Senses and activities: a virtual reconstruction of the Potter's workshop and the North Area of Quartier Mu at Malia (c. 1800-1700 BC)

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This article aims to reconstruct the sensory space in which craft activities took place in the Quartier Mu at Malia, an urban district dating to the beginning of the 2nd millennium BC in Crete. The study focuses on two areas: Room VIII 5* of the Potter's workshop and the North Area, where pottery manufacturing, stone roughing out, drilling, and polishing were carried out. The goal of the research is to address sensory questions, including the sounds surrounding and generated by these activities and the light ambiances in which they were performed, at several moments throughout the day and at dusk. To achieve this goal, the activities were experimentally reproduced and the sounds they emitted were recorded. The light ambiances produced were reconstructed using replicas of lamps found in Room VIII 5*. 3D models of the spaces were designed and short, animated videos focusing on the gestures of artisans and the captured sensory ambiances were generated. The study provides valuable insights into the sensory ambiances of a Bronze Age town, showing craft activities taking place until dusk and sounds generated by stone working that contributed to the rhythm of daily life.

Keywords
Minoan Crete, lived space, 3D modelling, sensory archaeology, craft activities.

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1. INTRODUCTION: FROM SPACE TO LIVED SPACE IN MINOAN CRETE

In 1941 the archaeologist Fernand Chapouthier published the results of a comprehensive investigation into the function of common clay vases within Minoan settlements [Chapouthier 1941]. Chapouthier conducted systematic ethnographic observations and scientific analyses in. However, the pioneering aspect of his study was the incorporation and consideration of sensory environments. In his work, the French excavator had brought to the fore the aromas of grilled meat that often

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permeated the Homeric epic. He suggested that such scents likely filled the Cretan palaces, creating an atmosphere of jubilation and feasting. Building on Chapouthier's findings and using advancements in archaeological technology, as well as documented craft activities of the site, our aim is to explore the sensory environments, particularly sound and light, that may have characterised everyday life in Quartier Mu at Malia, an urban district dating back to the beginning of the 2nd millennium BC.

This case study focuses on two specific areas within this quarter: Room VIII 5* of the Potter's workshop and the North Area. The process of selecting these two case studies required a preliminary phase of discussion among collaborators who had previously worked at Malia, provided and facilitated access to the material. This choice was influenced by the fact that Room VIII 5* of the Potter's workshop and the North Area represent indoor and outdoor areas respectively, allowing for the comparison of different ambiances. As demonstrated in previous works on the function of vessels and tools [Poursat et al. 1996; Procopiou 2013b], these spaces were multifunctional, serving as locations for both domestic and craft activities conducted either within the coolness of the walls or in the shade, as well as under the heat of the sun. The discovery of lamps also suggests that some of these activities continued beyond dusk [Rueff 2020].

In order to reconstruct the sensory ambiances, we experimentally reproduced the activities that occurred in these spaces and recorded the sounds they emitted. We also measured the light produced by replicas of lamps found in Room VIII 5* in order to simulate with maximal accuracy the artificial light ambiances that were illuminating the potter(s) at work. The textures of different wall plasters were also considered. For certain cultures (sub-Saharan Africa, Central Asia), color is inseparable from other sensory criteria [Pastoureau 2010]. It is more important to specify texture, such as whether an object it is dry or wet, smooth or rough than to determine its specific color. Finally, we designed 3D models of the spaces and generated short animated videos focusing on the body postures and gestures of artisans along with the captured sensory ambiances (https://hal.science/hal-04366770 and https://hal.science/hal-04366795).

It should be noted that, following the principles of computer modeling applied to archaeology, this approach aims not to reconstruct reality exactly as it was, but rather to come as close as possible to it using all available sources [Papadopoulos 2012; Vergnieux 2011]. In this context, virtual reality provides a powerful window into the past, allowing researchers to explore and experience, albeit virtually, the nuances and complexities of ancient environments, contributing to a more comprehensive understanding of historical landscapes and cultures.

2. STATE OF THE ART: SENSES AND CRAFTSMANSHIP

The role of senses and emotions during activities of everyday life is an important field of anthropology, especially in the context of craftsmanship [Classen 1993]. Yet, despite theoretical developments in recent years [Day 2013; Hamilakis 2013], their impact during craft production is rarely considered in archaeology [Procopiou 2013a]. Similarly, ethnoarchaeology often addresses questions related to the technical skills of craftsmen [Bril 2019; Bril and Roux 2002], but it frequently overlooks their sensory skills. Despite these gaps, research in neurobiology and cognitive psychology reveal that both aspects are essential during technical actions, from apprenticeship to the

transmission of know-how [Berthoz 2003; Damasio 1994; Streri 2003]. Furthermore, materiality serves as tangible evidence of the sensory engagement inherent in the creative processes. For example, the surfaces of stone vases can potentially shed light on the role of touch during the manufacturing process. This is supported by an ethnoarchaeological study that showed that traditional stone vase polishers "measure surfaces' softness with their hands" [Procopiou 2013a; Procopiou et al. 2011].

The investigation into the sensory perception of ancient craftsmen has been furthered by advancements in new technologies. In this context, virtual reality plays a considerable role, offering realistic rendering of sensory ambiances, especially concerning sight and hearing [Devlin and Chalmers 2001; Jordan 2023; Papadopoulos et al. 2015; Papadopoulos and Sakellarakis 2010; Pardoen 2015; Richards-Rissetto et al. 2013]. These two senses are directly accessible in comparison with touch, taste, and smell, which all require medium devices. While most of these studies emphasize the ritual character of light or auditory ambiances, especially when dealing with burials and sacred spaces, a few of them also investigate the role of sensory ambiances in creative processes [Papadopoulos & Sakellarakis 2010].

Additionally, the use of medium devices has proved to be useful for exploring sensory perception, serving as powerful tools for analyzing both material and immaterial culture. If sight is often considered the most objective sense in the western world [Classen 1993; Jaquet 2010] specialists are now exploring the use of electronic noses to identify ancient odours and flavours. Exactly as perfumery and oenology use *Noses* [Bembibre & Strlič 2017] to detect scent notes, they analyse and describe fragrances using specific vocabularies. The recent development of an instrumented finger equipped with sensors also permits the measurement of tactile perception [Procopiou 2013; Vargiolu et al. 2007; Zahouani et al. 2013], supplementing visual description of states of surfaces.

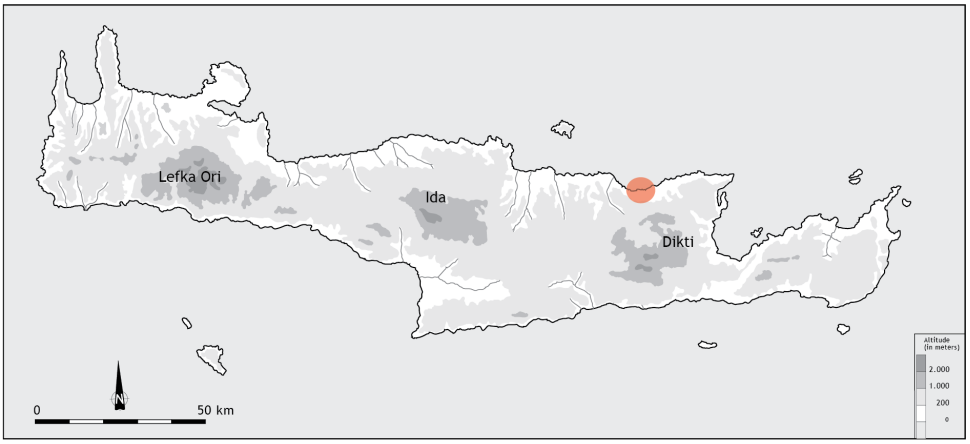
Finally, after a long period of prohibition, some museographic trends are encouraging the presentation of smells, light, textures and noises to the visitors [Merleau-Ponty et al. 2006]. Such experiences have been implemented in several museums, and proved to be powerful mediums not only to access ancient sensory environments but also to arouse the visitor's senses. This approach is also an integrating factor for disabled people and its healing potential has been recently explored [Chatterjee et al. 2009]. In short, it is a whole intangible heritage that museums and scholars propose to rediscover as we attempted to do through our case study.

3. ROOM VIII 5* AND THE NORTH AREA OF QUARTIER MU AT MALIA

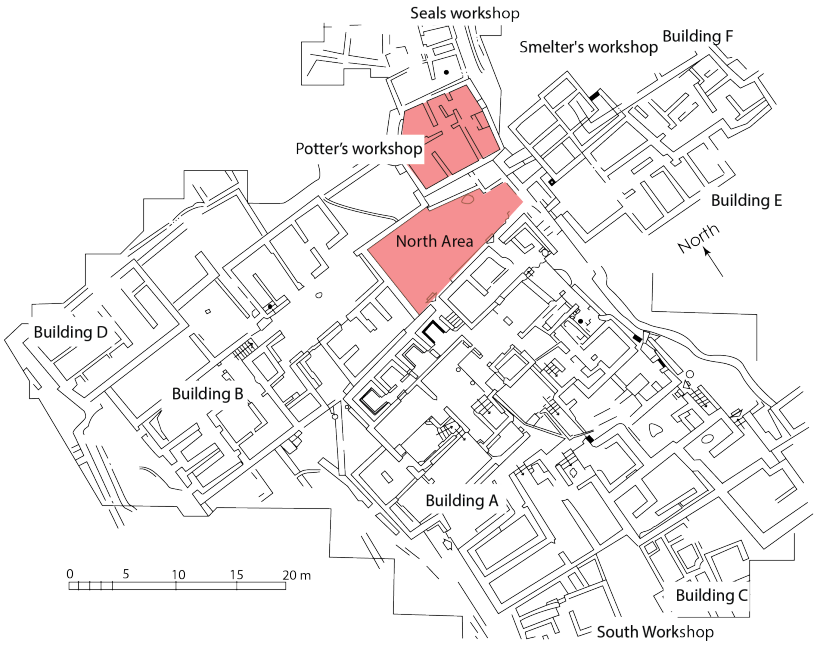
3.1 Quartier Mu at Malia: a brief overview

The palatial town of Malia is located on the north coast of east-central Crete. The excavations of Quartier Mu were conducted between 1965 and 1991. They unearthed one of the best-preserved Middle Minoan urban quarters in Crete, covering over 3000 square meters. The area comprises two main buildings (A and B), dedicated to administrative, storage and cultic activities; four storage and annex buildings (C to F); five workshop-houses hosting craftspeople who specialized in the manufacture of stone seals, pottery, metalwork and stone vases. These craftspeople lived in the workshop-houses with their families, as evidenced by numerous signs of domestic activities, such as food production and consumption, weaving or storing [Poursat 1992].

Quartier Mu at Malia (Fig. 1) is a rare example of grouped craft activities within a Cretan Bronze Age town. The buildings, made out of mudbricks, wood and stones, burnt down in a fire that destroyed the site. Pottery dates the destruction of the Middle Minoan II (MM II, c. 1800-1700 BCE), a phase that belongs to the First Palace period in Crete [Poursat and Knappett 2005]. The fire caused the creation of a clay screed that protected the remains from agricultural work and natural erosion [Poursat 1992].



a)



b)

Figure 1. a) Map of Crete and location of Malia; b) Quartier Mu at Malia, location of the Potter's workshop and the North Area.

Consequently, the complex can be considered as an *ensemble clos*, representing the last phase of a century of occupation captured within a single destruction layer.

It is theorized that the specialised craftsmen were working for the nearby palace and/or for an authority settled in Building A, receiving, in return for their work, supplies, commodities and raw materials required in their production [Poursat et al. 1996]. The finds suggest that the artisans performed activities such as pottery, metal, stone and bone working in the workshop-houses. Therefore, buildings have been named after the worked materials identified in each of them (e.g. Potter's workshop, Metal workshop, etc.). However, considering the diversity of products found in a same workshop, several scholars] have argued that craftspeople were specialised in a technique rather than in a material (e.g. rotative kinetic energy) and that the spaces were multifunctional [Poursat et al. 1996; Procopiou 2005]. Indeed, in the Potter's and the South workshops, stone, metal and bone working have been identified, while the Seal workshop was dedicated to the manufacture of seals, bone objects and beads. The Smelter's workshop is the only one devoted to a single activity (metallurgy), although stone working could also be suggested in its vicinity. In fact, as evidenced by J.-Cl. Poursat and his collaborators, "there is a specialisation in a field of production, more than a narrow technical specialization;" moreover, craftspeople seem to be rather integrated into a system of commissioned work, in which they produce according to the needs of the individuals or groups on whom they depend: their main technical specialisation does not exclude that they could be asked for various works" [Poursat et al. 1996:150–51].

3.2 Room VIII 5* of the Potter's workshop

Located in the north of the district, the Potter's workshop is the most well preserved in Quartier Mu, with a maximal elevation of 1.56 meters high (Fig. 2). It is a two-story building, oriented North-West / South-East, comprising a basement, a ground floor and a flat roof. Room VIII 5* is located in the north-west corner of the ground floor. Even though it is not preserved, the excavators reconstructed this room on the basis of the known architectural features of the lower Room VIII 5 and by analogy with other spaces at Malia and other Aegean prehistoric settlements.

Room VIII 5* has a similar trapezoidal shape and the same dimensions (L. 3.40 m x l. 2.90 m) as Room VIII 5. A fragment of blue painted plaster with horizontal red lines was found in the destruction layer and identified as a piece of the floor of the upper room [Poursat et al. 1996]. A door could have been located in its South-East corner, right above the one identified in Room VIII 5. This latter door, made of a single timber doorjamb, was 0.91-1.15 m wide and 1.52-1.55 m high. The restitution of two windows (L. 0.99 x l. 0.60 m) in the west wall is more hypothetical. It is based on the existence of a window in this same wall in Room VIII 5 and the repetition of this pattern on the upper floor, as observed on the Town Mosaic of Cnossos, the house model of Archanes and the well-preserved Late Bronze Age buildings of Akrotiri (Thera). "We have also superimposed the windows on the first floor on those of the ground floor by doubling them when the axis of the first floor window is offset from the axis of the room: the two windows on the first floor are then aligned; the situation is reversed when the first floor window is on axis" [Poursat et al. 1996: 81]. The height of the room - estimated at 2.2 m – is assumed based on the number of steps of the adjacent staircase VIII C. The walls were presumably coated with yellow and blue painted plasters, while the ceiling was made of longitudinal beams 0.05 to 0.07 m thick and covered with clay.

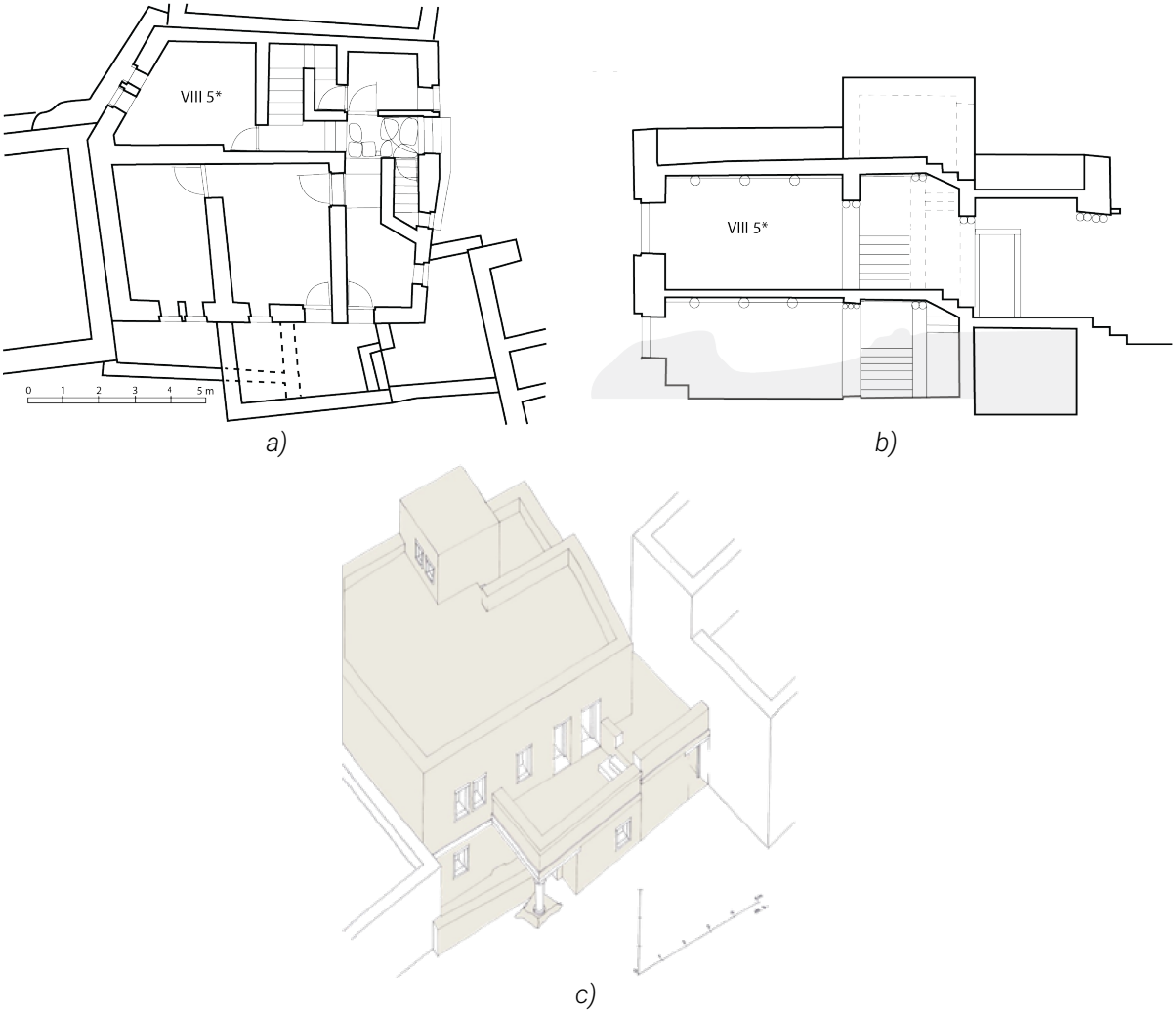


Figure 2. Potter's workshop: a) plan a); b) profile; c) axonometry. (by Martin Schmid, in Poursat, 1996. Inking: B. Rueff). The grey color in b) depicts the bedrock.

The most fragmented vases and the finds located in the upper part of the destruction layer in Room VIII 5 are expected to come from the upper floors, notably Room VIII 5*, rather than having fallen from shelves [Poursat et al. 1996]. The diversity of material suggests that Room VIII 5* was a polyvalent space in which various craft and domestic activities were performed. The discovery of two heads of a potter's wheel, made of clay, as well as of eight clay molds for reliefs *appliqués* led to its interpretation as a potter's workshop in which vases were manufactured and stored [Poursat et al.

1996][1]. Besides, the presence of a serpentine bore core, an unfinished limestone vase, a limestone pounder and two stone polishers suggests that stone vases were also manufactured in this room [Morero 2013, 2016]. Finally, several artefacts indicate that the space was also used for activities such as weaving, food production and consumption.

3.3 The North Area

The North Area is an outdoor area surrounded by the Potter's workshop to the North, Building B to the West and North, the Founder's workshop to the East, and Building A to the South. With its large dimensions (L. 14.9 m x l. 3.7-7.9 m), it served as a court, both to facilitate the circulation of people, light and air between and inside the buildings, and to perform domestic and craft activities. The surrounding buildings have two to three floors. Colorful coatings could have covered their façades. However, "in the absence of preserved clues […] neutral colors such as light beige" have been chosen for the two-dimensional architectural restitution [Treuil and Schmid 2017:250]. The floor of the court was made out of trodden earth and stones. Along the North façade of Building A, a paved sidewalk in local dune sandstone (*ammouda*) was identified. In the North-East corner, the outcropped bedrock, a blue cretaceous limestone known as *sideropetra*, was used to set a timber column supporting a terrace of the Potter's workshop.

Numerous stone tools have been discovered in the destruction layer in this space. Though not necessarily *in situ* they reflect craft activities that took place in this area or nearby. More specifically, the ethnographical record shows that stone polishing and drilling often took place in open areas [Procopiou 2013a; Procopiou and Morero 2014]. The nine active polishers found in this area, of different coarseness and raw materials (sandstone, shale, metamorphic stone), belong to a stone polisher's tool kit.

4. TOWARDS A LIVED SPACE: A VIRTUAL RECONSTRUCTION OF ROOM VIII 5* AND THE NORTH AREA

4.1 Architecture and material

The 3D modelling we propose is based on published architectural studies [Poursat et al. 1996; Treuil & Schmid 2017]. Both the architectural features and the texture of materials were designed with the software Autodesk 3dsMax.

4.1.1 Room VIII 5*

Figure 3a shows the view from the door located in the South-East angle of Room VIII 5*. The red lines of the floor are so fine that they are not quite visible. We chose to color the North wall blue, as this color was most likely used in the room, though it could not be localized so precisely. The window frame is similar to those identified in Buildings A and B, namely a simple square in timber [Treuil &

[1] The storage function is supported by the unusual absence of use-wear traces on seven braseros and two cooking pots, meant to be used at a later stage of their "potlife" [Poursat et al. 1996: 38].

Schmid 2017]. With regard to the ceiling, we added two longitudinal rounded beams along the North and South walls. This choice was made after a discussion with specialists who are currently involved in a project on timber in Minoan and Mycenean architecture (https://timma.efa.gr/s/timma/page/the-timma-project). Even though they are not attested, these beams could reinforce the transverse beams and have a structural role in supporting the floor.

Regarding the material, we chose to represent a selection of objects found in the destruction layer of Room VIII 5 that had possibly fallen down from Room VIII 5*. This is a much-debated question regarding Quartier Mu, and we decided to align with the reconstruction proposed by the excavator [Poursat et al. 1996]. We also added some artefacts in perishable materials that could be employed in the activities that took place in this space. This artistic license is due to the difficulty in identifying precisely the finds *in situ* in the room. Therefore, the material includes eight clay jars, one of Kamares style and the others with a dark and a light monochrome surface; nine clay basins, four with a lid and one filled with muddy water; four braseros in clay; three tall lamps in clay; six bowls in greenish serpentine; one pyxis in purple stone; two clay molds of tritons; one clipboard in wood; three benches in wood, two with four legs and one with two legs; one piece of cloth; one sponge; one potter's rib in wood; one polisher in grey sandstone; one goat's skin; one turntable and a wheel head in clay and a support in wood.

4.1.2 The North Area

In the North Area, Figure 3b looks towards the North façade, from the center of the court. In some parts of the quarter, such as Buildings A and B, archaeological evidence shows that several layers of plaster were added to the walls, indicating that façades were regularly treated. For this reason, we chose to represent the walls relatively neatly, but in a realistic way.

With regard to the material, we incorporated raw blocks of serpentine ready to be transformed; a passive polishing tool/work table and a handstone made from metamorphic stone; seven bowls in serpentine; two polishers in grey sandstone; one pyxis in purple veined schist; a few leaves forming a mat.

4.2 People and activities

We then designed a short 3D animation of everyday life and rendered depictions using the render engine Corona Renderer. We chose to focus on four activities identified in Room VIII 5* and the North Area, namely pottery manufacturing, stone roughing-out, polishing and drilling. Characters are incorporated to make it livelier and to focus on the gestures of the craftsmen. These gestures were achieved using montage techniques in Adobe Premiere. We chose to use shadows or zoom onto the hands since the knowledge of body ornamentation and everyday clothing of the Minoans is limited.

4.2.1 Pottery manufacturing

Pottery manufacturing is the main activity identified in Room VIII 5* of the Potter's workshop (Fig. 4). The discovery of a wheel head and of a wheel bat (Fig. 5) indicates that vases were wheel-fashioned in this space. This has been confirmed by technological studies which have identified wheel-coiling as the main technique employed in Quartier Mu [Poursat and Knappett 2005]. This

means that the rough-out of the vessels was obtained with coils that were subsequently shaped using Rotative Kinetic Energy (RKE) during preforming[2] [Roux and Courty 1998].

a)

b)

Figure 3. 3D reconstructions of a) the Potter's workshop; b) the North Area. Renderings on a sunny day in June, around 18:00 (3D and rendering by K. Messini).

[2] The preform constitutes "a hollow volume with the final geometric characteristics of the recipient without undergoing the finishing operations" [Roux 2019: 41].

Figure 4. 3D reconstructions of the potter's tools (polishing/burnishing stone tool, sponge, textile and wooden rib) and the turntable. Renderings on a sunny day in June, around 18:00 (3D and rendering by K. Messini).

The rotary instruments used for wheel-coiling in the 2nd millennium BCE are turntables (or *tournettes*). Such devices are mounted on an axis but do not provide sufficient RKE for wheel-throwing, unlike the potter's wheel (Fig. 5). However, one should keep in mind that "speed is but one of two main variables contributing to a measure of rotational stored energy. Therefore, the combination of both angular speed and moment of inertia to approximate the rotative stored energy of a device may make a clearer distinction between capacities of devices possible" [Jeffra 2013:44].

Turntables are activated by hand when having a low momentum of inertia thus liberating the hand when reaching a higher speed [Roux 2019]. One can assume, based on ethnographic and historical data, that the potter worked in a seated position, either on the ground, a carpet, an animal skin, or a low stool [Mohebbi 2011]. This is also supported by several pieces of evidence in the Eastern Mediterranean, such as Bronze Age Egyptian iconography and figurines depicted seated on low stools (Fig. 5d).

Based on the visual aspect of surfaces, technological studies have also revealed various surface treatments of the vessels, namely smoothing, softening, burnishing and coating. Smoothing, applied to wet and leather-hard paste, is usually obtained by hand or soft tools (such as cloth, sponge, leather, etc.) and scrapers. It is assumed, on the basis of the presence or absence of fine horizontal striations, that smoothing was achieved both with and without RKE [Poursat & Knappett 2005]. On the other hand, softening and burnishing are applied to leather-hard and dry paste with hard tools (stone, bone, wood), the former with input of water, the latter with dry hygrometry [Roux 2019]. Finally, clay coating or slip[3] have been applied to numerous vases.

[3] The difference between those two techniques lies in the particle size of clay, which can hardly be retrieved in the archaeological record

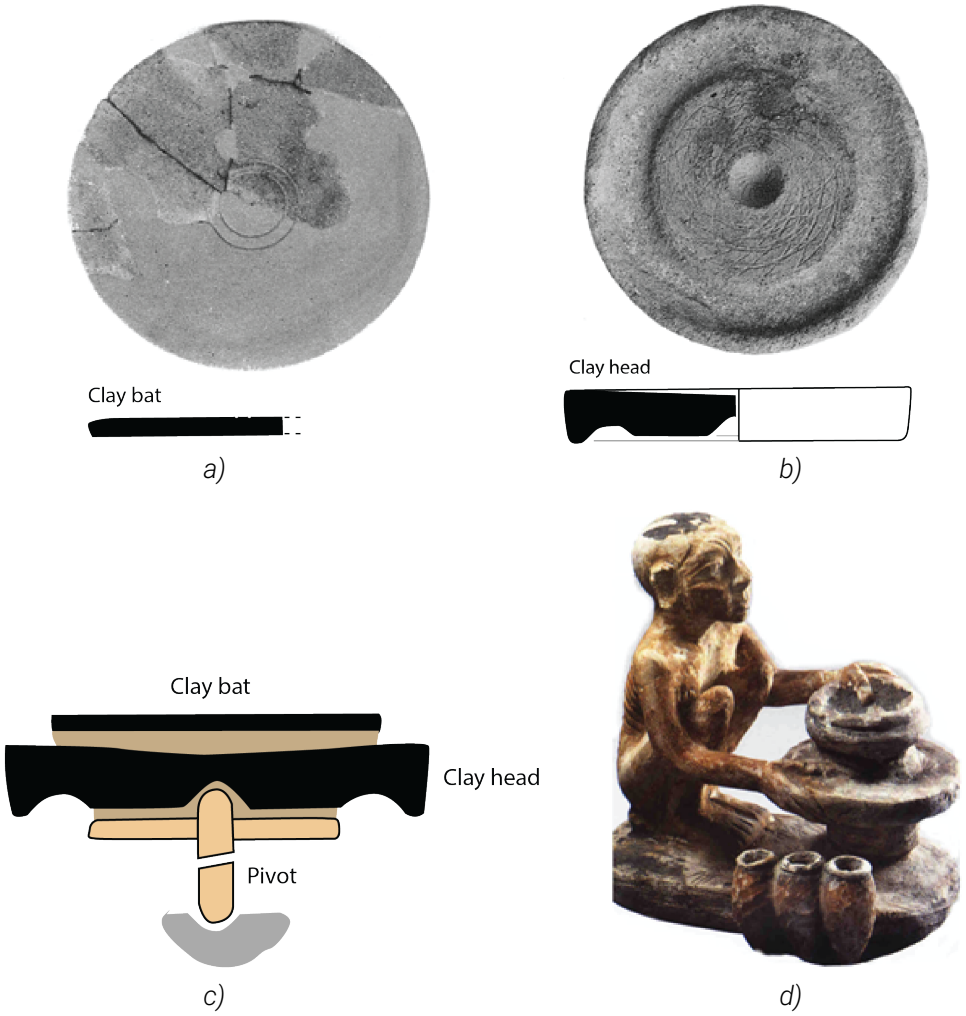


Figure 5. The clay bat: a) and clay head; b) of the Potter's workshop and the reconstruction; c) of the turn-table (after Poursat, 1996 ; inking: B. Rueff); d) exhibits an Egyptian statuette of a man seated on a low stool and manufacturing a clay vase on a turn-table (Tomb of Ny-kau-Inpu, Old Kingdom cemetery at Giza. Courtesy of the Institute for the Study of Ancient Cultures – formerly Oriental Institute - of the University of Chicago).

4.2.2 Stone Working

Stone working in Quartier Mu has been previously reconstructed on the basis of experimental, technological, ethnoarchaeological and use wear analyses. The reconstruction of stone drilling techniques have shown that the device employed was a bow drill and that the drill bits were made up of solid wooden borers, hollow reeds and copper tubes coated with wax [Morero 2013, 2016]. A lubricant (water) and an abrasive, such as quartz sand or ground quartz, were added during drilling. Additionally, the functional study of stone tools revealed their use for pottery and stone polishing, wood, leather and metal working and finally for food production [Procopiou 2013b]. In this frame, we have made suggestions of the gestures and body techniques, since the positions of the craftsmen is

relevant of technical traditions [Mohebbi 2011]. The ethnographic record refers to several positions, either seating on the ground, on a low stool, on a step, or standing in front of a workbench. These positions primarily affect the ways of immobilising the raw materials/objects under work. When necessary, the objects are anchored by the feet, by wedging on the ground or by applying immobilization systems (with sand or plaster) more invested but also more rigid.

In the 3D reconstruction, we chose to integrate stone working in the open area on the basis of the tools' distribution and of ethnographic analogy (Fig. 6).

a)

b)

c)

Figure 6. India, Tamil Nadu, Mahapalipuram (September 2011): a) stone polishing; b) and c) stone drilling with a bow drill. The stone is immobilised by craftsman's feet.

For stone polishing, on the basis of the working positions that we observed during our ethnographic study on manual polishing at Mahapalipuram (Tamil Nadu, India), we have chosen to represent the craftsman seated on a rug and in different bent leg positions[4]. On the same basis, for stone vases' drilling (Fig. 7b, and c) we represent here the craftsman sitting on the ground, using his feet to immobilize the vase (Fig. 7c).

[4] For the analysis of working positions see (Biryukova and Bril, 2008).

a)

b)

c)

Figure 7. 3D modelling of stone working in the North Area: a) and b) stone polishing with stone polishers on a passive polishing stone in sandstone; c) stone drilling with a bow drill (3D and rendering: K. Messini).

4.3 Sounds and light recording

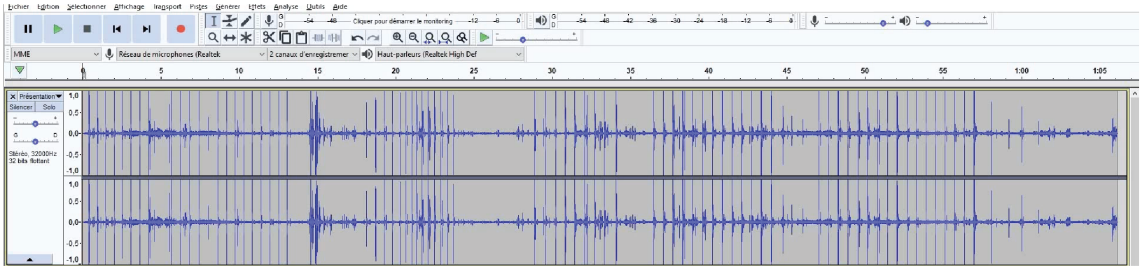
4.3.1 Sound Recording

In order to approach the sounds generated during craft production, we experimentally reproduced three activities identified in Room VIII 5* and the North Area; namely stone roughing-out, polishing and drilling (Fig. 8). These experiments were performed with stone tools in limestone and sandstone collected in the areas of Vrachassi and of the Mirabello Bay (Crete), in the district of Lassithi, respectively about 10 and 40 kilometers from Malia. The serpentine used for stone vases manufacturing was collected near the village of Gonies, in the *nome* of Iraklio, in the foothills of the Ida massif, about 13 km from Malia [Becker 1976]. Recording was collected indoors and outdoors (Fig 8a-c) with a camera and a sound recording device (H4n Pro). The sound recording device was placed at a distance of 15 cm from the sound sources.

a)

b)

c)



d)

Figure 8. Stone working sound recording: a) roughing-out; b) polishing; c) drilling with a bow drill (reed drill bit); d) sample of the audio record.

The duration of the recording, ranging from 1 to 5 minutes, enabled us to sample soundtracks of up to 30 seconds. To render a lively scene, we added birds' calls and the song of cicadas. We then treated the sounds with the software Audacity. This allowed us to erase parasite noises such as the wind and to extract each sound individually in order to avoid possible overlapping. Hence, it was possible to regulate sound intensities and to add the soundtracks to the final 3D rendering with the software VSDC Free Video Editor (Fig. 8d).

4.3.2 Light Measurements

Regarding artificial light, we used physical values based on photometric data. As advocated in a previous study [Rueff 2020], analyses of the soot deposits preserved on the rim and the spout of four lamps most likely used in Room VIII 5*, allowed the identification of animal fats used as fuels. Experimental measurements were conducted with a photometric cell and a thermocolorimeter C-700 SpectroMaster in a dark room, with an average temperature of 23 °C and a relative humidity of 50-58%, at a distance of 15 cm from the flame. The results allowed to determine an illumination comprising between 12 and 40 lux (median: 21.5 lux) and a flame color ranging from 1920 to 2040 degrees kelvin (median: 1990 degrees kelvin). Illumination was made even more intense by the shiny-coated surface and the reddish clay of the lamps.

Considering the orientation of the space and the location of openings (door and windows), we also simulated the natural light provided by the sun's rays at several times of the day, from the afternoon to the evening, on a sunny day, assuming that the windows were not closed with shutters, skins, curtains or any other closing device (Fig. 9).

a)

b)

c)

Figure 9. Room VIII 5 at: a) 9:00; b) 13:00; c) 21:00.*

5. DISCUSSION

Inspired by Appadurai's [2001] concept of scapes, the sensoryscape defines the multiple sensory ambiances that shape a space and affect its perception. Even if its current use goes far beyond its original meaning, its primary aim was to report on the diversity of such ambiances and their variability according to cultural and social contexts [Classen 1993; Classen et al. 1994]. This concept borrows from the notion of representative space, which, according to the mathematician Henri Poincaré [1914], is not only "geometrical", but also visual, motor, and tactile.

This study contributes to demonstrating the essential role of virtual reconstructions in approaching sensory ambiances – or sensoryscapes – within ancient spaces, thereby extending our understanding of the sensory perceptions of past inhabitants. As previously highlighted by other scholars [Papadopoulos 2012], it is important to acknowledge that virtual reconstructions, while valuable, cannot achieve a completely accurate representation of the past. In our specific case, the absence of vegetation in the North Area, a key feature in ambient light, exemplifies such limitations. However, through the attainment of photorealistic rendering with maximal accuracy, virtual reconstructions can offer significant models. Achieving this precision necessitates conducting sensory measurements using specialized tools and utilizing render engines capable of handling such data.

In alignment with the perspectives of other scholars, especially Papadopoulos [2015], we argue that these models must be complemented by additional approaches, such as experiments, measurements, and ethnographic investigations. Concerning craft activities, a comprehensive understanding requires complementary approaches, including ethnographic investigations, experiments, and in-depth technological analyses. These combined methods ensure maximal accuracy in collecting appropriate materials and reconstructing the techniques, body postures and gestures of craftsmen. Furthermore, these parameters play a direct role in shaping the auditory environment, as we have demonstrated, and likely influence olfactory ambiances. For instance, stone working produces odours and surface textures that contribute to shaping the lived space. While short animations effectively convey techniques, gestures, light, and auditory ambiances, the challenge now lies in determining a convenient method for conveying odours and textures to the audience.

To sum up, adopting a multi-faceted approach that integrates various sensory dimensions enhances our understanding of ancient spaces and moves us closer to a more holistic interpretation of the past. Additionally, it can enhance our understanding of ancient craftsmanship. The sensory skills of craftsmen are seldom considered in archaeology; however, they are crucial in the creation processes. Reconstructing sensory ambiances is, therefore, highly significant in the process of reconstructing the work environment and skills of ancient artisans. In the case of Bronze Age Crete, archaeologists tend to assume that workshops existed within fixed built spaces, following models that developed in historical periods [Platon 1993]. However, the distribution of stone toolkits in Quartier Mu at Malia, as well as ethnographic models, suggest that stone working was performed both indoors and outdoors. This indicates that craftsmen were not only based in fixed, built workshops but were also mobile, transporting simple toolkits [Procopiou 2013]. When working outdoors, craftsmen could take advantage of natural illumination, depending on the season, time of day, and weather. In contrast,

pottery manufacturing was primarily an indoor activity. However, several ethnographic models [Psaropoulou 2005, 1990, 1984; Psaropoulou and Simandarakis 2007; Voyatzoglou 1974, 1973] suggest that outdoor production may have also existed in Minoan Crete. This may be especially true since illumination is considered an important factor in the manufacturing process [Papadopoulos and Sakellarakis 2010]. Lamps found in the Potter's workshop of Quartier Mu at Malia show burn marks [Rueff 2019], indicating that they were not only produced by the potter(s) but were also used by them. While there is no evidence to suggest that these lamps were used to light the potters at work, their deep capacity and coating suggest that they could be used for several hours to light domestic and craft activities after dusk [Rueff et al. 2021]. Experimental sound recordings also show that roughing out, drilling, and polishing produced distinctive and noisy sounds depending on the materials and craftsmen's gestures. As previous studies have shown , artisans rely on their visual, haptic, and olfactory skills, as well as their sense of hearing during creation processes [Procopiou 2013a; Procopiou et al. 2011].

6. CONCLUSION

On Chapouthier's steps, this article aimed to seek the sensory ambiances at Malia, and more specifically in the North Area and the Potter's Workshop at Quartier Mu, an urban district of the beginning of the 2nd millennium BC. The use of virtual reality, based on ethnographic investigations and experimental measurements, allowed us to approach the sound ambiances surrounded and generated by stone-working (stone roughing out, drilling, and polishing) and pottery manufacturing, as well as the light ambiances in which they were performed at different times of the day and dusk, both indoors and outdoors.

In doing so, our study not only illuminates the technical aspects of ancient craftsmanship but also underscores the importance of considering the sensory dimensions inherent in the fabric of spaces and activities. As we step back into the echoes of Quartier Mu's workshops, we recognize the challenges and potential inherent in recreating a multisensory past. This exploration encourages a broader discourse on integrating sensory experiences into archaeological investigations and would foster a deeper understanding of the lived experiences of those who shaped and inhabited the past.

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