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CREATIVE INTEGRATION OF EGYPTIAN CULTURAL HERITAGE IN ELECTRIC VEHICLE STYLING

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Abstract. This paper explores the integration of Egyptian cultural heritage into electric vehicle design, aligning with Egypt Vision 2030 principles. The purpose is to investigate how ancient Egyptian symbols can inspire innovative electric vehicle styling and assess the educational outcomes of such a design project. Conducted as a coursework project at the October 6 University in Giza, 6 of October, Egypt, this initiative challenged product design students to design electric vehicle's using symbols and motifs used in ancient Egyptian civilization. The methodology included four phases: 1) research and inspiration; 2) ideation and refinement; 3) digital modelling, and 4) physical modelling. The findings showed that integrating cultural symbols enhanced the aesthetic and symbolic value of the electric vehicle's, fostering creativity and deeper cultural appreciation among students. Practical implications suggest that such designs can appeal to consumers seeking unique and culturally meaningful products. The originality and value of this paper lie in demonstrating how cultural heritage can be preserved and promoted through contemporary design, contributing to both educational outcomes and market innovation.

Keywords: ancient Egyptian symbols, car styling, creative design, cultural heritage, cultural symbolism, design education, Egypt Vision 2030, industrial design, product innovation.

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1. Introduction

The design of electric vehicles intersects sustainability, technological innovation, and aesthetic appeal. With the rising demand for environmentally friendly transportation, the automotive industry is developing electric vehicles that meet functional needs and resonate with consumers on cultural and emotional levels. This study is particularly novel and relevant as it examines the integration of Egyptian cultural heritage into electric vehicle design, aligning with Egypt Vision 2030 (Ministry of Planning and Economic Development, 2023), a national strategy that emphasizes sustainable development and cultural identity preservation.

In recent years, the integration of cultural heritage into product design has become increasingly prominent, especially in European and Western contexts. Culturally symbolic design allows products to differentiate themselves in competitive markets while connecting with consumers on a deeper, emotional level. For instance, Scandinavian minimalism, known for its simplicity, functionality, and connection to nature, has become a global design trend, influencing industries such as furniture and architecture. Similarly, Japanese automotive design incorporates cultural principles of harmony and precision, which are globally recognized and

have contributed to the success of its car brands. These examples demonstrate that culturally inspired designs, even when rooted in local traditions, have global market potential.

The research explores how ancient Egyptian symbols can inspire innovative electric vehicle styling. The hypothesis is that incorporating cultural heritage into electric vehicle design enhances the vehicles' aesthetic and symbolic value, creating a unique product identity that appeals to consumers while promoting cultural appreciation and sustainability. Ancient Egyptian motifs hold global recognition for their aesthetic and symbolic significance, making them suitable for integration into modern design.

This study blends ancient Egyptian visual and symbolic elements with contemporary electric vehicle design to create a distinctive product in the competitive automotive market. This approach preserves and promotes cultural heritage while aligning with global sustainability and innovation trends. Engaging product design students in this process aims to enhance educational outcomes, fostering creativity and a deeper understanding of cultural heritage.

The novelty of this research lies in its focus on Egyptian cultural symbols as inspiration for electric vehicle design. Although integrating cultural symbols into product design is not a new concept, applying ancient Egyptian motifs to electric vehicles offers a fresh, unexplored perspective that aligns with global trends of cultural differentiation. This study contributes to sustainable design and cultural preservation, providing insights for both academic research and practical applications in the automotive industry.

2. Background and context

The integration of cultural heritage into modern design has gained attention in recent years, driven by a desire to preserve cultural identity in a rapidly globalizing world. Cultural heritage encompasses the tangible and intangible assets of a society, including traditions, symbols, values, and historical artifacts that define its unique cultural identity. In the context of design, these elements can provide a rich source of inspiration, enabling designers to create products that are not only aesthetically pleasing but also culturally meaningful. This approach aligns with the broader goals of sustainable development, as it promotes the use of local knowledge and resources, fosters cultural continuity, and enhances the cultural significance of contemporary products.

2.1. The role of cultural heritage in design

Cultural heritage significantly influences product design, fostering deeper connections with consumers. Incorporating intangible cultural heritage elements infuses products with unique cultural qualities, enhancing emotional connections and reinforcing cultural identities (Zong et al., 2023). This distinct character strengthens the bond between consumers and the products they use.

Designing products inspired by cultural heritage increases consumer satisfaction and fosters stronger connections. Enhancing cultural resonance in products bridges the perceptual gap with local culture, leading to more efficient development and higher consumer satisfaction (Zhang & Wen, 2020). Integrating cultural creativity into emotional design also boosts regional and national cultural confidence (Yu et al., 2022).

Ancient Egyptian symbols are visually distinctive and have been embraced globally in various design fields. The ankh, with its unique cross shape and loop, and the Eye of Horus, with its stylized falcon-like markings, have transcended their cultural origins to become iconic elements in fashion, architecture, and art. These symbols not only represent Egyptian heritage but also serve as universally recognizable motifs, allowing designers to infuse their work with both historical depth and contemporary appeal. Their incorporation into electric vehicle design offers a fusion of ancient aesthetics with modern technology, creating a product with broad cultural resonance.

The design industry for intangible cultural heritage products holds significant potential for innovation and growth. Three-dimensional (3D) printing technologies facilitate the creation of culturally inspired products, generating economic benefits while preserving and promoting heritage (Liang, 2021). Strengthening the protection of intangible cultural heritage and integrating it into art and design education fosters cultural self-confidence and builds cultural power (Xu & Zou, 2022).

Incorporating cultural symbols into products establishes a profound emotional connection with consumers, enhancing their market appeal. Traditional cultural symbols in design impart unique qualities, fostering emotional resonance and cultural identity (Zong et al., 2023). Exposure to culturally symbolic brands serves as a cultural reminder, evoking values and beliefs that influence consumer behaviour (Torelli & Stoner, 2015). Moreover, cultural symbols and motifs enhance the aesthetic appeal of products, making them stand out in a competitive market. These culturally symbolic brands activate associated cultural schemas, reinforcing emotional ties with consumers (Torelli & Ahluwalia, 2012).

Marketing strategies that leverage cultural symbols emotionally impact consumer perceptions. Symbolic appeals in advertising allow consumers to internalize brand meanings and emotions, fulfilling experiential and pleasure-seeking needs, thus strengthening consumer-brand relationships (Bauer, 2023). This emotional connection is essential in contemporary consumption culture, where symbols stimulate buying habits and shape perceptions (Khuong & Bich Tram, 2015).

The infusion of traditional cultural symbols helps brands create a sense of identity and emphasizes cultural richness and heritage, influencing consumer behaviour and perceptions of authenticity and value. Designers must carefully select and apply traditional symbolic elements based on functionality, form, and aesthetic requirements to highlight cultural connotations and regional characteristics (Yijing & Sharudin, 2023).

The aesthetic perception of cultural symbols positively influences purchase intentions by enhancing perceived value, with traditional elements moderating this effect (Y. Li & J. Li, 2022). The symbolic and aesthetic aspects of product appearance communicate functional characteristics, quality impressions, and ease of use, further enhancing consumer choice and purchase intentions (Creusen & Schoormans, 2005).

2.2. Cultural elements in automotive design

Cultural heritage significantly influences automotive design by reflecting societal values and narratives. Incorporating traditional symbols and cultural narratives creates visually significant and culturally resonant vehicles, ensuring they embody broader cultural contexts and societal values (Hyun et al., 2017).

The design of automotive interiors, particularly aspects like colour, material, and finishing, can evoke positive psychophysical and emotional responses from customers, guiding automakers in creating distinct and appealing products (Song et al., 2023). The concept of the emotional pattern generator facilitates the design of aesthetically pleasing car interiors that meet specific customer requirements more effectively (Song et al., 2023).

Integrating traditional symbolic elements into modern automotive design enhances market competitiveness and appeal (Yijing & Sharudin, 2023). By incorporating cultural symbols and narratives, automakers can create products that resonate deeply with consumers, ensuring they are both visually and culturally significant.

Cultural sensitivity in design elements is important for enhancing usability and universal access in automotive design. Considering cultural nuances when developing human–computer interaction in vehicles is essential for culturally adaptive design, enhancing user experience and satisfaction in diverse markets (Khan et al., 2016).

2.3. Egypt Vision 2030 and the transition to electric mobility

Egypt Vision 2030 is a national roadmap outlining strategic objectives for sustainable development, built on the pillars of economic development, social justice, and environmental sustainability (Ministry of Planning and Economic Development, 2023). The document emphasizes preserving and promoting Egypt's rich cultural heritage while fostering innovation and technological advancement. It highlights that Egypt's wealth lies in its cultural heritage and intellectual capital (Ministry of Planning and Economic Development, 2023, p. 66), and promotes the transition to clean transportation systems, such as electric vehicles, to reduce pollution and encourage fuel conservation (Ministry of Planning and Economic Development, 2023, p. 152).

The popularity of electric vehicles in Egypt is growing, with approximately 3500 to 4000 electric cars on the roads as of 2023, up from 1000 to 1800 in 2021 (Singh, 2024). This growth reflects rising interest driven by government incentives and increasing environmental awareness (Habib, 2023).

The Egyptian government supports domestic electric vehicle production through initiatives like the establishment of the Supreme Council for Automotive Industry, which formulates policies to revitalize the automotive industry with a focus on electric vehicles (Ahram Online & MENA, 2022). The government also covers 35% of production costs per electric vehicle and offers subsidies of up to Egyptian pounds 50 000 (United States dollars 2500) for locally manufactured electric vehicles (Singh, 2024), aiming to make electric vehicles more accessible to consumers.

Despite these efforts, the infrastructure for electric vehicles in Egypt is still developing. The networks of charging stations are expanding, with the government planning to establish a more extensive charging infrastructure to support the growing number of electric vehicles. Public interest in electric vehicles is also growing. A survey showed that 90% of respondents plan to buy an electric vehicle within the next decade, with about 20% intending to make a purchase within the next year. However, high upfront costs, limited model availability, and nascent charging infrastructure remain significant barriers to widespread adoption (Enterprise: The State of the Nation, 2022).

Egypt Vision 2030 targets the transition to electric mobility while emphasizing cultural identity preservation (Ministry of Planning and Economic Development, 2023). The document's goals of sustainable development and cultural enrichment are intertwined, aiming to improve Egyptians' quality of life through innovative and environmentally friendly technologies (see Table 1).

Table 1. Selected statements from Egypt Vision 2030 that align with and support the aims of the research (source: created by authors, based on Ministry of Planning and Economic Development, 2023)

Strategic goal	General goal	Quotes
#1 Improve Egyptians' quality of life and raise their living standards	1.6 Enriched cultural and sports life	Egypt's wealth lies in its tangible and intangible cultural heritage, as well as its soft power derived from its abundance of intellectuals, writers, scientists, thinkers, authors, artists, and creators in fields such as music, visual arts, cinema, and theatre (Ministry of Planning and Economic Development, 2023, p. 66).
		Culture is a lifestyle encompassing the set of values, ethics, ideas, knowledge, habits, traditions, beliefs, worldviews, customs, arts, and various forms of individual creativity, both material and immaterial, as well as everything an individual acquires as a member of society (Ministry of Planning and Economic Development, 2023, p. 65).
		Egypt's Vision 2030 aims to preserve and enrich Egyptian culture and sports, while raising awareness among Egyptians about their significance in achieving a decent life (Ministry of Planning and Economic Development, 2023, p. 65)
		Encouraging the preservation, protection, and accessibility of tangible and intangible cultural heritage, and harnessing its potential for sustainable development, creativity, and the promotion of cultural identity (Ministry of Planning and Economic Development, 2023, p. 67).
#5 Well-developed infrastructure	5.2. Providing secure and sustainable transportation systems	Gradually transitioning towards clean modes of transportation, such as electric and hydrogen powered vehicles that do not use fossil fuel, to minimize pollution and foster a culture of fuel conservation among all stakeholders (Ministry of Planning and Economic Development, 2023, p. 152).

In line with Egypt Vision 2030, educational institutions are encouraged to integrate cultural heritage into their curricula (Ministry of Planning and Economic Development, 2023). This approach enhances the educational experience and prepares students to contribute to the country's Sustainable Development Goals (The United Nations Development Programme [UNDP], 2015).

This paper reports on a product design coursework project at October 6 University (O6U) exemplifying the Egypt Vision 2030 initiative. Students were tasked with designing an electric vehicle inspired by ancient Egyptian cultural symbols, blending traditional motifs with contemporary technological advancements to create a vehicle that is both innovative and culturally significant.

3. Theoretical framework

3.1. Design theory related to cultural symbolism

This framework explores how cultural symbols can be effectively incorporated into contemporary product design to enhance meaning and consumer connection. The integration of symbolic elements into product design has been shown to positively influence consumer perceptions and brand identity (Brunner et al., 2016). The importance of cultural grounding and narrative engagement in product innovation is emphasized to ensure designs reflect broader cultural contexts and societal values (Yijing & Sharudin, 2023).

3.2. Principles of sustainable design

Sustainable design principles emphasize the importance of using environmentally friendly materials and processes in product design. This approach aims to reduce the environmental impact of vehicle production and use (McDonough & Braungart, 2008). The integration of these principles into the design process is critical for promoting sustainability and supporting long-term ecological balance (Ceschin & Gaziulusoy, 2016).

3.3. Educational frameworks for project-based learning

Project-based learning approaches are utilized to engage students in real-world design challenges, promoting deeper learning and skill development (Blumenfeld et al., 1991). This framework assesses the educational outcomes of such projects, including the development of critical thinking, creativity, and collaborative skills (Kokotsaki et al., 2016; Thomas, 2000). By participating in a project that combines cultural heritage and contemporary design, students gain valuable experience that enhances their educational and professional development.

4. Methodology

This study seeks to address two primary research questions: how might ancient Egyptian cultural symbols inspire innovative styling for electric vehicles? What are the educational outcomes of engaging students in such a design project?

The participants in this process were 20 students in the third year of a four-year Product Design degree program at the O6U, a private higher education institution located at 6th of October city, a satellite city of the Greater Cairo region of Egypt. The students were enrolled in the course of Experimental Models and Prototype Design. The course ran for 12 weeks between February and May, 2023, and the electric vehicle project was the only assessment task in the course.

In the project brief it was clarified that the following criteria should be met:

- The electric vehicle should be a battery electric vehicle (BEV). Also known as pure electric vehicle, fully electric vehicle, or all-electric vehicle, a BEV is powered solely by rechargeable battery packs without the use of any internal combustion engine and is designed to be charged through external electric power sources. BEVs produce zero tailpipe emissions, unlike hybrid vehicles and plug-in hybrid electric vehicles, which still

emit pollutants due to their internal combustion engines. BEVs also have fewer moving parts, reducing maintenance and costs. This choice supports Egypt's commitment to reducing greenhouse gas emissions and promoting clean transportation solutions as outlined in Egypt Vision 2030;

- The electric vehicle should be designed around the following technical specifications: permanent magnet synchronous motor, front-wheel drive, 177-horsepower output, 347.5-NM torque, top speed of 156 km/h, range of 390 km, battery capacity of 56 kWh, and 45-minute charging time. These specifications were arrived at by averaging the data from four popular BEV models sold in Egypt;
- The electric vehicle should target market middle-income consumers who are environmentally conscious, residing in urban and suburban areas, and typically younger professionals and families. These buyers are value-oriented, tech-savvy, and motivated by environmental responsibility. They are early adopters of new technology and budget-conscious, seeking reliable and cost-effective transportation solutions.

By adopting these specifications, the project ensures technical soundness and alignment with Egypt Vision 2030's broader goals of promoting sustainable transportation solutions.

The electric vehicle design process was structured into the four phases outlined below. Each phase was carefully planned to ensure that students could effectively integrate cultural elements into their designs.

4.1. Phase one: research and inspiration

The initial phase focused on understanding automotive market trends and target user needs through secondary research. Students acquired knowledge of emerging automotive technologies via Internet searches. They collected images, textures, and colours to evoke the feel of an Egyptian-made electric car, creating mood boards to visually convey the overall theme and style of their concepts.

A unique source of inspiration was the visual analysis of 32 ancient Egyptian cultural symbols listed in Table 2. This involved reviewing visual literature and artifacts to understand the significance of these symbols. Lectures provided deeper insights into the symbolic meanings of these icons, which was integral to every aspect of the culture of the ancient Egyptians.

Table 2. Ancient Egyptian cultural symbols that served as sources of inspiration during phase one of the project (source: created by authors)

Symbol	Visual description	Meaning
Ankh	Cross with a loop at the top	Life and immortality
Eye of Horus	Stylized human eye with markings	Protection, health, and restoration
Eye of Ra	Similar to the Eye of Horus, often with a tear	Sun and power
Ouroboros	A serpent eating its own tail	Cycle of life, death, and rebirth
Scarab	Beetle-shaped	Transformation, protection, and resurrection
Djed	Column with horizontal sections	Stability and strength
Tyet	Knot resembling the ankh but with arms curving down	Femininity and protection (Isis)
Ka	Two upraised arms	Vital essence or spirit

End of Table 2

Symbol	Visual description	Meaning
Ba	Human-headed bird	Soul and its mobility between life and the afterlife
Feather of Maat	Single feather	Truth, justice, and cosmic order
Deshret	Red crown	Lower Egypt
Hedjet	White crown	Upper Egypt
Pschent	Combination of the red and white crowns	Unity of Upper and Lower Egypt
Shen	Circle with a line at the bottom	Eternity and protection
Uraeus	Cobra with hood expanded	Power of the gods and pharaohs
Seba	Star or starburst	Stars and constellations
Heka and nekhakha	Crook and flail	Royal authority and kingship
Menat	Necklace with counterpoise	Prosperity, fertility, and fortune
Was-sceptre	Staff with a forked base and an animal head at the top	Divine power and dominion
Khepresh	Blue war crown	Royalty and war
Tree of life	Stylized tree with branches and leaves	Destiny and eternal life
Akhet	Sun rising between two hills	Horizon and the cycle of the sun
Atef	Crown with feathers and a central element	Rulership and the deity Osiris
Sistrum	Musical instrument resembling a rattle	Joy and divine worship
Cartouche	Oval with a horizontal line at one end	Royal name enclosure
Lotus flower	Stylized flower	Creation, rebirth, and the sun
Papyrus plant	Tall, reed-like plant	Lower Egypt and regeneration
Anubis	Jackal-headed deity	Mummification and the afterlife
Horus	Falcon-headed deity	Kingship and the sky
Thoth	Ibis-headed or baboon-headed deity	Wisdom and writing
Ra	Falcon-headed deity with a sun disc	Sun, life, and growth

4.2. Phase two: ideation and refinement

In this phase, students generated and refined initial ideas into viable concepts. Brainstorming sessions produced a wide range of ideas through sketching, incorporating the studied cultural symbols. The process began with quick thumbnail sketches to explore different forms, proportions, silhouettes, and directions, followed by more detailed concept sketches to refine promising ideas into polished, high-quality renderings.

Students used both traditional pen-and-paper methods and digital tools like styluses and drawing tablets. Traditional media, including watercolour, gouache, acrylic paints, graphite pencils, coloured pencils, pastels, airbrushes, and markers, were also used for their tactile and expressive qualities. Regular critiques and feedback sessions with peers and academic staff facilitated the refinement of designs, ensuring cultural relevance, innovation, and functionality.

4.3. Phase three: digital modelling

In the third phase, refined sketches were translated into detailed computer-aided design (CAD) models using *Blender* (software), a free and open-source 3D modelling software. *Blender*'s versatile tools facilitated detailed modelling, surface refinement, photorealistic rendering, and animation. Its export options ensured seamless preparation for rapid prototyping and computer numerical control (CNC) machining.

This step allowed for the intricate incorporation of cultural elements into the vehicle design, focusing on both aesthetic and functional aspects. Continuous refinement of the digital model ensured that cultural symbols were seamlessly integrated into the vehicle's form and structure.

4.4. Phase four: physical modelling

The final phase focused on rapid prototyping of physical models using CNC router machines, transforming digital 3D designs into tangible representations. This involved addressing manufacturing challenges such as material selection, fabrication techniques, and assembly processes. Solutions were developed to ensure the final products were both functional and aesthetically pleasing.

5. Results

5.1. Design outcomes

The students' final electric vehicle designs seamlessly integrated ancient Egyptian cultural symbols with contemporary automotive aesthetics. These designs uniquely incorporated symbolic elements into various aspects of the vehicle's exterior.

The journey began with students collecting images of various Egyptian cultural symbols, including those generated using artificial intelligence tools like DALL-E (Figure 1). This approach provided diverse and rich visual references, aiding the creative process by offering unique interpretations and variations of cultural motifs. These images inspired their initial sketches of electric sports cars.

a) b) c) d)

Figure 1. A selection of artificial intelligence-generated depictions of ancient Egyptian symbols that students referenced to for a culturally inspired electric vehicle concept: a – Eye of Horus; b – sacred scarab; c – winged feather of Maat; d – winged sun disk (source: created authors, using DALL-E by *OpenAI*)

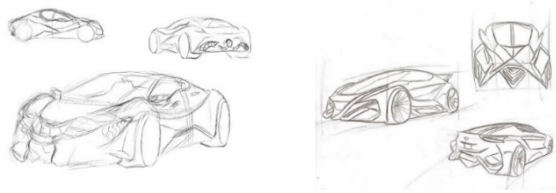

Figure 2. Pencil sketches of electric vehicle concepts, drawn by the students who participated in the study (source: created by Abdullah Hany, Sherine Ashraf, and Yasmine Mahmoud)

The hand-drawn images in Figure 2 highlight the early conceptual stages, focusing on sharp, angular lines, and aerodynamic features, suggesting high-performance vehicles. The loose, rough lines show pronounced wheel arches, large air intakes, and low, sleek profiles. Multiple views ensure consistency across different aspects of the car. These sketches demonstrate the students' exploration of form and function, laying the foundation for their design vision influenced by ancient Egyptian architecture and artifacts.

In the next phase, students refined their designs by deeply integrating elements inspired by Egyptian cultural heritage. They blended contemporary car design with intricate cultural motifs reminiscent of ancient Egyptian art. Figures 3–4 present conceptual renderings of blue electric sports cars embellished with gold accents inspired by these motifs.

Figure 3 depicts a sleek electric vehicle with a rounded shape and gold lines accentuating the headlights, grille, and stylized wings. Figure 4 shows an electric vehicle with sharp angles, a low profile, and gold accents emphasizing its aerodynamic shape. Both feature a blue and gold colour scheme, reminiscent of lapis lazuli and gold in Egyptian jewellery and decorations, symbolizing the heavens, royalty, and opulence.

The concept car in Figure 3 combines the Eye of Horus and the sacred scarab in the grille emblem, symbolizing protection, rebirth, and divine power. Stylized golden wings run along the side, inspired by ancient Egyptian gods, giving the car a dynamic and regal appearance.

The concept car in Figure 4 draws inspiration from the ancient Egyptian winged sun and feather of Maat, the goddess of cosmic order. These motifs are integrated into the front emblem, hood detail, and side panels, reflecting protection, harmony, and the sacred significance of gold in Egyptian culture.

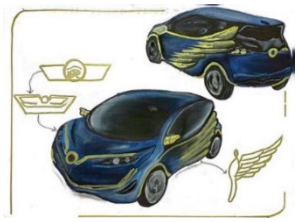

Figure 3. Hand-rendered concept of an electric sports car featuring symbolic cultural details, created using gouache by the student who participated in the study (source: created by Mariam Mohammed)

Figure 4. Digitally rendered concept of an electric sports car featuring symbolic cultural details, created using *Adobe Photoshop* by the student who participated in the study (source: created by Yasmine Mahmoud)

Figure 5. Three-dimensional digital models of an electric vehicle concept created using *Blender* software by the student who participated in the study (source: created by Sherief Fawzy)

This phase showcases the students' efforts to merge cultural symbolism with contemporary design, creating a unique and innovative aesthetic for their electric vehicles. The transition from two-dimensional (2D) sketches to coloured renderings reflects the natural progression from rough ideas to detailed refinement.

Transitioning from 2D to 3D, the students developed CAD models using *Blender*. The sport utility vehicle, with its elevated stance and off-road capability suited for Egypt's desert regions, became the preferred body type for this electric vehicle project.

Figure 5 shows an intermediate stage in the 3D modelling process, focusing on refining the vehicle's geometry, surface features, and detailing components. This phase bridges the gap between conceptual sketches and final models. Placeholder materials visualize the structure before detailed texturing. Key details like roof rails, rear spoilers, and side mirrors are visible, with highlighted edges indicating areas needing attention. Mesh modelling, wireframing, shading, colouring, and technical validation ensure the model is aesthetically pleasing and functionally sound, ready for the next steps.

With digital models in hand, the students produced high-quality renderings of their vehicles using *Blender*, showcasing electric vehicle variations (Figure 6). These renderings provide a realistic preview of the final designs. The car body has a compact, aerodynamic shape with smooth curves and a slightly muscular appearance, emphasizing the electric vehicle's sporty character.

The electric vehicles are presented in various two-tone colour schemes: bright red, purple-burgundy, silver grey metallic, and off-white cream, all with contrasting black roofs. These colour schemes evoke symbolic themes aligned with ancient Egyptian culture. Black symbolizes fertility, rebirth, and the rich soil of the Nile; the black roof subtly references these themes of regeneration and prosperity.

Red in Egyptian art and hieroglyphs symbolized life and victory. The goddess Isis, associated with healing, magic, and motherhood, was often depicted in a long red dress. During celebrations, Egyptians painted their bodies with red ochre. The bright red body colour of the electric vehicles alludes to these attributes of energy, boldness, and dynamism.

Figure 6. Studio renderings showing colour variations of an electric vehicle concept, created using *Blender* software by the student who participated in the study (source: created by Sherief Fawzy)

Purple is associated with royalty, luxury, nobility, and wealth. Purple amethyst gemstones were used to make amulets and talismans for religious and magical purposes. The purple burgundy body nods to these ancient themes of high status and elegance.

In ancient Egypt, silver known as white gold, was used in jewellery and ceremonial items and associated with the moon, symbolizing clarity. The metallic grey or silver body colour of the electric vehicles represents these attributes of high value.

White, often used in art to depict ancient Egyptian gods, symbolized the sacred and divine. The off-white or cream-coloured body refers to these themes of purity and cleanliness.

Symbolic connections to Egyptian motifs in the electric vehicle designs are subtle and interpretative, adding depth without being overtly evident. The Eye of Horus inspired the shape and placement of the sleek, narrow headlights with integrated daytime running lights. The circular badge on the front grille hints at the sun disc, a motif representing the sun god Ra and symbolizing power and protection. The sides of the car subtly reference the sacred scarab and feather of Maat, the goddess of cosmic order. Maat's influence is seen in the car's smooth, balanced lines and harmonious proportions, symbolizing precision and equilibrium. The sacred scarab motif is reflected in the rounded shapes and patterns on the sides, evoking the beetle's form. These ancient motifs subtly communicate themes of stability, protection, and renewal, creating a visually appealing and symbolically rich contemporary vehicle.

Environmental renderings were created to display the electric vehicle concept in realistic outdoor settings, simulating actual use. These renderings provide a practical portrayal of the product's appearance and function in its intended context, helping viewers understand its usability, scale, and visual appeal. Figure 7 shows a vibrant blue electric vehicle connected to a charging station on a paved road, demonstrating its use in an urban or suburban environment. The blue car body symbolizes the Nile river and the sky, central elements of ancient Egyptian civilization.

Moving from digital to physical, tangible prototypes were fabricated from the students' 3D models. Figure 8 shows a 1:5 scale model, produced by CNC routing of expanded polystyrene foam, representing the culmination of the students' design journey. While the carved foam model does not overtly exhibit ancient cultural symbols, it reflects Egyptian philosophies through the design principles of symmetry, balance, and geometric precision. This prototype showcases the students' dedication, creativity, and technical skill, merging innovative electric vehicle styling with rich Egyptian cultural heritage.

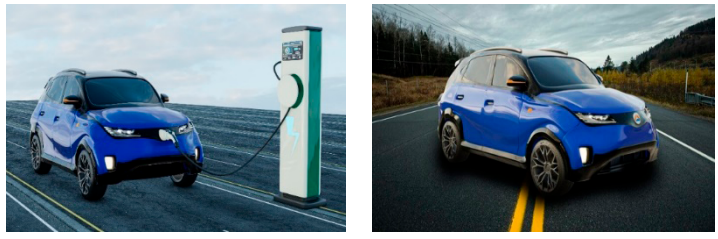

Figure 7. Contextual renderings of an electric vehicle concept, created using *Blender* software by the student who participated in the study (source: created by Sherief Fawzy)

Figure 8. Scaled prototype of an electric vehicle concept, fabricated using computer-aided design routing of expanded polystyrene foam from a digital three-dimensional computer numerical control model prepared by the student who participated in the study (source: created by Sherief Fawzy, fabricated by *Creative Solutions Factory*)

5.2. Student learning outcomes

Through this project, students gained a comprehensive understanding of how cultural heritage can be leveraged in contemporary design. They developed skills in cultural research, creative interpretation, and practical application of traditional symbols. Technical skills in 3D modelling and CNC machining were also significantly enhanced. Students learned to balance aesthetic considerations with functional requirements, ensuring that the cultural elements added value to the vehicle's design without compromising performance.

Course feedback from students indicated a high level of engagement and satisfaction with the project. They appreciated the opportunity to explore their cultural heritage in a creative and innovative context, finding the experience both educational and inspiring. Academic staff noted significant improvements in the students' design thinking and technical capabilities, highlighting the success of the project in bridging theoretical knowledge with practical application.

6. Discussion and interpretation of results

6.1. Effectiveness of cultural integration

The electric vehicle designs produced by the O6U students successfully embodied the essence of Egyptian cultural heritage. Each design seamlessly integrated ancient Egyptian symbols. The cultural integration was achieved through a rigorous design process that included in-depth research, iterative sketching, detailed 3D modelling, and practical implementation. This comprehensive approach ensured that the cultural symbols were authentically represented and harmoniously integrated into the overall design.

Ancient Egyptian symbols were specifically chosen for their ability to add layers of depth and meaning to contemporary electric vehicle designs. These symbols not only carry historical and cultural significance but also enrich the product's identity, allowing it to stand out in the modern marketplace. The integration of such symbols is reflective of current design trends, where culturally meaningful products are increasingly sought after by consumers who value authenticity and storytelling in their purchases. This approach aligns with the broader movement towards products that connect emotionally with users by embedding cultural narratives into their design.

Culturally inspired vehicles stand out from contemporary electric vehicle designs due to their unique aesthetic and symbolic value. While most electric vehicles focus primarily on technological innovation and streamlined aesthetics, the inclusion of ancient Egyptian symbols adds an additional layer of meaning and differentiation. This cultural dimension enhances the vehicles' appeal, offering a distinctive alternative in the electric vehicle market.

6.2. Educational value

Using cultural heritage as a ɒesign inspiration demonstrated clear educational benefits. Students deeply engaged with their cultural roots, gaining a comprehensive understanding of ancient Egyptian symbols and their meanings. This engagement fostered pride and connection to their heritage, reflected in their creative and innovative designs. The project provided a multidisciplinary learning experience, combining cultural studies with technical skills in design.

Students developed critical thinking and problem-solving abilities, learning to balance aesthetic considerations with functional requirements. This approach enhanced their overall design capabilities and prepared them for future challenges in industrial design. The process encouraged them to think outside the box and develop unique design solutions, demonstrating that cultural heritage can drive innovative and original design concepts.

6.3. Market and cultural implications

The market potential for culturally inspired electric vehicles is substantial. Consumers increasingly seek products that offer more than functionality – they desire items that resonate with their values and cultural identity. The electric vehicle designs rooted in Egyptian cultural heritage meet this demand by providing a distinctive and emotionally engaging alternative to conventional vehicles. These designs attract a niche market of consumers who appreciate the fusion of tradition and modernity.

Global interest in cultural heritage and sustainable design further supports the market viability of these vehicles. By combining cultural elements with sustainable technology, these electric vehicles align with current trends and consumer preferences, appealing to a broad audience.

Integrating cultural heritage into modern design extends beyond the automotive industry. This approach can be applied in various fields, promoting cultural identity preservation in contemporary contexts. Designers can keep cultural heritage alive and relevant by incorporating traditional symbols and motifs into modern products, ensuring its value for future generations.

This project aligns with Egypt Vision 2030's goals of cultural preservation and sustainable development. It demonstrates how cultural heritage can inspire innovative and marketable products, contributing to economic diversification and enhancing cultural identity. The project highlights the role of design education in fostering a deeper understanding of cultural heritage and its modern applications.

7. Conclusions

This study demonstrated the successful integration of Egyptian cultural heritage into electric vehicle design. O6U students created electric vehicle designs that are both innovative and

culturally significant, bridging the gap between tradition and modernity. These designs not only stand out aesthetically but also resonate deeply with users' cultural identities.

The educational benefits for the students were substantial. They gained a comprehensive understanding of leveraging cultural heritage in contemporary design, developed critical technical skills, and enhanced their creativity and problem-solving abilities. The project provided a holistic learning experience, preparing students for future challenges in industrial design.

Future research could explore integrating cultural heritage into various automotive design aspects, including interior layouts, user interfaces, and material selection. Similar projects in other cultural contexts could examine how different heritage elements can inspire innovative and marketable designs. Collaborative projects with international design institutions could provide broader insights and foster cross-cultural exchange.

Potential developments in cultural design are significant for the automotive industry. Manufacturers could adopt similar approaches to differentiate their products, appealing to consumers' desire for unique and meaningful vehicles. This strategy could be particularly effective in markets with rich cultural histories, where consumers have a strong connection to their heritage.

The electric vehicle designs produced in this project successfully embodied Egyptian cultural heritage, offering a distinctive alternative that combines tradition with modernity. The market reception for these designs is promising, as consumers increasingly seek unique, meaningful, and culturally resonant products. By integrating traditional symbols and motifs into modern products, the project promotes the appreciation of Egyptian cultural heritage. This approach aligns with Egypt Vision 2030's goals of cultural preservation and sustainable innovation, demonstrating how cultural heritage can inspire innovative and marketable products, contributing to economic diversification and enhancing Egypt's cultural identity on a global stage.

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