to use various new technologies better, one which applies just as much in our world of cultural heritage and in that of international cooperation.

While many topics remain unaddressed by today's seminar, JCIC-Heritage will be presenting more seminars and symposia to come, in consideration of the various opinions lodged with us. Regarding the points raised earlier on the creation of networks concerning technology and of the significance of multinational cooperation, we at JCIC-Heritage are reminded that we have a major responsibility to fulfill in these contexts.

While I'm sure our presenters have more to say, our time today terminated, and the seminar must conclude here. Thank you very much.

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