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How do you display 3D cultural heritage data in museums?

A case study on “Culpticon” developed at Nagoya University

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Abstract— In this paper, we present “Culpticon,” a project developed at Japan’s Nagoya University to present three-dimensional (3D) cultural heritage data in museums. Culpticon represents a unique response to the challenges facing social education on cultural heritage in museums. Our project’s primary objective is to facilitate seamless museum access via the World Wide Web. Recognizing the critical issues that Japanese museums are facing is essential to understand this project’s background. Decreasing visitor interest in cultural heritage has resulted in severe financial constraints, which Japan’s economic difficulties since the 1990s have further exacerbated due to diminishing administrative support. This has put our cultural heritage’s preservation at risk. To address these

challenges, our approach focuses on engaging the public directly with museums and utilizing education as a form of entertainment. Concentrating on smartphone accessibility, we have devised a user-friendly method that enables users to explore 3D heritage data in museum collections. One of the system's key features is the ability to provide a comprehensive view of cultural heritage data from any angle. Furthermore, it is accessible from any location with an Internet connection, ensuring that information on cultural heritage is readily available to the public. Thus, Culpticon represents a significant step toward democratizing access to cultural heritage. Bridging the gap between museums and the public enhances social education and reinforces the preservation of our invaluable cultural legacy.

Keywords—Cultural Heritage; Digital Museum; 3D data

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I. INTRODUCTION

We are not familiar with the term “cultural heritage” in our daily lives. When culture is mentioned, art and music usually come to mind. A work of art by a famous painter or a classical music performance by an orchestra gives an impression of culture, while museums and concert halls are somewhat inaccessible. This inaccessibility is likely related because culture was originally a monopoly of the upper classes. With modernization and democratization, however, the government has become the custodian of culture; nevertheless, the hurdle has remained high. The theme of this symposium is “Recent Studies on Cultural Heritages and Social Science Education.” To connect cultural heritage with social education, psychological barriers to culture must be eliminated. More specifically, we need to create an environment where people are willing to access cultural heritage, rather than educating them as school teachers would educate their students. The reality is that cultural heritage today is generally managed by the government and financed by taxes. There is little objection to public infrastructure being funded by taxes. However, cultural heritage does not provide a basis for livelihoods or saving lives. It may generate profit from tourists visiting an area, but it is difficult to generate significant profits alongside other industries, and if successful, overtourism may result, damaging the cultural heritage itself. The characteristics inherent in cultural heritage pose challenging issues in today's society that prioritizes profit-seeking.

Under these difficult circumstances, those of us who are professionally involved with cultural heritage must constantly think of ways to improve it. In particular, as long as cultural heritage's existence depends on public financial support, we must give back its benefit to the members of society that support it. So how can we make our cultural heritage more accessible to the public while fulfilling our responsibility to society? In this paper, we will consider this issue by examining the philosophy and background of “Culpticon,” a web application for viewing 3D data of cultural properties in museums, which is being developed and tested at Nagoya University in Japan, and by considering the voices of actual users.

II. ABOUT “CULPTICON”

“Culpticon” is a web application for viewing 3D data of cultural properties in museums that is being developed by Nagoya University (Fig. 1). “Culpticon” is a coined term derived from the fusion of “Cultural properties” and “Panopticon,” a prison surveillance system conceptualized by the English philosopher Jeremy Bentham (1748–1832), renowned for his utilitarianism. Of course, we do not seek to create something as horrifying as a prison; instead, we apply the structure of the Panopticon, which allows one to see all places from a single location, to the appreciation of cultural properties.

It is designed to allow users to view 3D data of cultural properties from a smartphone or a Personal Computer (PC) via a web browser and does not require a dedicated application to be downloaded for use (URL: <https://www.culpticon.jp>). The development plan for Culpticon began in 2021, and the Nagoya University Archaeology Laboratory and Nagoya University Graduate School of Informatics (Yasuda, Endo, and Urata Labs) have collaborated on its development. The trial operation began in March 2022 at Nagoya University Museum, and as of December 2023, it has been used by museums and local governments. Six organizations are actively using the system. Currently, the only language it supports is Japanese.

The development of Culpticon started in response to the COVID-19 pandemic that erupted in 2020, leading to temporary closures and ongoing visitor restrictions in numerous museums. This was a challenge for museums traditionally reliant on on-site exhibit viewing. However, as they adapted to disseminating exhibit content via the Internet, they began actively sharing information through social networking services and video-sharing platforms. Using 3D data, which has become increasingly

popular since the latter half of the 2010s, has garnered attention. Unlike photographs and videos, 3D data portray objects in a three-dimensional format, providing viewers with a sense of proximity to the actual artifact. Although this proximity offers considerable advantages, concerns have also arisen regarding the potential misuse of the data. Nonetheless, the COVID-19 crisis prompted a reevaluation of the fundamental role of museums, resulting in a growing movement to disseminate cultural properties globally as 3D data.

In the summer of 2021, during the initial stages of Culpticon's development, numerous museums and art institutions still enforced admission restrictions. Preceding this period, from January to July 2021, the first author oversaw 3D exhibitions at the Aichi Prefectural Ceramic Museum and National Crafts Museum. Drawing from our experiences with 3D exhibitions and the regulations enforced since the preceding year, we contemplated devising a tool capable of effectively disseminating 3D data of cultural properties to society. This brainstorming was the start of Culpticon's development.

Incidentally, as of 2021, numerous systems existed for disseminating 3D data on cultural properties. Many were independent systems developed by local governments and museums, typically outsourced to private enterprises. Other organizations used international 3D data sharing platforms, such as Sketchfab. However, independent systems often operate within specific municipalities or museums, requiring users to download particular applications for each location visited. Furthermore, using foreign platforms might require internal organizational approvals; acquiring such usage permissions might be cumbersome and



Fig. 1. Culpticon's poster and operating screens (for smartphones and PC browsers)

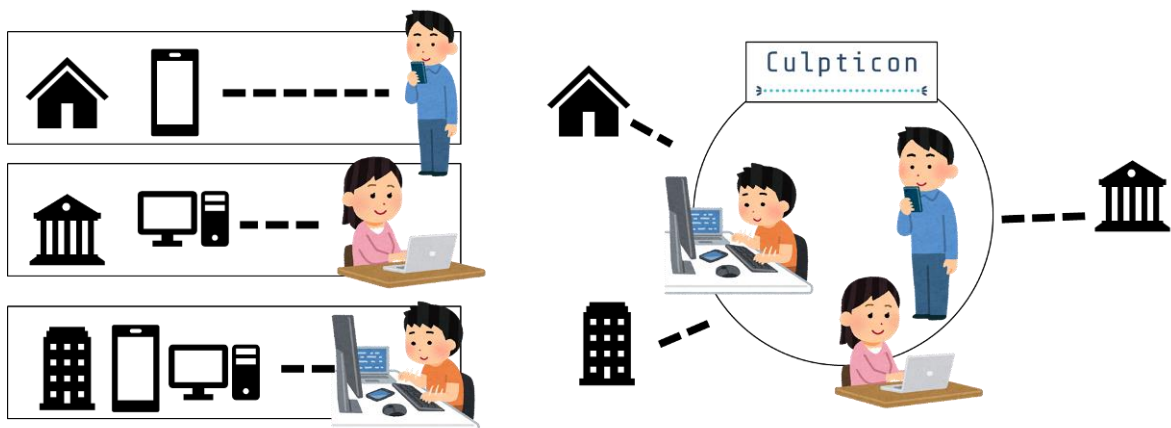


Fig. 2. Differences between each museum's independent 3D exhibition system and Culpticon

particularly for public institution-operated museums. Even if they receive access permission, there may be abrupt alterations in service content. Thus, there is a demand for a system operated by a domestic public institution that displays 3D data of cultural properties on an aggregated basis. Culpticon was developed to meet this demand. The system is designed to allow multiple museums and galleries to upload 3D artwork data on a unified platform, which users can view (Fig. 2).

III. USAGE AND FUNCTIONS

Using Culpticon is easy. The website is simply accessed from a smartphone or PC browser. To incorporate it into an exhibit, a Quick Response (QR) code is printed and attached. By scanning the QR code with their smartphones, users can view the 3D data of the material in front of them (Fig. 3). The system also includes functions to search for works by keywords or museum names.

Because Culpticon is a system born from experience in the field of exhibitions, it is designed specifically for viewing and sharing cultural properties so that it can be smoothly introduced as part of an exhibition at a museum. Among the system's features are the ability to turn textures on and off to facilitate observation of the surfaces of 3D data and displaying related maps linked to Google Maps, which, especially in the case of archeological materials, can somewhat show where the artifacts were excavated. Furthermore, there is a QR code button on every material page that can be printed and pasted into the caption or read by someone on the spot.

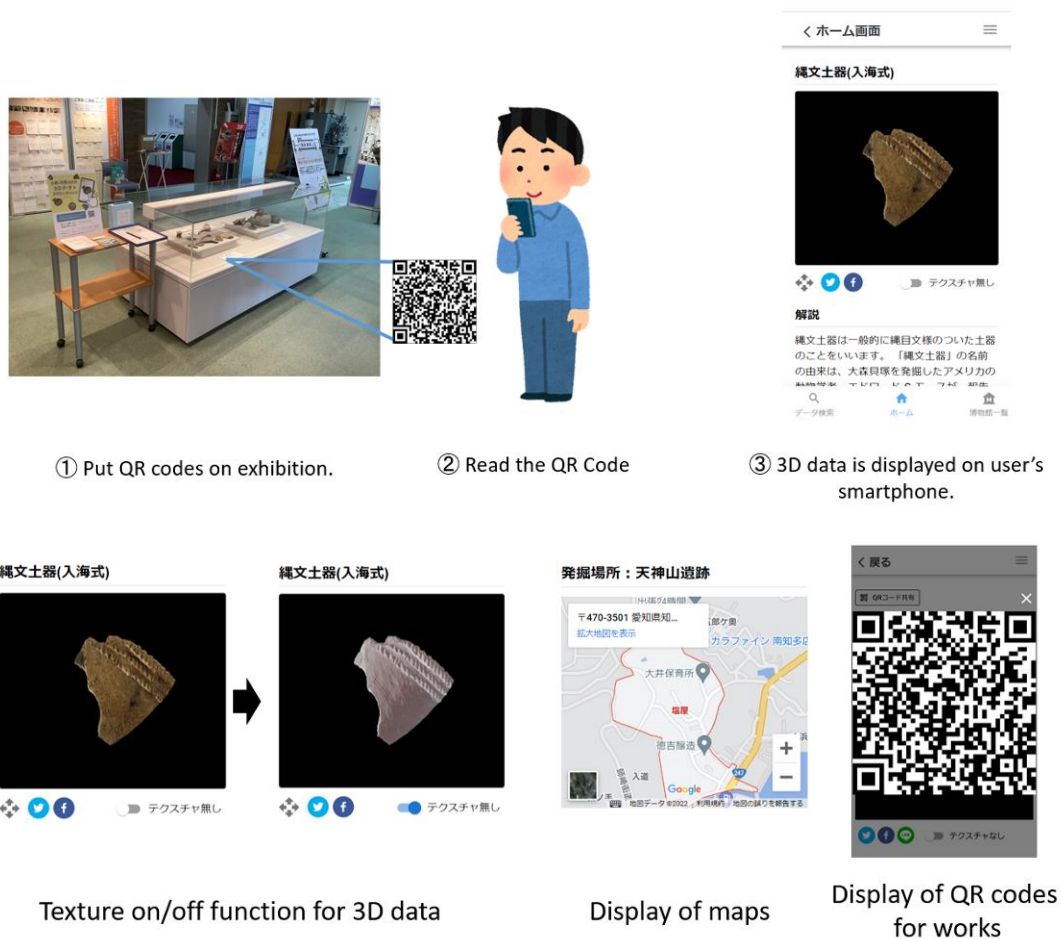


Fig. 3. Usage Instructions for Culpticon at the exhibition for smartphone users and its functions

IV. OBJECTIVES

The development of Culpticon was propelled by the challenging economic circumstances faced by Japanese museums, in addition to the aim of establishing an efficient 3D exhibition system. Japan's economic growth initiated in the 1950s, followed by an economic boom, establishing a framework that offered financial assistance for managing cultural properties. However, the economy has stagnated for nearly 30 years starting in the 1990s, reducing the financial support previously granted to museums. Consequently, museums have been compelled to raise funds and boost visitor numbers independently. However, at the same time, people's interest in cultural properties and heritage has waned compared to the prosperous years before the 1990s.

The Ministry of Finance in Japan made a recommendation to "consider securing financial resources for the comprehensive restoration of cultural properties by leveraging their potential and enhancing revenues, particularly due to the relatively low admission fees for cultural properties in Japan compared to Europe. (我が国の文化財の入場料は、欧州に比べ低額であることから、文化財を活用し、収入を増加させることで、文化財全体の修理財源を確保することを考えるべき。)." Furthermore, it was claimed that, "Museums and art museums in Japan ought to proactively enhance their financial resources by establishing appropriate admission fees and exploring various fundraising methods, such as crowdfunding (我が国の博物館・美術館は、適切な水準の入場料の設定や、クラウドファンディング等の多様な資金調達の実施により、自己収入の拡大に向けた取組を進めるべき。)" [1]. The fundamental policy requires museums using their cultural assets (heritage) to generate funds. For instance, the museum suggested strategies such as increasing admission fees and using crowdfunding. However, elevating admission fees may result in a further decline in visitor numbers, and crowdfunding might not yield sustained outcomes.

From August to September 2023, the National Museum of Nature and Science raised over 900 million yen through crowdfunding. However, the museum's director, Dr. Kenichi Shinoda, told Kyodo News in an interview, "Even Kahaku (Abbreviation of National Museum of Nature and Science in Japanese) cannot do it next time. (科博でも次は無理だ。)." In the same interview, he added, "I hear from many museums that they do not have the money to buy collections. Even though we have reached the point where we can no longer function as a museum, we are still holding out. We are beyond the point of return. (いろいろな博物館から『収蔵品を買うお金がない』と聞く。博物館機能が無理だということまで来ても、まだ我慢しちゃってる状況。(後戻りできない)ポイント・オブ・リターンを超えている。)." [2] He also noted that museums in Japan have reached a point where they are no longer financially viable.

For public museums to be sustainable, society must establish a framework to support museums and cultural heritage properties. While fundraising is crucial, relying on fundraising along might sideline the museum's fundamental mission, including preserving cultural heritage and social education. If museums prioritize profit-making over their primary objectives, they risk losing credibility and standing. Thus, the first goal is to increase the number of people willing to support them.

This is also the aim of Culpticon. In designing the functionality of this system, we were conscious of the need to disseminate 3D data of cultural properties as content in the online space, and believed the Internet could be a gateway to generate interest in cultural properties and cultural heritages and to create opportunities for people to visit museums. As mentioned at the beginning of this article, culture, and art are generally considered inaccessible, and museums are at the center of the world of culture and art; they are not places people casually consider visiting. Devising ways to make people aware of cultural assets in an interesting way through online spaces, such as social networking services, may be an effective way to overcome this situation. We predict that only then will there be a possibility for people to take an active interest. In fact, it is common for unique museum materials that capture people's attention to be noticed on social networking services such as X (Twitter). Culpticon's aim is to take advantage of such opportunities to increase the number of fans of cultural properties and cultural heritage, and, in turn, support museum operations.

This may be understood as undermining the value of cultural properties and cultural heritages. However, as museums founded and operated with public funds, museums have the mission to return value to the citizens. In these times of economic hardship, the importance of returning the value of cultural properties and cultural heritage to society is greater than ever. Cultural properties and cultural heritage do not generate economic benefits. However, we should not forget that cultural properties and cultural heritages can revitalize local communities and serve as a source of spiritual support. This is perhaps what is meant by giving back value to society. However, for this to happen, the existence of cultural properties and heritages must first be recognized by society. Only then can they be related to people's behavior. We believe that one effective way to achieve this is to disseminate cultural properties and heritages as online content.

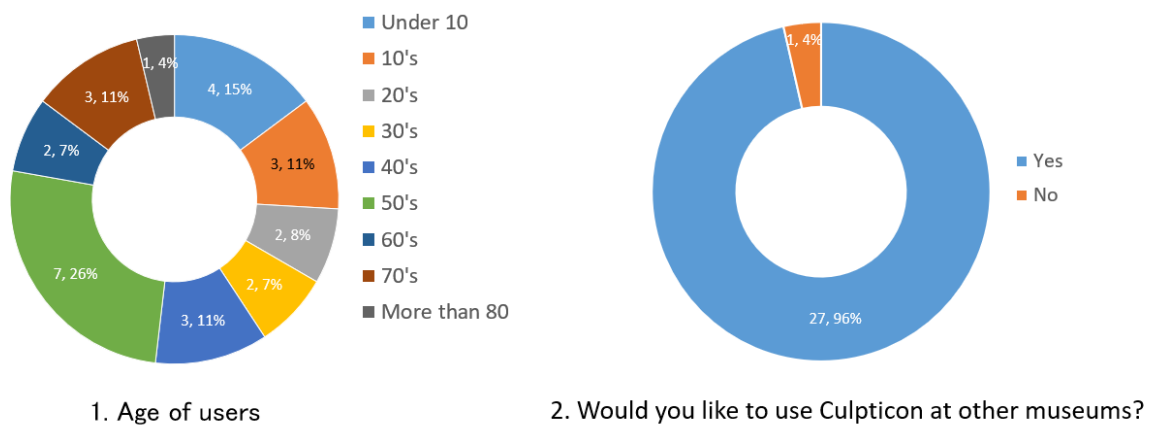
V. CASE STUDIES

The Nagoya University Museum started trial operations of Culpticon in March 2022. At the same time, user surveys were conducted, collecting survey responses in March 2022 and March 2023, spanning a year. Additionally, two workshops targeting children were conducted from July to August 2023 (Fig. 4). In this context, we aimed to introduce the voices of Culpticon users as a case study, highlighting the survey results obtained from visitors of all age groups at the Nagoya University Museum.

There were 28 respondents to the survey conducted at the Nagoya University Museum, with an age range spanning from under 10 years old to individuals in their 70s, indicating a broad range of generations (Fig. 5-1). As Culpticon is designed to be integrated into exhibitions at museums, these results indicate the need to anticipate that users will not be familiar with digital devices as well as the participation of preschoolers and elderly individuals. Regarding the question “Would you like to use Culpticon at other museums?” most respondents expressed their desire for its implementation. (Fig. 5-2). As more museums adopt Culpticon, the available content that can be enjoyed through this system will increase. In the open-ended responses to the survey, suggestions were made to increase both the works and facilities using Culpticon. In the open-ended section, in addition to comments expressing satisfaction with the usage, there were also mentions of issues and requests regarding functionality. Table 1 presents representative comments from these categories (Table. 1). Because Culpticon has been developed primarily by students, there are some difficulties in fully meeting the users’ expectations in terms of functionalities. However, it is encouraging to note that satisfaction with the current system and a desire to increase the number of museums adopting Culpticon have been expressed. Regarding the comments on functionality, we are gradually making revisions based on what is feasible.



Fig. 4. A workshop participant using the Culpticon for PC browser.



Culpticon user survey in Nagoya University Museum (2022 March~2023 March)
28 respondents

Fig. 5. The graphs of the user survey

TABLE I. CULPTICON USER COMMENTS AT THE NAGOYA UNIVERSITY MUSEUM

No.	Translated in English	Original texts
1	I enjoyed it more than I thought.	思っていた以上に楽しかった。
2	The back was a single color and the details were not discernible.	裏の色が一色で詳細がわからなかった。
3	Rotates freely and provides a fan experience.	自由にまわせておもしろい。
4	I would like to see more of the museum collections.	もっと増やしてほしい。
5	I enjoyed it so much. I hope other museums will introduce Culpticon.	めっちゃ楽しいです。他の博物館でも導入してほしいです。
6	Hard to move when the image is enlarged.	データを拡大すると動きづらい。

VI. FUTURE PROSPECTS

Culpticon is intended to undergo continuous improvements, focusing on appreciating its cultural properties and heritage. Future enhancements are planned to further disseminate the appeal of cultural properties and heritage as content, considering the implementation of new functionalities. Our vision for the future is for Culpticon to serve as a gateway to foster interest in cultural properties and heritage, becoming an infrastructure-like asset for museums and art galleries. Therefore, we aim to advance functionalities and explore methods for practical use.

We are also progressing in preparations for using Culpticon in school education as another direction. Currently, we are exploring using Culpticon in educational practices through workshops for children and outreach classes to high schools. Moving forward, we aim to develop plans for using Culpticon in school education, envisioning collaboration with educational professionals and faculties of education.

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[1] Ministry of Finance. Japan “歳出改革部会（令和5年10月11日開催）資料1 文教・科学技術”, 2023-10-11, p.30

[2] The Chunichi Shimbun “CF9 億円集めた科博館長 警鐘”, 2023-12-23, morning paper, p. 23.