Intervención

ISSN 2448-5934

JULIO-DICIEMBRE 2023
JULY-DECEMBER 2023

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From Space to Data: Smart Survey Methods in Architecture and Archeology

Ir a la versión en español

DOI: 10.30763/Intervencion.290.v2n28.69.2023 · YEAR 14, NO. 28: 229-240

Submitted: 31.01. 2023 · Accepted: 02.10.2023 · Published: 16.02.2024

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Translation by Araceli Paola Salinas Gómez

SUMMARY

This review reports on the work carried out in the *From Space to Data: Smart Survey Methods in Architecture and Archaeology* course, taught by Hungarian specialists Dr. Zsolt Vasáros and Master Mór Bendegúz Takáts, from January 9 to 18, 2023 at the Museo Nacional de Historia (MNH), Castillo de Chapultepec (National Museum of History, Chapultepec Castle), and organized by the Coordinación Nacional de Monumentos Históricos (CNMH, National Coordination of Historical Monuments, Mexico) within the framework of the *Technical Contribution Agreement* signed between the governments of Mexico and Hungary in 2020. The course was attended by 27 participants: archaeologists and architects affiliated with different work centers and two guests from the Universidad Nacional Autónoma de México (UNAM).

KEY WORDS

technology, digital photogrammetry, Hungary, earthquakes

It is well known to all of us living in Mexico that earthquakes are natural phenomena that have struck the country since immemorial time. The earthquakes of September 7 and 19, 2017, caused significant damage to 2 340 historical properties located in different states of the Republic and Mexico City. The international community did not remain oblivious to this tragedy. Among others, the Government of Hungary responded to the emergency through its *Hungary Helps* program, which offered support to the Mexican

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people in the challenging task of architectural restoration. That gesture of solidarity was formalized on April 9, 2019, with the execution of the *Cooperation Agreement* between the Mexican Ministry of Culture and the Hungarian Ministry of Foreign Affairs (Secretaría de Cultura, 2019). One of the heritage sites benefiting from economic resources and specialized technical advice to perform restoration work was the ancient temple and convent of *La Natividad (The Nativity)* in Tepoztlán, Morelos.

Later, in 2020, new agreements were signed between the Hungarian and Mexican governments through Hungary's embassy in Mexico and the Instituto Nacional de Antropología e Historia (INAH, National Institute of Anthropology and History) and the Instituto Nacional de Bellas Artes y Literatura (INBAL, National Institute of Fine Arts and Literature), under which the Technical Contribution Agreement was signed on November 24 (Secretaría de Cultura, 2020), seeking to provide economic resources to buy and update materials, equipment, and software, such as a Flir C5 infrared thermal camera, a Leica GLS112 prism pole, a DJI Air 2S drone with a Xiaomi cell phone to operate it, a Nikon Z50 20.9MP camera, four reactivations and upgrades of Leica Cyclone CloudWorx AutoCAD pro CCP, Leica Cyclone Model CCP, and Leica Cyclone Register CCP software. This contribute to the improvement of the Laboratorio de Imagen y Análisis Dimensional (LIAD, Dimensional Image and Analysis Lab) of the Coordinación Nacional de Monumentos Históricos (CNMH, National Coordination of Historical Monuments) of the INAH and the organization of the *From Space to Data: Smart Survey Methods in Architecture and Archaeology* course, dictated under the supervision of the CNMH and which aimed to strengthen the technical capacities of personnel affiliated with the INAH.

In line with the requests made by Hungarian specialists Dr. Zsolt Vasáros[1] and Master Mór Bendegúz Takáts,[2] the CNMH proposed the Museo Nacional de Historia (MNH), Castillo de Chapultepec (Nacional History Museum, Chapultepec Castle), as the venue to

[1] Dr. Zsolt Vasáros studied architecture, archaeology, and Egyptology at the Budapest University of Technology and Economics in Hungary. He graduated as an architect from the Faculty of Architecture of the same university in 1997. In 2000, he opened the *Narmer Architecture Studio* in Budapest. He is known for his innovative designs and research projects for museums, archaeological sites, and natural environments. He is currently working on several research projects in Hungary, Central Europe, and the Middle East and is Head of the Department of Explorative Architecture at the Faculty of Architecture of the Budapest University of Technology and Economics.

[2] Master Mór Bendegúz Takáts is an archaeologist, 3D expert Imaging systems, and associate professor at the Institute of Archaeology of the Pázmány Péter Catholic University in Budapest, where he is also Director of the Archaeological GIS Laboratory. His main fields of research are the archaeological legacy of the late Sasanian and early Muslim periods, the archaeology of the medieval Near East, non-invasive archaeological research, and the application of 3D imaging systems.

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teach the course. The museum was chosen since it is a historical building with an important collection of heritage objects, surrounded by green spaces, and with archaeological remains in its immediate surroundings, making it ideal for carrying out the exercises planned by the specialists. In addition, it was also possible to have a suitable space, such as the auditorium, for taking lessons, attending the lectures given by the Hungarian specialists, and holding the opening and closing ceremonies. The Museum's director, historian Salvador Rueda Smithers, acknowledged the value of the course and, together with his team, gave his full support to its success.

Based on the premise that the INAH "researches, preserves, and disseminates Mexico's archaeological, anthropological, historical, and paleontological heritage in order to strengthen the national identity and memory of the society who owns it" (INAH, 2022),[3] the purpose of the course was to show architects and archaeologists affiliated with different INAH work centers the use of various smart technologies from a theoretical perspective and the interaction among them as tools that can deliver a 3D survey of cultural heritage at a micro and macro scale; that is, from objects to historical and archaeological sites. Considering the above, professors Vasáros and Takáts developed a 75-hour course-workshop to be held in 10 days, from January 9 to 18, 2023.

Due to the limited number of participants, a selection process was carried out by the CNMH, the Coordinación Nacional de Arqueología (CNA, National Archaeology Coordination) and the INAH work centers across the country. This process took into account both the professional experience of the interested candidates and the specifications submitted by the Hungarian specialists and the CNMH, which included the ability to handle technology, commitment and willingness to undertake institutional responsibilities, the ability to transmit knowledge to their work center colleagues, understand English and, if possible, have an iPhone 12, 13, or 14 Pro and a laptop.

Finally, a total of 27 participants attended the course, 14 of whom came from outside of Mexico City and were affiliated to the INAH centers of the states of Aguascalientes, Chihuahua, Guanajuato, Morelos, Nuevo Leon, San Luis Potosi, Sinaloa, Sonora, and Zacatecas.[4] The remaining 13 participants were Mexico City resi-

[3] All quotes are editorial translations from the Spanish versions.
[4] Architect Iván Israel Sánchez Silva, Centro INAH Aguascalientes; Dr. Eduardo Pío Gamboa Carrera, Centro INAH Chihuahua; Master Paola Lizette Cruz Garay and architect Pablo César Rodríguez Alvarado, Centro INAH Guanajuato; Dr. Laura Díaz Flores, Centro INAH Morelos; Master Gloria Mariana Vázquez Jiménez, Centro INAH Nuevo León; Master Leonardo González Leos, Centro INAH San Luis Potosí; archi-

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dents, associated with the Dirección de Salvamento Arqueológico (Archaeological Salvage Directorate) of the CNA, the MNH, Castillo de Chapultepec, the Escuela Nacional de Conservación, Restauración y Museografía "Manuel del Castillo Negrete" (ENCRYM), the CNMH and two guests from the Universidad Nacional Autónoma de México (UNAM, National Autonomous University of Mexico).[5]

The opening ceremony was held on Monday, January 9 at the MNH, attended by the Head of the Hungarian Mission, Gábor Endrény, representing Ambassador Zoltán Németh; archaeologist Luis Antonio Huitrón Santoyo, National Coordinator of Institutional Development, representing anthropologist Diego Prieto Hernández, General Director of the INAH; Master Valeria Valero Pié, National Coordinator of Historical Monuments; and historian Salvador Rueda Smithers, Director of the museum. Afterwards, Dr. Vasáros and Master Takáts dictated the introductory lecture "From Crisis to Crisis-question for a Useful Documentation",[6] explaining and exemplifying the work they have done using technologies such as digital photogrammetry and 3D surveying with a laser scanner of cultural heritage in Hungary, Germany, Egypt, Syria, and Iraq for architectural, archaeological, exhibition, and documentation purposes. One of the most impressive examples was the digital photogrammetry survey of a mummy from excavations being conducted in Egypt. The level of detail of the 3D model makes it possible to clearly see the warp and weft in the fabric. This lecture allowed the attendees to realize the array of possibilities that could be implemented in their daily work in each of their fields and at their workplaces.

Subsequently, a visit was made to the archaeological remains by the Castle, guided by the archaeologist María de Lourdes López Camacho, and followed by a visit to the historical building led by the author of this article, seeking to learn about the structure, its archaeological environment and its history, and analyze the specific places to do the exercises, since it is not possible to carry out

tects Humberto Moreno Téllez and Jorge Arturo Gastélum Zepeda, Centro INAH Sinaloa; archaeologist Cristina García Moreno, Centro INAH Sonora and archaeologists Jorge Cuauhtémoc Martínez Huerta; Carlos Alberto Torreblanca Padilla and Juan Gerardo Rivera, Archeological Monuments Department of La Quemada, Zacatecas.

[5] Archaeologists Janis Verónica Guadalupe Gaytán and Guillermo Antonio Goñi Montilla, Dirección de Salvamento Arqueólogico, CNA; Architect Luis Fernando López Cortés, Museo Nacional de Historia, Castillo de Chapultepec; Restorer María Teresa Ramírez Miranda and Master Luis Carlos Bustos Reyes, ENCRYM; Dr. María Sánchez Vega, architects Erika Liliana Hernández Martínez, Óscar Ibarra Vega, Emanuel Herrera Dávila, Ángel Mora Flores, architecture intern Marisela Gónzalez Quiroz and archaeology intern Áyax Horacio Segura Galván, from the CNMH, and Masters Naydé Tepox Padrón and Fabian Bernal Orozco Barrera.

[6] Both the opening ceremony (INAH TV, 2023a, 00:00:00-00:20:05 min.) and the Introductory lecture (INAH TV, 2023b, 00:21:56-2:00:17) were broadcast by INAH Media and are available on INAH TV on YouTube.

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any type of survey without first studying the site, the building or object, its historical and stylistic context, its construction stages, and its constructive and constituent materials, as the case may be. In addition, it is also necessary to have a clear object of study or research to conduct an analysis that leads to a proper survey. The first day ended with the 27 participants introducing themselves and sharing their professional experience and what they expected from the course, which allowed the Hungarian specialists to get to know them better and modify the activities and exercises according to the knowledge and expectations of the group, if necessary, all of which shows their interest in making the best use of the course. It is worth mentioning that, at the request of the specialists, participants had already submitted an email with their resume and a PowerPoint presentation containing the abovementioned specifications, so that the Hungarian specialists would have a better idea of who would participate in the course.

In the following days, the course consisted of an explanation of the digital photogrammetric process by Dr. Vasáros and Master Takáts, starting with the methodology for collecting data using technological devices such as cell phones and drones, followed by the post-processing with Agisoft-Metashape 2.0 software (Figure 1) installed on the computers used by the participants to finally obtain a 3D scale model of the site or object surveyed and demonstrate how this technology can coexist and be complemented by other technologies.

The architectural venues in the museum where the exercises were carried out were those known as the *Caballero Alto (Tall Knight)*, a tower located in the *Jardín del Alcázar*; the dining and reading rooms; the *Escalera de los Leones (Lion's Staircase)*, in the Alcázar; as well as the staircase in the *Jardín de las Pérgolas* and a historical metal object called *samovar*. One of the challenges was learning to work with the computer equipment available, since not all the participants had an iPhone with the required characteristics, and in the case of laptops, either PC or Mac, practically none had the capacity to process that amount of information. However, the analysis was fruitful, as complete, high-resolution 3D models were successfully generated (Figures 2, 3, 4, 5, 6, 7, and 8).

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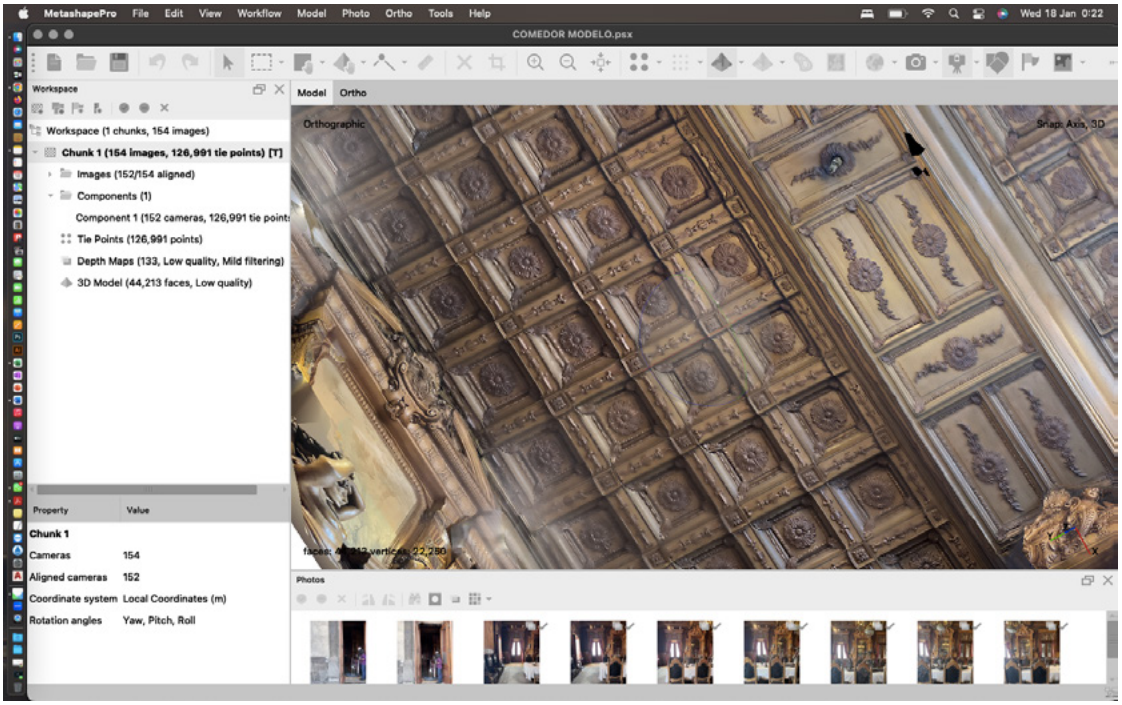

FIGURE 1. *Agisoft-Metashape 2.0* software interface showing the ceiling of the dining room of the MNH, Castillo de Chapultepec (Survey and model elaboration: María Sánchez Vega, January 12, 2023; courtesy: Museo Nacional de Historia, CNMH).

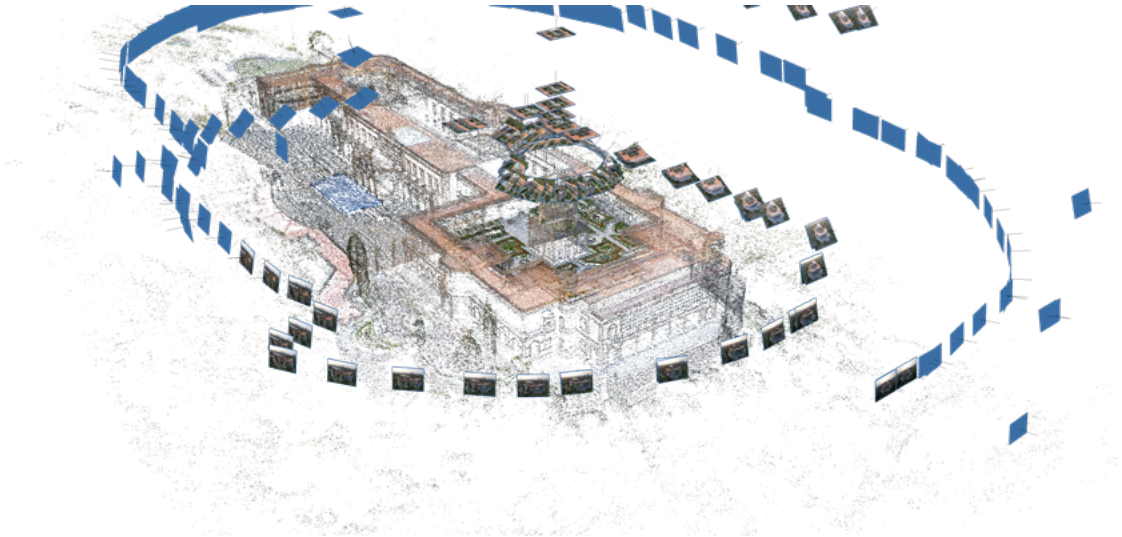

FIGURE 2. Point cloud image of the MNH, Chapultepec Castle (Survey: Jorge Cuauhtémoc Martínez Huerta and Marisela González Quiroz. Model elaboration: Marisela González Quiroz, January 13, 2023; courtesy: Museo Nacional de Historia, CNMH).

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FIGURE 3. *Caballero Alto*, MNH. 3D model elaborated by digital photogrammetry (Survey and model elaboration: Marisela González Quiroz, January 12, 2023; courtesy: Museo Nacional de Historia, CNMH).

FIGURE 4. Staircase of the Jardín de las Pérgolas, MNH. 3D model elaborated by digital photogrammetry (Survey and elaboration of the model: Áyax Horacio Segura Galván, January 14, 2023; courtesy: Museo Nacional de Historia, CNMH).

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FIGURE 5. *Fuente del Chapulín*, Alcazar of the MNH. 3D model elaborated by digital photogrammetry (Survey and model elaboration: Emanuel Herrera Dávila, January 16, 2023; courtesy: Museo Nacional de Historia, CNMH).

FIGURE 6. Staircase, MNH. 3D model elaborated by digital photogrammetry (Survey and model elaboration: Fabián Bernal Orozco Barrera, January 16, 2023; courtesy: Museo Nacional de Historia, CNMH).

FIGURE 7. Image of the textured mesh in the *Escalinata de los Leones*, Alcazar of the MNH. 3D model elaborated by digital photogrammetry (Survey and model elaboration: María Sánchez Vega, January 16, 2023; courtesy: Museo Nacional de Historia, CNMH).

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FIGURE 8. *Samovar*, MNH. 3D model elaborated by digital photogrammetry (Survey and model elaboration: Ángel Mora Flores, January 17, 2023; courtesy: Museo Nacional de Historia, CNMH).

It was also possible to conduct exercises to join interior and exterior 3D models in order to have a fully surveyed property or site. In addition, digital surveys were made using applications or Apps designed for cell phones with an IOS operating system merely to explore the LiDAR sensor on iPhone Pro devices. There was a session to export the *Agisoft Metashape 2.0* point cloud to *AutoCAD* using *Autodesk ReCap* as a means between those two programs in order to draw plans.

The sessions were strenuous though productive, but all good things come to an end, and eventually on January 18, the last activity took place with a lecture given by Dr. Vasáros and Master Takáts, *From Space to Data (and back): Smart Solutions. Knowledge Transfer Based on Field Experience*,[7] where Dr. Vasáros shared some highlights discussed during the course, such as the assistance to communities and architectural properties in case of disasters; how technology can be useful to carry out the first surveys and help follow up the relevant restorations and reconstructions afterward; the questions to be made before starting any survey

[7] As noted in previous lines, the introductory lecture was broadcast on INAH Media and is available on INAH TV on YouTube.

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and the methodology depending on the object at hand; and the challenges that participants would have to face, mainly in the field of computer equipment. For his part, Master Takáts listed the challenges faced during the course and the results obtained, showing the work, achievements, and strengths of each participant, or, in other words, their ability to solve specific problems in each exercise in a particular way, following their own process of analysis and experimentation. Finally, he focused on the good results obtained with the 3D models. To close the workshop, some attendees thanked the specialists and the authorities for the opportunity to participate in this type of experiences and to support both the growth and the knowledge of professionals devoted to culture.

The last activity of the course consisted of the closing ceremony,[8] with the presence of the specialists Dr. Zsolt Vasáros and Master Mór Bendegúz Takáts; the Hungarian Ambassador in Mexico, Mr. Zoltán Németh; anthropologist José Luis Perea González, Technical Secretary, representing anthropologist Diego Prieto Hernández, General Director of the INAH; Master Valeria Valero Pié, National Coordinator of Historical Monuments; architect René Alvarado López, National Coordinator of INAH Centers; and historian Salvador Rueda Smithers, Director of the MNH, Castillo de Chapultepec. As stated by the authorities of the Hungarian Government and those of the INAH, the course was a complete success thanks to the support that the Hungarian and Mexican authorities provided, the availability and professionalism of Dr. Vasáros and Master Takáts, the organization and logistics of the CNMH staff, the support of all those who work at the Museo Nacional de Historia, and the effort, interest, and dedication of the 27 participants, who not only worked intensely, but also engaged in an atmosphere of respect, team spirit, and support. The greatest beneficiary of this academic event is Mexican cultural heritage, which will have better professionals devoted to its research, preservation, and dissemination. Clear examples of this are the digital photogrammetric surveys that, on the one hand, the Unidad de Apoyo Tecnológico (Technological Support Unit) has performed in some historical buildings in Mexico City damaged by the earthquakes mentioned above in this REVIEW and which are under restoration, and, on the other, seek to study cultural objects stored in the MNH, Castillo de Chapultepec, surveys and research that may hopefully be published soon.

[8] The closing lecture (00:00:00-01:45:00 min.) was broadcast on INAH Media and is available on INAH TV on YouTube.

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