Promotion of the Museum of Oriental Art in Turin by AR and Digital Fabrication: Lady Yang

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Abstract

A fundamental aspect of visiting museums is the involvement of visitors to facilitate the understanding of the collections on display [Black 2005, p. 7]: museums must therefore adopt techniques derived from the fields of relational and experiential marketing to improve the services offered.
This contribution focuses on an ongoing experience, conducted at the Museum of Oriental Art in Turin (MAO), which involves the use of augmented reality (AR) combined with digital fabrication, applied in the field of cultural accessibility and marketing.
In June 2021 the museum chose *Lady Yang* as artwork/mascot that would symbolically accompany the users in the visit path. It was decided to make this accompaniment tangible through digitally fabricated objects (a bookmark and a tactile replica) and an AR experience.
The contribution wants to show the research workflow, from the digital acquisition of the artwork up to AR experience and digital fabrication, in a continuous transition between real and virtual, to demonstrate how they are mutually enriching in the visiting experience and process of knowledge.

Keywords
AR, digital fabrication, replica, museums, promotion.

Introduction

Advances in the technological field have become increasingly rapid in recent decades but it is unde-
niable that the current pandemic situation has produced significant changes in the field of content
use: they have allowed, in many areas, to address the contingency by building new digital paths to
access knowledge, culture, to promote and share.
In this panorama, museum institutions have undergone a radical transformation, subtended to take
the museum itself outside its physical boundaries, making the collections usable through highly
diversified digital modalities, guided by values of inclusivity. The trends already in place, oriented to
the transformation of the museum experience through the overlapping of a digital experience to
the physical experience, are now affected by a very significant phase of implementation, which will
lead soon to an increasingly varied range of fruition modes.

Contemporary Museum Communication and Promotion

Before the Franceschini reform of 2014, museums in Italy had primarily been places where art-
works were protected and preserved. The reform, stating that museums have to "talk with their
public" offering real experiences of knowledge [Agostino et al. 2020, pp. 362-372], highlighted the
importance of the educational and entertainment role of museum collections.
Marketing specialists theorize that in order to maximize visitor experiences and attract new audi-
ences, a museum's communication strategies and engagement activities should focus on new tech-
nologies, creative events, and edutainment [Nechita 2014, pp. 269-278]. The increasing availability
of digital technologies is making the promotion of museum collections more interactive, which
greatly benefit from both acquisition techniques and promotion applications. Augmented reality
(AR) is rightfully among these: it is recognized as one of the innovations that most engage
users during their visit [Chung et al. 2015, pp. 588-599; Stogner 2014, pp. 11-21]. Thus, users
are directed towards the complementarity between the real and the emerging digital (or
virtual) universe.
The experience presented here starts from the consideration that "If there is one frustrating road-
block shared across the gamut of art lovers, it's the frustration over not being able to personally
handle and explore a piece of art in a museum". In this sense, an interesting similar operation was
carried out (2010) by the Getty museum with the Augsburg Display Cabinet. The museum pro-
posed an AR web experience to overcome the constraints of a traditional gallery, where viewers
can't touch the real cabinet. The virtual model of the 17th-century collector's cabinet is accessible
in the gallery and on the Getty's website through an AR tag to generate excitement for what mu-
seums are all about: discovery and wonder [Hughes 2017, pp. 17-21].

The Museum of Oriental Art of Turin: State of the Art and Perspectives

The MAO is one of the most important and dynamic realities on the Italian scene as regards the
valorization and diffusion of Asian art and culture.
The attention to digital communication of its heritage has always been present since its
opening to the public at the end of 2008. It manages a dedicated website and has a YouTube
channel and several social profiles: Facebook, Instagram, Flickr. Since October 2020, it has
been participating in the new digital channel In Onda of Fondazione Torino Musei, designed
to provide remote educational content and promote workshops for schools – not only re-
motely [Spallone et al. 2021, pp. 697-704].
The museum is totally visitable virtually via Street View by Google Arts and Culture. In June 2021,
the Fondazione Torino Musei also launched a new app, created by La Consulta per la Valorizzazione
dei Beni Artistici e Culturali, which can be downloaded for free and used to facilitate the usability of
museums for different types of visitors, as well as increase the cultural and tourist attractiveness of
the area. This new tool will provide various multimedia contents related to the three museums that
are part of the Foundation (Palazzo Madama – Museo Civico d'Arte Antica, GAM – Galleria Civica

d'Arte Moderna e Contemporanea and MAO), to create new visiting itineraries, some of which can also be explored at home with a smartphone. The itineraries dedicated to Palazzo Madama are currently available; in the future, the project will also be developed for MAO and GAM [Fondazione Torino Musei 2021]. This tool will thus redress the current lack of multimedia in the visit to the permanent collections of the MAO: at the moment, only the classic audio guides in Italian and English with numerical selection are available.

The experience presented here is developed within the agreement between the Politecnico di Torino – Department of architecture and design and the MAO – Museum of Oriental Art.

The project has seen the involvement of different figures, bringing together the knowledge of representation and information processing systems with the historical, artistic, archaeological and museographic skills and cultural marketing to test new ways of communication and fruition of heritage. It represents at the same time an increase of the proposals usable in situ and remotely and the first step towards a more digital and more accessible/inclusive MAO.

This contribution focuses on an ongoing experience that combines the use of AR and digital fabrication, applied in the field of cultural marketing. Specifically, in July 2021, the *Abbonamento Musei* (Museums Subscriptions) association launched the initiative *L'arte con chi ne parte* (art with those who are part of it), for which MAO chose a work from its collection to be the mascot accompanying visits to the museum. The choice fell on the *Dancing Lady* from the Chinese collection, nicknamed *Lady Yang* for this occasion.

For this reason, it was decided to create a tactile replica of it in scale 1:1 to be exhibited at the entrance to the museum with an information panel in Italian, English, and Braille, with relief images. An interactive bookmark, depicting *Lady Yang*, completes the project. The visitors can obtain it by donating an up-to-you amount to finance the larger project *MAO for all* which aims to create accessible exhibition paths. In this way, in addition to the memory of the visit, they will have the opportunity to appreciate the digital replica of *Lady Yang* at any other time and place.

The Work Methodology

The work presented here complements the broader work that is the subject of Francesca Ronco's doctoral thesis (*Arquitectura, Edificación, Urbanística y Paisaje program of the Universidad Politècnica de València*), which involves the development of a management model aimed at the creation of inclusive, multisensory and modular itineraries, including multi-sensory experiences *in situ* (tactile paths and AR experiences) and online (VR proposals) [Ronco 2021, pp. 49-61].

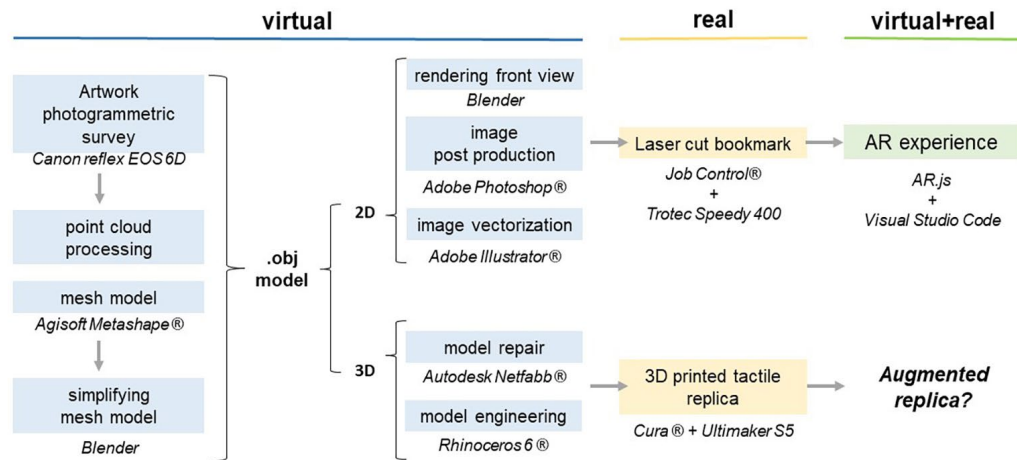Fig. 1. Lady Yang sculpture: the photogrammetric survey (photo by S. Tamantini).

virtual | **real** | **virtual+real**

Artwork photogrammetric survey
Canon reflex EOS 6D

↓

point cloud processing

mesh model
Agisoft Metashape®

↓

simplifying mesh model
Blender

.obj model

2D
- rendering front view
  Blender
- image post production
  Adobe Photoshop®
- image vectorization
  Adobe Illustrator®

→ Laser cut bookmark
Job Control®
+
Trotec Speedy 400

→ AR experience
AR.js
+
Visual Studio Code

3D
- model repair
  Autodesk Netfabb®
- model engineering
  Rhinoceros 6®

→ 3D printed tactile replica
Cura® + Ultimaker S5

→ ***Augmented replica?***

Fig. 2. The workflow.

Lady Yang is one of five MAO artworks (one from each geographic area) selected to test this model (Fig. 1).

The acquisition of the work takes place through a photogrammetric survey that provided the metric reference data, followed by the restitution of the virtual model of the same, from which it is possible to obtain different two-dimensional and three-dimensional outputs, real and virtual.

In the case analyzed here, the survey was performed with a Canon EOS 6D SLR from which an .obj model was obtained through Agisoft Metashape®, simplified with Blender.

The real outputs are represented by the bookmark (printed by laser cut on cardboard) and the tactile 3D replica of the work (3D printed with the Fused Deposition Modelling technique), while the digital output is an AR experience based on the AR.js system, that is a library in javascript language that needs only a web page to work. AR.js allows to develop AR functions with different anchoring and tracking systems, including image targets, two-dimensional matrix codes, and location-based systems (Fig. 2).

The Use of Digital Fabrication

The project involves the use of two different digital manufacturing techniques: laser cutting for the bookmark and 3D printing for the tactile replica. Since this is a launch proposal, we tried to contain production costs, so the realization of these two products will be managed exclusively within the MODLab Arch. of the Department of Architecture and Design of the Politecnico di Torino.

The bookmark represents at the same time a promotional object, but also a souvenir for the visitor. This double function is carried out by the object itself and by the AR experience that is activated by framing a code on it. In this way, the user can take the work outside the museum and enjoy it anywhere.

It, therefore, contains a frontal view of the artwork, a QR code, an AR tag, the logos of the partners (MAO and Politecnico di Torino) and an instructional text for the activation of the virtual contents. The used laser-cut printer (Trotec 400, located in the MODLab Arch.) performs for this project all three possible processes: cutting (cyan), half-cutting (red) and raster engraving (black) (Fig. 3a).

The frontal view was obtained from the model acquired by photogrammetry, through an operation of rendering and subsequent vectorization of the black and white version.

A first debated topic has been the choice of the material. Plexiglass and cardboard were initially evaluated, but for reasons of perceptibility of the image, thickness and physical characteristics, Plexiglass was discarded. It was therefore decided to use 700gr colored cardboard in three colors (coffee, blue and raspberry) by the Fedrigoni company that kindly donated the material (Fig. 3b). The choice of colors was not random; particularly intense one were chosen that, on the one hand, were in line with the museum's graphics and with the aesthetics of *Lady Yang* and, on the other hand, were appropriate for the printing process. Specifically, attention was paid to the fact that with the raster engraving process of the laser printer, the lightest areas

would emerge, corresponding to the color of the cardboard pulp. In this way it was possible to ensure a high contrast that allows one to better perceive the various contents listed above, but especially the image of the work and the AR tag. In this regard, it was necessary to invert the whites and blacks, since from the point of view of production (raster engraving) the black areas represent those in which the machine removes the material, and which will therefore be the clearest when the work is finished.

Several hypotheses of AR tags were also examined that were consistent from a graphic point of view and that guaranteed sufficient stability to the visualization of the virtual model: finally, the one with *Lady Yang*'s initials was chosen, realized with the font used in the launch campaign of the initiative.

The other digitally manufactured product will be the 1:1 scale replica of *Lady Yang*, whose purpose, in addition to the promotional one, is to allow a tactile enjoyment of the work, making the launch of the broader project *MAO for all*.

The artwork is 49 cm height and the first theme addressed within the team was that of the scale. Initially, for visibility issues, the idea of making the replica in 2:1 scale was considered. This idea was then discarded in favor of the 1:1 scale, taking into consideration, among others, the manual of relief drawing [Levi, Rolli 1994, pp. 31-52] from which it is possible to extrapolate indications that, although referring to two-dimensional representations, can be applied to three-dimensional objects. One of the principles contained in this book is that of allowing the reader/user an easy 'vision' of the whole figure based on the simultaneous use of two hands. It should also be considered that the smaller the figure, the more easily it can be perceived.

Fig. 3. The bookmark: a) design; b) realization with laser printer (raspberry and coffee colours) (by F. Ronco).
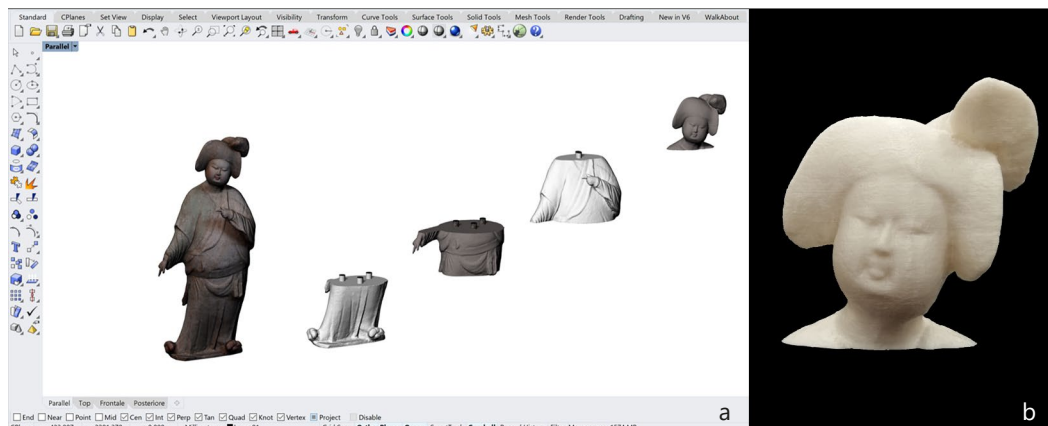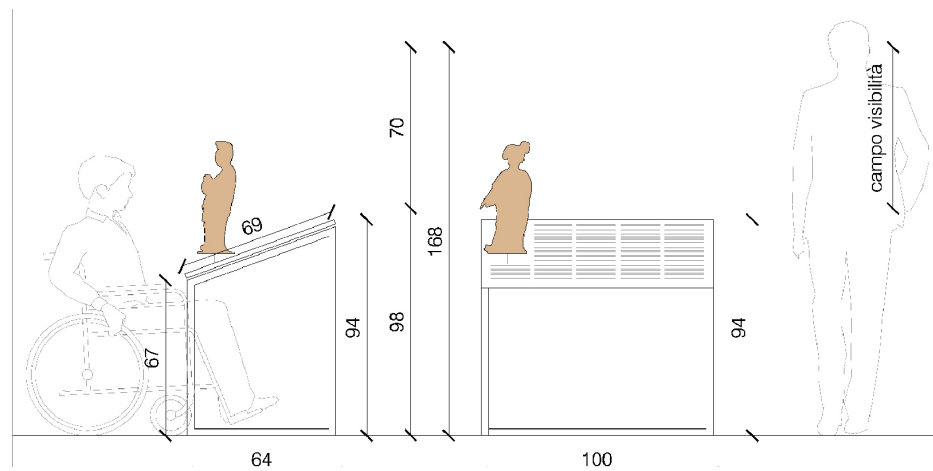

Fig. 4. a) Virtual model subdivision in Rhinoceros®; b) 3D printed head (by F. Ronco).

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Fig. 5. Exposition hypothesis: 3D printed replica and tactile panel (design by F.Ronco).

The replica will be realized for parts, because of the dimensional constraints of the printer used (Ultimaker S5), each of which will be equipped with male-female joints to facilitate the correct assembly. The virtual model has been subdivided into four portions with the software Meshmixer and imported into Rhinoceros® for the modelling of the joints (Fig. 4a). The next step is to pass from Cura software® for slicing operations and the 3D printing (Fig. 4b).

The material used is PLA, the coloring is still being defined. At the moment the portion of the face was printed with the following parameters: 0.4 mm nozzle, fine detail level 0.15mm and 15% of filling. The realization time was 1 day, 4 hours and 12 minutes, using 213 gr of white pearl filament. The work will be accompanied by an explanatory panel containing texts in Italian, English and Braille, as well as some relief drawings (Fig. 5). They will presumably be placed at the main entrance of the MAO, in the seventeenth-century atrium of Palazzo Mazzonis.

The AR Experience: the Pilot Project

Along with virtual reality and the other nuances of immersive technology (the so-called reality-virtuality continuum [Milgram, Kishino 1994, pp. 1321-1329]), AR has been extensively studied over the past 20 years as an enabling technology for CH [Bekele et al. 2018, pp. 7:1-7:36]. AR can make the consultation of spatial information more intuitive than the typical on-screen display of three-dimensional models by superimposing digital layers on images of the real world [Amin, Govilkar 2015, pp. 11-26]. By tracking the user's position with respect to the surrounding environment (or a portion of it, such as a suitable small target), an AR system can generate images of virtual objects in physical space. In the field of CH, these tools have shown benefits for professionals in accessing, comparing and understanding space-related information about artifacts, and advantages in the development of compelling forms of storytelling aimed at visitors [Bekele et al. 2018, pp. 7:1-7:36; Luigini 2019, pp. 3-12].

The developed application is a study case to propose these emerging technologies to the museum visitors. The user-friendly and immediate solution allows recalling the museum experience and connected knowledge, even remotely. The AR application was developed through the AR. js library for the Javascript programming language [Shepiliev et al. 2020, pp. 84-93; AR.js Org Community 2022]. AR.js is a web-based system allowing AR development through different anchoring and tracking systems. These include image targets, two-dimensional matrix codes, and location-based systems. The project is free and open-source (FOSS) and supports fast prototyping and deployment of simple AR applications.

Producing a physical marker rather than markerless systems is a deliberated design choice. On the one hand, this solution is compatible with the lightweight web app system employed. On the other hand, we intended to design a tangible memento of the museum visit as a means to access digital information. We chose a class of matrix targets that features custom image integration ("pattern marker"). The image is interpreted as a small-sized matrix of grayscale values; there-
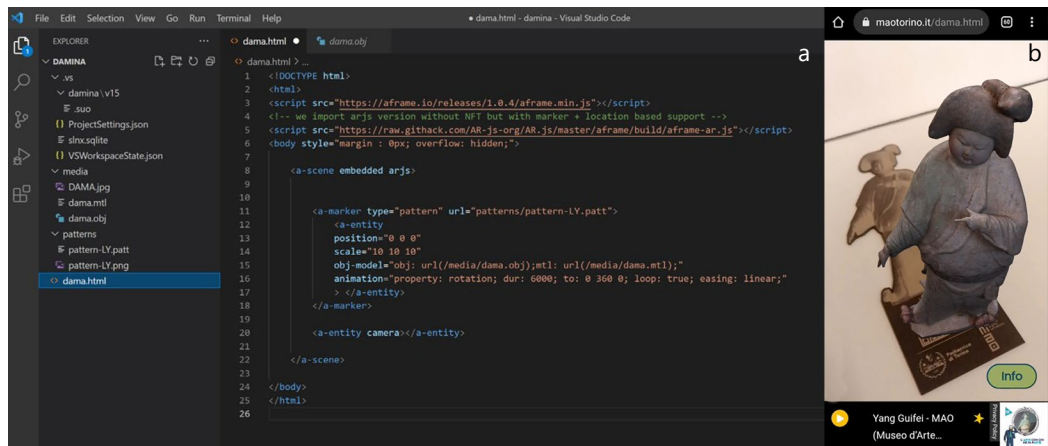
Fig. 6. a) AR.js scripting (by V. Palma); b) screenshot of AR experience on bookmark.

fore, the selection of a high-contrast image is significant for its recognition. This type of marker is more customizable than barcode-like markers, but provides very stable tracking, supports the production of small targets, and is less CPU consuming than image targets.

The main advantage is that the web app can be reached simply by a link, without the need for registration, download, and installation processes. The app is lightweight, cross-browser, cross-platform, and is thus compatible with a wide range of mobile devices. In addition, new development and production versions can quickly be tested (even with just a local server) and updated. The distribution depends on the availability of a public server, although several free hosting services are available. The project is supported by good documentation and an active community. Being based on well-known technologies such as Javascript, HTML, and CSS, the development of basic AR.js programs does not require long learning times and allows you to easily integrate functions (buttons, links, and media embedding). In our case, the .html script (Fig. 6a) has been uploaded on the MAO's server website. Through a QR code we provided a link to an informative page about the project and the museum. It includes an audio player with the description of the artwork.

The main AR function can be activated by framing the target printed on the bookmark (sized 15x15mm). When the pattern is recognized, the app presents the model of *Lady Yang*. The model, in OBJ format, was reduced to a disk size of about 40MB (polygons and texture) to speed up page loading and foster smooth rendering. A detailed material texture (4096x4096 pixels), obtained through texture baking, balances the reduction in the geometric detail. The model is perpendicular to the target and is rendered at a 1:4 scale, making the displayed statue approximately 12 cm tall (Fig. 6b). The reduction in scale and the relative position of the target and the model allows the user to effortlessly frame the statue on the screen of a small mobile device, just placing the bookmark on a horizontal surface.

The main limitations of a web app concern the variety and complexity of functions. The anchoring modes are limited, e.g., they do not include plane recognition or markerless anchoring functions. Extended tracking, that is, the possibility of maintaining the relationship between model and real space by tracking the user's position is not available. Therefore, the two-dimensional targets must remain framed for the entire duration of the experience (except for the location-based option).

Conclusion

The research experience presented here constitutes a piece of a much broader panorama of activities, which involves the Politecnico di Torino – Department of architecture and design and MAO in the supervision of degree theses, educational workshop activities (currently being planned), and diversified research activities oriented towards the promotion of the museum and the construction of an inclusive offer .The final phases of the project presented here are currently being revised and upgraded, also concerning some changes regarding the distribution of spaces and functions in the museum's entrance hall.

The initial idea of displaying the tactile replica of *Lady Yang* at the entrance of the museum could be replaced by a stand for the promotion and dissemination of the research activity through which it is possible to share the whole experience with the museum public: the 3D printing of the replica could be live carried out, using a 3D printer that allows the use of natural materials (e.g. *terracotta*) to communicate the tactile characteristics (roughness, temperature, reflection, etc.), and not, of the materials and relate the work of art with the phases of processing that characterize its creation.

Credits

This paper, whose authors shared the methodological framework, was written by Marco Vitali (par. Intro, Contemporary Museums) Francesca Ronco (par. Museum of Oriental Art, Methodology, Digital Fabrication), Valerio Palma (par. AR Experience).

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