From Tradition to Digital Fabrication: Safeguarding the 'Mashrabiya' Craftsmanship and Artisanal Communities

Abstract. Handmade crafts hold a cultural value worldwide. 'Mashrabiya' wooden lattice is an architectural element in the Arab world, historically used to allow air and light circulation. The craft declined in the 19th century due to shifts in the global markets, mass production, and technological advancement. It is gaining attention due to architectural trends considering sustainability, conservation, and heritage revival. Traditional artisans and modern technologies play a role in reviving crafts, and this study explores their connection. The research methodology involves desk and field research, participatory design workshops, interviews with craftsmen, and building a digital database of 'Mashrabiya' knowledge. Organizations in Morocco and the Kingdom of Saudi Arabia (KSA) support the study. The research involves creating block archives of 'Mashrabiya' designs and exporting patterns into a digital database for 3D printing applications. The main steps involve constructing 2D drawings, converting them to 3D models, and customizing sizes, shapes, and materials. The main challenges are understanding design software, materials, and craftsman's needs. The study aims to document patterns, structure, and materials using parametric design and adopting digital techniques. The findings are relevant to artisans, designers, educators, and organizations contributing to heritage revival, cultural continuity, and innovation by providing access to a comprehensive database of this traditional craft. The 'Mashrabiya' craft revival aligns with sustainable architecture and restoring the Arab world's heritage.

1 Introduction

1.1 Background and history

The 'Mashrabiya' is a wooden lattice-based window frame in the Middle East, North Africa, and other parts of the world, including Europe. It is made from interconnected wood piercings to allow ventilation and carries functional, social, and aesthetic values (Alothman, 2023). The term 'Mashrabiya' (مشربية) is etymologically derived from 'shurb' (الشرب), which means 'drinking,' and made from turned wooden bays. Its primary purpose is cooling water, ultimately facilitating air and light circulation (Paccard, 1980, 427). The craft developed during the Tulunid era (868 CE to 905 CE) and spread across various Arab regions (Maspero, 1974).

   In the early 20th century, its use declined due to cultural and economic factors, such as rapid modernization, industrialization, globalization, and economic change (Akbar, 1994; Özsavaş Akçay & Alotman, 2017). In recent years, the craftsmanship of 'Mashrabiya' has seen a wave of revival due to interest from government and private organizations (Mazeh, 2020). It is being used in the restoration plans of old buildings and introduced in new architectural buildings and interiors, for example, the façade of the Louvre Abu Dhabi Museum in the United Arab Emirates (Condé Nast Traveler website, 2023) and digitally fabricated 'Masrabiya' projects by Almashrabiya Screen specialists (Almashrabiya Screen Specialists website, 2023).

1.2 Research objectives

The study aims to digitize 'Mashrabiya' designs, using data and archives to develop a new database by collaborating with various target audiences, such as artisans, design practitioners, educators, and organizations. The research objectives are the following:
   1. To make 'Mashrabiya' a globally accessible craft while maintaining its semiotics.
   2. To collect data and create a digital archive of 'Mashrabiya' designs by conducting field surveys of historical art and craft in Morocco and KSA.

3. To explore digital resources and expedite a large scale production by generating templates for custom craft design.

1.3 **Methodology**

The paper follows a methodology that includes desk and field research under the 'Research about Design' category, which studies design features such as aesthetics, design theory, and design activity exploration (Frankel & Racine, 2010; Schneider, 2007). Activities initiated involve photographic documentation, site visits, conducting interviews, learning the craft from artisans, and designing and conducting workshops that include a participatory design process for understanding and disseminating knowledge of the crafts.

Participatory design is the approach considered for this research as it contributes to defining strategic, innovative techniques where design experiments are co-interpreted by the designer and the artisans (Spinuzzi, 2005). The author collects information about the craft, conducts interactive workshops, and will include public feedback for further steps [Table 1].

Table 1. Methodology: Data collection and Data Analysis

Phase	Description of tools/activities
Literature review	Collecting historical background. Studying the element's functionalities. Comparing the differences between 'Mashrabiya' of Morocco and KSA.
Site Visits	Visiting cities in Morocco (Rabat - Fess - Eljdida - Casablanca) and KSA (Riyadh - Mecca - Jeddah) to understand the 'Mashrabiya' past and present trends. Visiting an artisan's workshop, Abdulsalam AlKhulaif, in Rabat, Morocco. Visiting the 'Horizon Design' wood factory in Riyadh, KSA.
Interviews	Conducting interviews with artisans and organizations: 1. KSA (Saudi Heritage Preservation Society, Turquoise Mountain, Art Jameel).

	2. Morocco (Chambre d'Artisanat de la Région Rabat-Salé-Kénitra, Académie des Arts Traditionnels)
Attended Workshops	Attending workshops on UNESCO activities and wood crafts at The Royal Institute of Traditional Arts (TRITA) in Riyadh, KSA.
Conducted Workshops	Conducting a workshop on products depicting 'Traditional 'Najdi' Wood Doors.' Duration: 02 weeks at TRITA in Riyadh, KSA. Designing products for the 'Wood Vessels' workshop at TRITA in Riyadh, KSA.
Comparative Analysis	Analyzing the traditional and modern technology used to design and produce the 'Mashrabiya.'
Data Analysis	Studying data about 'Mashrabiya': Types/styles - crafting styles - techniques - tools - materials - temperature - production - patterns.
Design Conclusions	Understanding the craft's problems and artisans' conflicts for generating knowledge to preserve the craft. Developing an ongoing digital archive of 'Mashrabiya' patterns. Building a digital tool to generate new 'Mashrabiya' designs and connect the designer, client, and artisan.

2 The new database: connecting craftsmanship and current technologies.

2.1 Design Process

The design process involves extracting patterns from images collected during field and desk research. It begins with 2D drawings, building 3D blocks using Rhinoceros software, and utilizing Artificial intelligence (AI) to generate new designs based on available patterns.

The paper redefines the patterns for AI design generation as simple patterns (S) containing straight lines and acute angles and complex patterns (C) interconnected by various shapes and angles. The 'Mashrabiya' types are based on the Moroccan wood artisan Abdullah Morchidi. (S) patterns include 'Almamouni.' (C) patterns include 'Basic, Arabesque, and Andalusian.' [Table 2] sorts the original digitized designs for cohesive access to the desired pattern for further development. It consists of 2D-3D drawings, the main pattern component, the grid utilized for the array, and the pattern itself.

Table 2. Rhinoceros archiving template. (S-ALM1/C-B1/C-AR1) taken by author. (C-AN1) (Paccard, 1980, 447)

Pattern Type	Pattern Style	Photo	Code	Unit 2D	Unit 3D	Grid Unit	Pattern
Simple	Almamouni		S-ALM1				
Complex	Basic		C-B1				
Complex	Arabesque		C-AR1				
Complex	Andalusian		C-AN1				

The archiving template shown in [Table 2] follows the steps demonstrated in the following [Fig. 1], drawing original designs using Rhinoceros software and Grasshopper plug-in.
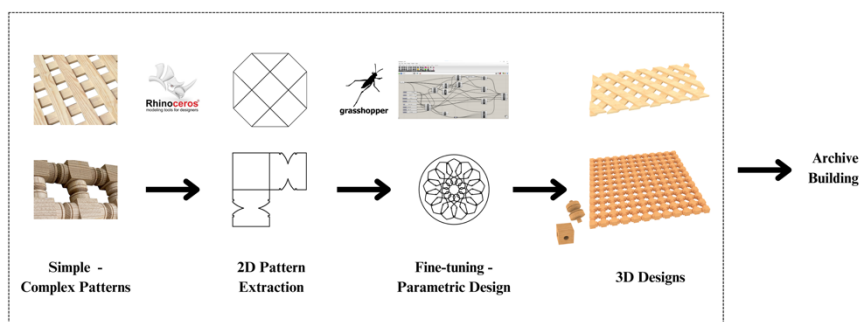

Fig. 1. Phase 1: Database building

2.2 **Results:**

The intention of coding an AI algorithm is to generate new patterns based on digitized data sourced from original 'Mashrabiya' designs [Fig. 2]. The new patterns are sent to Rhinoceros to recreate 3D models and Grasshopper for fine-tuning. The new database uses technology to combine traditional and modern aspects of generating designs and constructing customized patterns based on the client's requirements, shapes, and dimensions [Fig. 2].
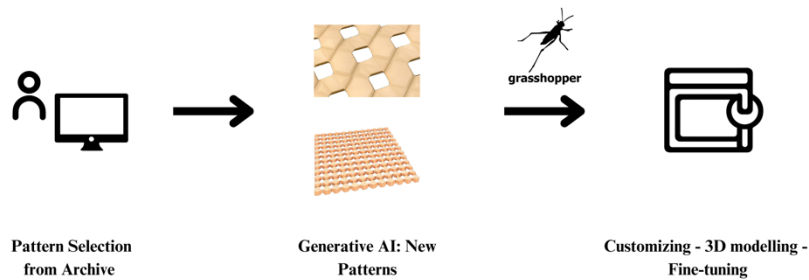

Pattern Selection from Archive   **Generative AI: New Patterns**   **Customizing - 3D modelling - Fine-tuning**

Fig. 2. Phase 2: Client input and generating new 2D/3D designs.

The newly generated design works cohesively with input from the client and designer to achieve a new 'Mashrabiya' customized design. Here, the client decides the production method and the material. After this phase, the client can take two fabrication options. First, a craftsman is involved in the final production of the 'Mashrabiya,' using the design of a material of the client's choice (wood, stainless steel, fiberglass). Second, the 'Mashrabiya' is 3D printed, where the client would be limited to materials that are possible in digital fabrication (PETG, ASA, ABS) [Fig. 3]. The author considers a third way for future research: combining artisan and 3d printing.
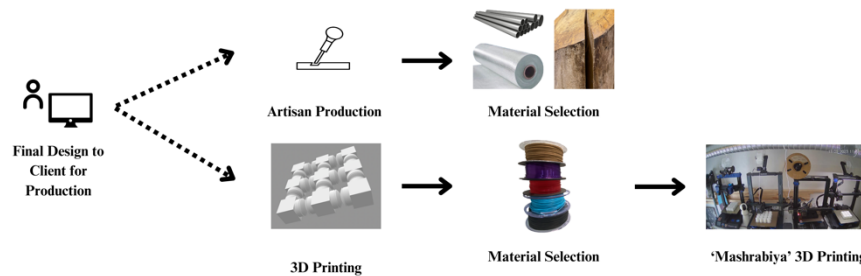
Fig. 3. Phase 3: Production

2.3 **Conclusion:**

Modern societies tend to exist only in the presence of technology, and introducing new social forms relying on advancements allows effective change (Manzini, 2015). Meanwhile, the distance between human creation and technological production is shrinking (Balsamo, 2019). The cohesion of compositional dialogue between mechanical routines, human gestures, and a will for AI in the creation process is visible (Balsamo, 2019). Access to technologies is highly beneficial to customers where the community gains access to new market opportunities (Ratti & Claudel, 2015). Leaving the possibility of craftsmanship was to preserve the tradition and highlight the chance of achieving the product by utilizing intermediate technologies for small-scale enterprises (Schumacher, 2011).

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