CALLIGRAPHY IN DIGITAL ARCHITECTURE: UNDERSTANDING THE AESTHETIC FUSION IN DESIGN STUDIO

Quratulain Asghar*1, Dr. Mamuna Iqbal2, Dr Munazzah Akhtar3

*1Ph.D. Scholar, Associate Professor Department of Architecture University of Engineering and Technology Lahore;
2Assistant Professor Department of Architecture University of Engineering and Technology Lahore;
3Associate Professor Department of Architecture University of Engineering and Technology Lahore

*1quratulainasghar@gmail.com; 2mamunaiqbal@uet.edu.pk; 3munazzah@uvic.ca
Corresponding Author: *

ABSTRACT

This research explores an innovative approach integrating calligraphy, architecture, and digital tools within an architectural studio. It examines the design process and learning outcomes of two studio projects that combine traditional calligraphic techniques with contemporary digital architecture. The exploration aims to address the increasing homogenization of architectural designs in the digital age by offering a unique solution that integrates art, architecture, and technology. The study was conducted over four months during the fall semester of 2023 at the 4th-year level in the Architecture Department at the University of Engineering and Technology Lahore. The research recognizes the pressing need to develop a framework that allows students to leverage digital tools in their architectural workflows while preserving traditional practices' expressive and crafted qualities. Students motivated by a shared passion for calligraphy and architecture undertook this research to bridge the gap between traditional craftsmanship and cutting-edge design. This studio practice presents a transformative approach to architectural design and expression, where students employ calligraphic tools to create hand-drawn architectural elements that emphasize the expressive nature of letterforms and strokes.

Key Words: Callitecture, Design language, Interdisciplinary Studio Teaching methods, Digital tools Integration, Art of Calligraphy

INTRODUCTION

Recent theoretical developments have revealed that an architect's artistic vision and practice are currently influenced by the digital tools and technology utilized in this industry, which is changing architecture in the modern world. Image architecture, digital simulation, and virtual scenes, among other applications, have gradually become progressive architectural design phases in practice nowadays and have become a requirement in the field. With the advent of this influence, some people are accepting or depreciating this change of process. Everyone acknowledges the change in the process of designing brought by these tools and understands the flow of how and where these tools are helpful in the field of architecture(Kalay,2019.). A challenging problem in this domain is the future directions of digital tools in this field. Different advancements in digital technology that were formerly thought to be challenging to undertake are now within reach, notwithstanding their complexity with time. These tools are changing the course, but is this change overcoming the symbolic value of what architecture represents? The industry that has opened doors to using these tools in creative designing and executing has, for some reason, been not upfront in making this a part of the criteria for becoming an architect. This makes up for the problem of schools in Pakistan that are behind in technological upgrades and are open to learning and using these tools in academia(Asghar 2023)This research attempts to understand how digital tools are being used equitably in architecture academia. Discussing to what extent

these tools and technology help architecture is essential, as this implies other associated aspects like education systems and the architect's design process. No research has investigated the extent of digital tools in academic institutions and students' learning experiences contextually in Pakistan.(Arif Hasan 2003). All collected data generally utilized on this topic shows the expanding influence of architectural technology on the design and construction of buildings, resulting in an expansion and widening of the subject's competence. The main reason for developing computer applications practice is to improve their professional field. It will be more efficient if computer applications are integrated into all the phases among different disciplines and are valued for their importance.(Iftikhar, Osborne 2018).

In an era where technological advancements are rapidly transforming the creative landscape, this confluence of ancient art and contemporary tools offers a unique opportunity to explore new avenues of artistic expression and architectural innovation(Papamaolis Antonis 2012). With its rich history and cultural significance, calligraphy has long been revered for its aesthetic beauty, expressive power, and spiritual depth. The intricate strokes and fluid movements of the calligrapher's hand imbue each character with a sense of dynamism and vitality(Krishnamurti 2001). In the digital realm, these calligraphic elements can be manipulated and transformed in myriad ways, giving rise to novel forms and compositions.

Digital tools and techniques such as computer-aided Architecture design (CAAD), parametric modeling, and generative algorithms can be employed to incorporate calligraphic elements into architectural design. These tools enable designers to explore the expressive potential of calligraphy in various ways, such as by creating intricate patterns, manipulating spatial relationships, and generating dynamic forms. On the contrary, if we discuss the changes in architecture studio education, lots of research has been conducted on the changing needs of architectural education due to the integration of technology and the changing attitude of the learner. Ashraf Salama emphasizes the importance of transcritical pedagogy, which focuses on transdisciplinary education in architecture(Salama 1995). When discussing the studio learning outcomes, this research will help develop an expression of design language into architectural

studio teaching, allowing students to explore traditional line, form, and composition techniques. Students can use calligraphic tools to create hand-drawn architectural elements, emphasizing the expressive nature of letterforms and strokes. Furthermore, exploring digital calligraphy tools enables students to translate traditional calligraphic principles into the digital realm. Using software like Grasshopper and Rhino allows for precision and experimentation, providing a bridge between analog and digital design expression. Integrating calligraphy into the architectural studio training allowed students to explore different cultural contexts and historical influences. This broader understanding of the undermined subject has enriched the conceptualization of architectural designs and improved their traditional vocabulary. Students were allowed to study calligraphic traditions from various cultures and periods, leading to a more holistic understanding of design influences and making it an interdisciplinary technique. On the other hand, utilizing digital technology particularly has allowed advancements to mainly be achieved in the architectural design field, which is quite significant. Now, things that were previously impossible to do are within essentially reach and can be done, which is quite substantial. The field of architecture encompasses a wide range of subjects, including technology as one of those subjects, which, for the most part, shows that utilizing digital technology has allowed advancements to be achieved in the field of architectural design, or so they specifically thought. The field of architecture is continuously evolving, and pursuing innovative design approaches has become increasingly vital. Integrating diverse disciplines is reshaping how we envision and construct the built environment. This study explores the multifaceted realm of interdisciplinary collaboration, emphasizing the broader range of professions involved in this transformative synergy.

The merging of architecture and calligraphy design represents an exciting and cutting-edge field that appeals to the desire to push the boundaries of traditional architecture. The topic of calligraphy design, which often emphasizes artistic expression and cultural heritage, aligns with the growing global focus on holistic and integrative architectural practices(Alashari and Mohd Azhar Abd. Hamid 2021). This research approach

examines the fascinating interdisciplinary connections between architecture and the ancient art of calligraphy, offering valuable insights into how diverse disciplines such as art, history, and materials science can collaborate to create unique and culturally responsive architectural solutions. It showcases the tremendous potential for groundbreaking ideas that emerge when professionals from various backgrounds work together, making it a precious contribution for those interested in innovative architectural practices. This research explores the synergies between diverse fields in architecture, emphasizing the crucial role of interdisciplinary education. It aims to explain how the collaborative efforts of professionals from various disciplines within architecture, coupled with calligraphy design principles, can lead to innovative and culturally enriched architectural solutions(Khajavi 2018). The study highlights the vital importance of interdisciplinary and technology-oriented teaching methodologies in architecture by analyzing two different studio explorations based on the art of calligraphy and the use of digital tools. This research is driven by the recognition of the pivotal role that architectural education plays in shaping the futures of aspiring architects. By addressing the broader question of how challenges in architectural education can be identified, analyzed, and mitigated, the research aims to foster a more effective and enriching learning experience for students, ultimately contributing to the development of competent and innovative architects.

Literature Review:

Calligraphy is a rich and multifaceted art form, with diverse styles and scripts found worldwide, each reflecting the unique cultural traditions and artistic expressions of its respective society (Krishnamurti 2001). This captivating art form continues to be valued for its ability to evoke emotion, convey messages, and preserve cultural heritage through the meticulous craftsmanship of words and symbols. Calligraphy, often described as the art of beautiful writing, is a timeless practice deeply admired for its aesthetic qualities and the profound connection it fosters between the human hand, mind, and artistic expression. It is essential to recognize that calligraphy is a dynamic and ever-evolving art form with cultural and aesthetic variations.(Alashari and Mohd Azhar Abd. Hamid 2021). Arabic calligraphy, in particular, is a fascinating art form that gives rise to expressions that beautifully combine spiritual meaning with aesthetic beauty. Calligraphic expression is a fundamental decorative element in all forms of Islamic art, ranging from architecture to ornamental design, and has been widely used throughout history and into modern times. Over time, various script styles have been developed, each with various expressions and yielding different compositions, including several Kufic and Cursive styles. Arabic calligraphy encompasses diverse styles, each with its unique principles and cultural significance, such as Naskh, Diwani, and Thuluth, reflecting the rich tapestry of Arabic culture.(Haider 2021). The choice of script and style can convey specific emotions and themes, making it a powerful tool for self-expression and cultural preservation.

Calligraphy is an art form that celebrates the human touch and expression. The delicate yet powerful strokes and the harmonious flow of lines and forms all come together to create a captivating aesthetic. Arabic calligraphy, in particular, is renowned for its rhythmic and dynamic qualities, as calligraphers pour their heart and soul into each brushstroke, infusing their compositions with a mesmerizing sense of movement and energy.(Shiekh 2018.).

The art of forming letters is achieved through a balanced interplay of thick and thin lines, curves, and angles.(Haider 2021). This mastery of line and form reflects the calligrapher's control over the medium and, in a broader sense, echoes the importance of balance and harmony in life.

Calligraphers, through their work, seek the sacred words of the Quran to emerge together as a holy level for spiritual meditation. Tunisian professor Rashida Triki writes, "The gaze is constantly deprived of its ability to read and is brought back to pure pictorial seeing." (Paul, 2009). The Arabic calligraphy evokes language as well, echoes the classic traditional style, and uses Quranic colors that are famous in ancient Eastern societies. However, all conventional calligraphers produce their artwork by building upon the long history of Arabic calligraphy style as a source of inspiration. Traditional Arabic calligraphy art has power and expresses the beauty concept and the depth of heritage in the Arabic language. Also, it presents the complexity of different Arabic cultural

societies. In addition, traditional Islamic calligraphy art has a unique style that presents the complex composition of the unique perspective of Islamic art (M. Alashri, 2019). In today's architecture, practical tools and modern technologies are being used rigorously in academia. The expanding influence of architectural technology on the design and construction of buildings has resulted in an expansion and widening of its subject capability ((Varinlioglu 2019.)). The early design stages need high cognitive effort from both the software and hardware tools. The evolution of novel information technology has made it feasible to use novel techniques for spatial organization and aesthetic expression of architectural designs, which is significant(Tzonis 2014). This generally has resulted in significant advancements in the built environment, showing how the evolution of novel information technology, for the most part, has made it feasible to use novel techniques for the spatial organization and the aesthetic expression of architectural designs, generally contrary to popular belief.(Soliman et al. 2019)

With the increasing expansion of computer applications in the architectural profession, there is a greater need to build a framework for integrating computer applications into the architectural curriculum.(Dorta 2007). As a result, it became necessary to investigate the influence of computer integration on architectural schools while also investigating the demands of the architecture profession to assist in the development of an efficient framework for architectural education. (Soliman et al., 2019). Investigating strategies to boost undergraduate students' use of CAAD is required. It is helpful to assess and reevaluate the educational process to make sure that it is comparable to the working world and current with computer applications. (Soliman et al., 2019). This research helps to understand and reflect on how digital tools can help explore the interdisciplinary merger with the complex art of calligraphy and how tools can help enhance architecture studio learning.

Several researchers have delved into the convergences of calligraphy and digital architecture, providing valuable insights into this burgeoning field. Notable studies include those by Alice Kueng (1999), who stated, "Calligraphy and architecture are all about spaces, not only two dimensional, but three dimensional (letter sculpture)(Haider 2021)By analyzing the strokes, space, and moods of calligraphy and then generating/transforming them into new spaces for the building, the building can capture the essence of calligraphy, which itself is three-dimensional calligraphy. "

Research Objectives:
The two main objectives of this research are to explore the synergy between calligraphy and architecture through a digital design studio and to reflect on the learning outcomes and the embedded challenges by observing the studio's progress and output. The second objective is to explore how learning in the studio can explore the transformative potential of contemporary digital tools, particularly Rhino and Grasshopper, in seamlessly incorporating calligraphic elements into architectural design.

Research Methodology:
Reflective practices in architectural design are essential for architects to continually improve their work, enhance their understanding of the built environment, and refine their design processes (Schön, 1983). This research method mainly focuses on the challenges and opportunities provided to the researcher from design studio projects. Two studio projects designed to research calligraphy art and its transformation using digital tools are discussed and analyzed here. A detailed reflection on the design process and the use of digital tools is presented. This methodology was evaluated by examining the learning through this specific methodology and how it helped stimulate students' critical thinking. The reflection is mainly focused on how the synergy between two disciplines (calligraphy and architecture) can enhance creativity and improve the design process, and how using digital tools can help simplify the complexities of the design process and provide creative outcomes.
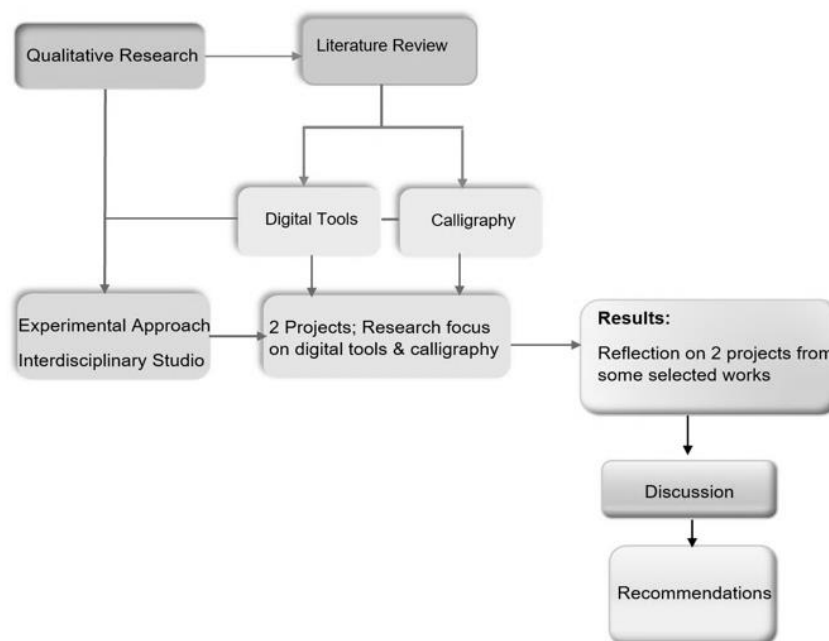
Figure 1: Framework of Methodology

 The studio is conducted during the fall semester of 2023. The studio brief demanded detailed research on calligraphy. The studio methodology followed a framework for digital design studios that encourages interdisciplinary teaching methods as a part of design teaching. This framework is proposed in a conference paper Methodology Framework for Digital Design Pedagogy: Comparative Analysis of Architectural Studios: Comparative Analysis of Digital Design Studios(Asghar and Naqvi 2021) .This research has delved into four different digital studio teaching methodologies in different regions to come up with this proposed framework for Pakistan.

The framework is shown in Fig 2 Architecture schools employ diverse design methodologies, including algorithmic, performative, parametric, and fabrication-based approaches. These studios ground their theories in natural sciences and phenomena, leveraging research to inform design tool usage. Integrating technology can foster creative processes, with an emphasis on using tools as a medium rather than an end. A proposed framework for digital design studios includes theory, creative development, tool integration, fabrication, and programming. However, many schools lack the necessary infrastructure and skilled teams to fully implement this framework, requiring a cautious and gradual approach(Asghar and Naqvi 2021).

 A literary investigation was launched in this complex, artistic domain offering students an opportunity to delve into areas of their interests. Each student was afforded the liberty to narrow down their research to one area within the subject based on personal interest, thereby empowering them to explore topics of individual intrigue. Studio learning through this methodology is discussed and how it helped to enhance critical thinking among students. The reflection is mainly focused on how the synergy between two disciplines (calligraphy and architecture) can enhance creativity, improve the design process, and how the use of digital tools can help simplify the complexities of the design process and provide creative outcomes.
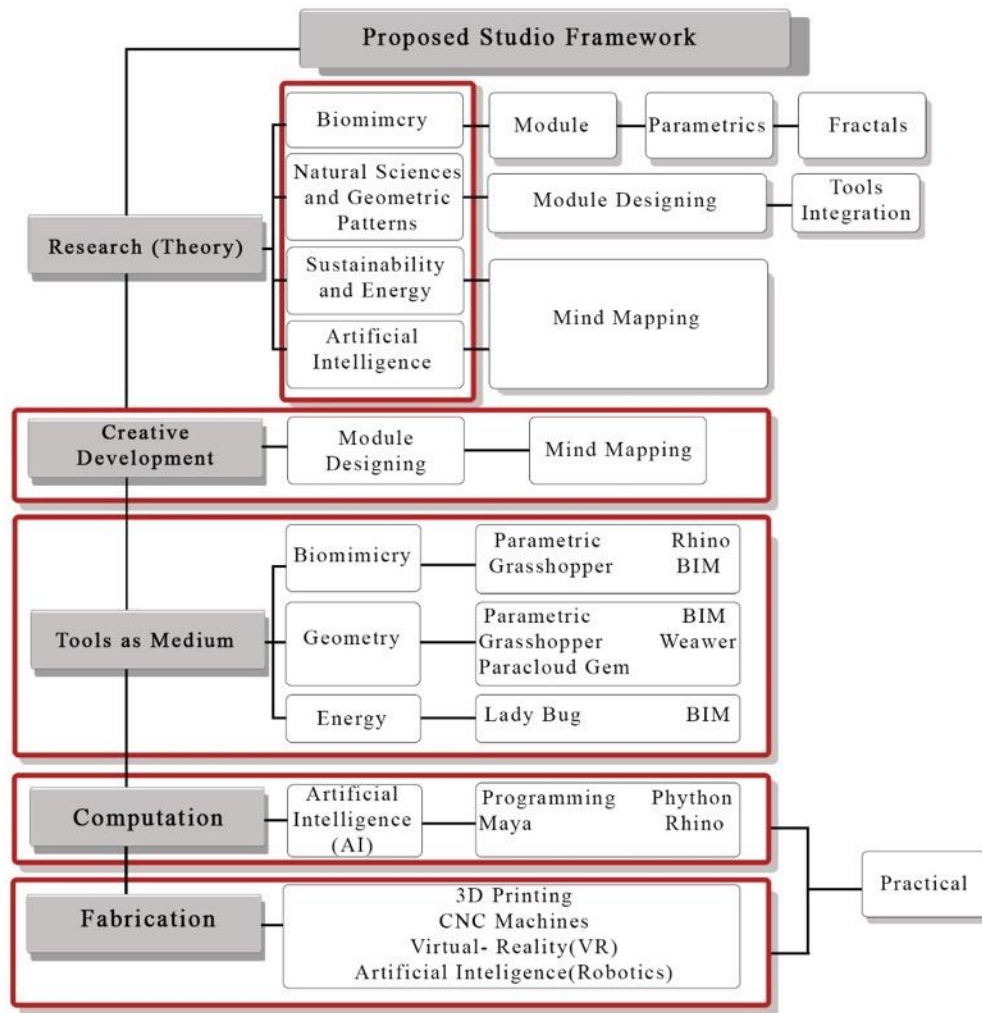
Fig2-Framework for Digital Design Studio in Pakistan.(Asghar and Naqvi 2021)

Project I: Extension Design of Sheikh al Zahid Islamic Center Punjab University Lahore

The extension project of the Sheikh al Zahid Islamic Center at Punjab University in Lahore showcased a captivating blend of Arabic calligraphy and architectural design. The project team deliberately selected this existing structure to design its extension using modern digital technologies. After meticulously studying the strokes of the Arabic letter "Haa" and their translation into architectural elements, the project reflects a thoughtful fusion of cultural symbolism and spatial form. The design focused on the "Haa" letter from the Thuluth script, thoroughly examining its strokes and significance. As a connecting letter in Arabic calligraphy, particularly in the Thuluth script, the Haa displays remarkable versatility and fluidity, offering a rich repertoire of shapes and strokes within words. The architectural interpretation of the "Haa" letter was manifested in the design of various structural components, including the exterior facade, fenestration, and interior spaces.
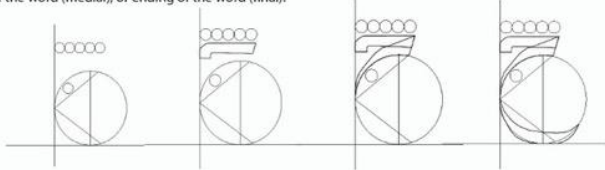
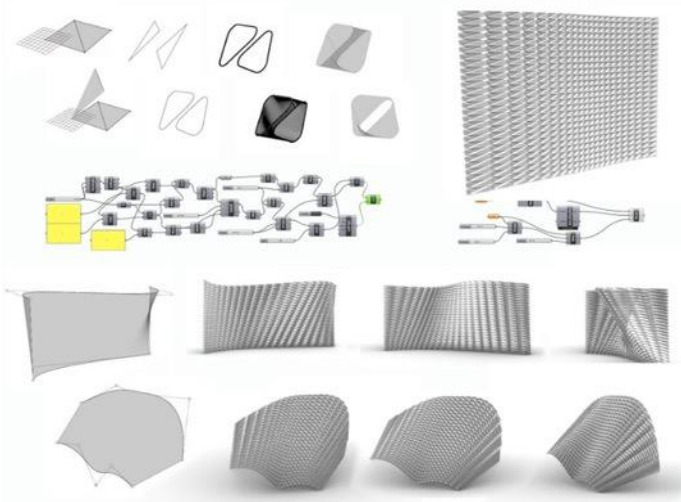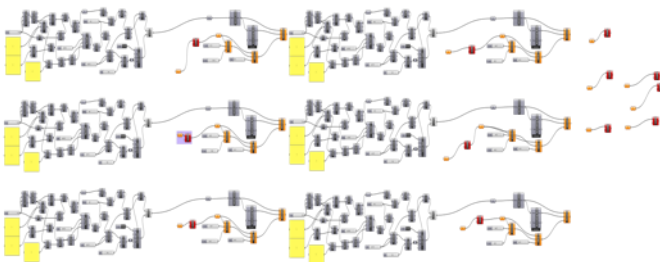Fig3: Study of Letter HAA in Thuluth Script

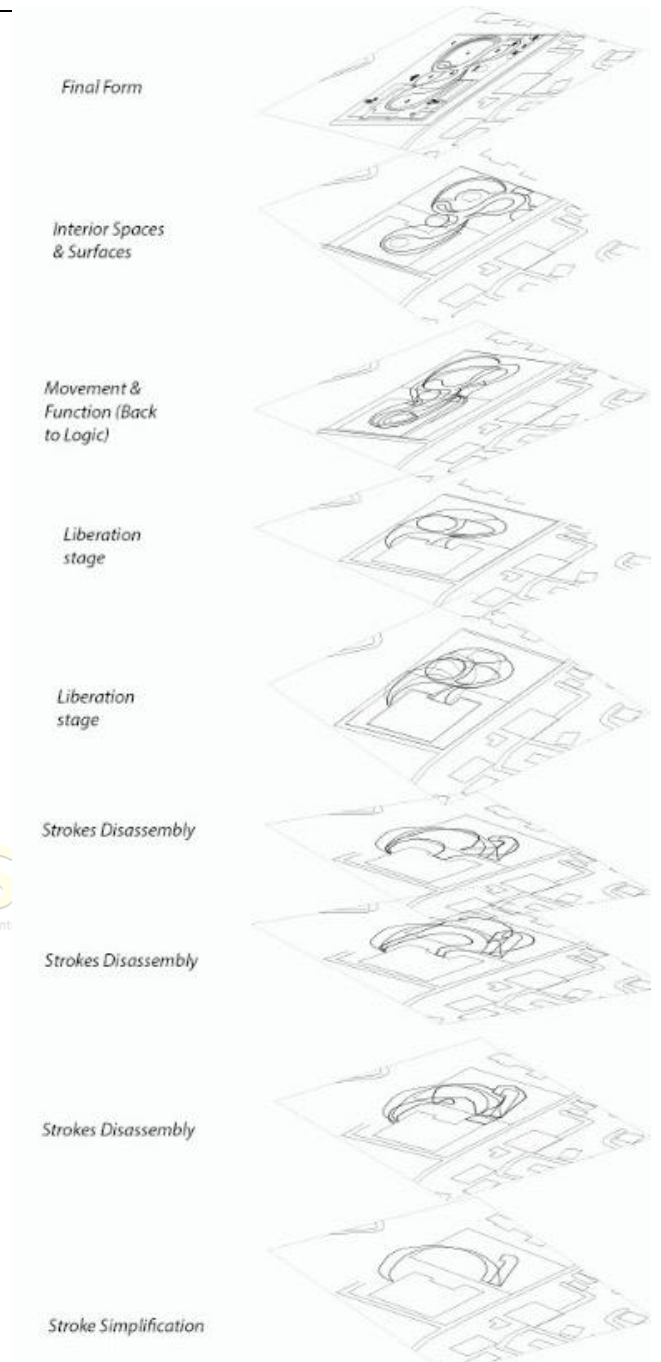Fig4: Module Derivation and Population on Grasshopper

(student work)

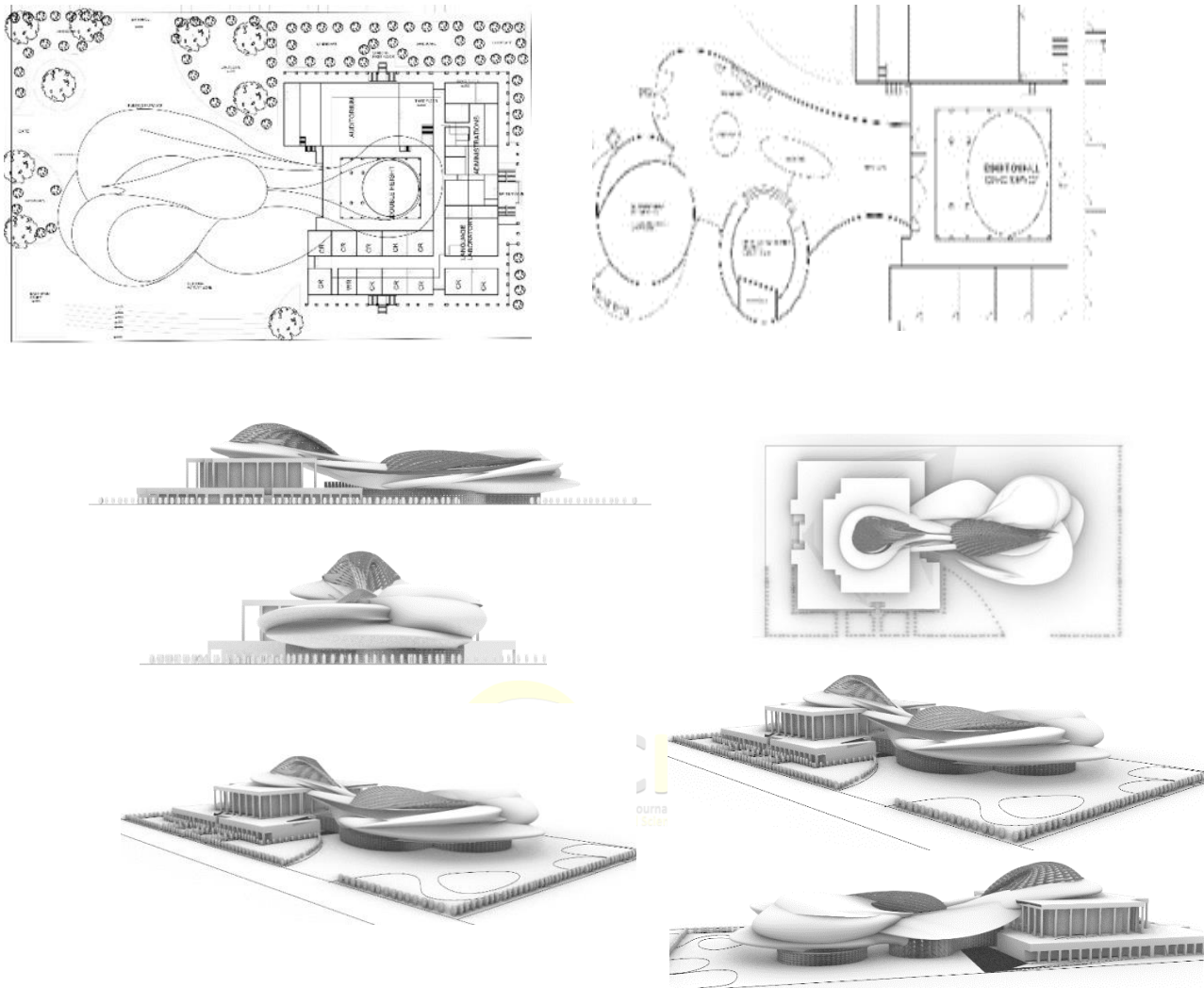Fig 5: Design Transformation from letter HAA

Fig 6- Plans of Extension and 3d models of the final structure (Student work-Tayaba)

The decision to apply the calligraphic module to surfaces where skylights are needed is particularly noteworthy. By integrating elements of the natural environment into the built environment, the project creates a sense of harmony and tranquility, reflecting the spiritual essence of the Islamic center. The use of slopes instead of stairs further underscores the fluidity and grace inherent in calligraphic strokes, transforming the spatial experience into a seamless flow of movement and contemplation.

The use of Rhino Plugin Grasshopper to design a module based on the strokes of "HAA" and then populating the mesh on the existing and new stricture required a laborious use of software(Fig 4)

Ladybug plugin in Rhino is also used to come up with the climatic analysis. The student went through a rigorous process of study, experimentation, and synthesis, the project embodies the transformative power of cultural heritage in shaping the built environment. As a testament to the enduring relevance of calligraphy as a source of inspiration and creativity. The major limitation of this project was the time constraint as the student was given only four weeks to learn Rhino-Grasshopper and explore calligraphy as an art. The instructor believes that this is very little time to understand calligraphy art and digital software the same time for those students who have

no background knowledge of the subject and tools and digital theory.

Reflection on the Project:

One of the biggest hurdles that the student faced in pursuing this project was the transformation of the research on the letter HAA into the architectural form to design an extension for the existing structure. The process of transformation is shown in Fig 5. A lot of iterations and repetitions were performed easily with the use of Rhino and Grasshopper. The process of module derivation was also based on the research on the calligraphic letter, The parametric and the visual programming made it simpler to draw complex forms and the populated facade This is because the software uses mathematical algorithms to produce incredibly accurate drawings with the tiniest of details. The second challenge was the familiarity and use of Grasshopper and Rhino, Students were introduced to this software in the same semester, initially, they were intimidated by the software and later in the semester, they had difficulty handling the complexities of the software so they limited the use of it in the design process. The studio design methodology which was initiated with interdisciplinary research and readings was also new to the students and they were not sure how to delve into the research domain and narrow it down to the extent of designing the module. The most intriguing aspect of the project is the iterative nature of the design process. The systematic deconstruction of the Haa letter into abstract lines and shapes demonstrates attention to detail and a commitment to exploring the full expressive potential of calligraphic forms in architectural composition. By experimenting with different strokes and configurations, the student transcends the constraints of conventional architectural vocabulary, inviting a dialogue between tradition and innovation (fig 4). Setbacks are inevitable in any design process. One of the main learning during this project is that rather than viewing failures as obstacles, students should see them as opportunities as the importance was given to the process and not the product. By analyzing what went wrong and why, students learn to avoid repeating the mistakes and explore new avenues to design.

Project II: A study to explore the synergy of calligraphy and digital architecture

Mahmoud Darwish's poignant quote, "Art is a necessity, not a luxury," underscores the profound significance of art as a fundamental requirement rather than a mere indulgence, particularly during times of adversity and struggle. This quote forms the foundation for the design development of the second pavilion façade. The design process unfolded systematically, beginning with the selection of Darwish's quote and the extraction of the word "fann" from it, which served as the focal point for exploring the expressive potential of calligraphy for the first Pavilion. The Mahdaoui calligraphy artwork, with its emphasis on the aesthetic aspect of Arabic letters rather than their semantic meaning, exemplifies this contemporary interpretation of traditional forms. Utilizing digital tools such as Rhino, designers leverage the Thuluth script component and parametric controls to produce a diverse array of profiles while preserving the integrity of the Thuluth stroke style. By employing various tools with the same stroke, students experimented with (Fig 6) iterations, exploring design possibilities and integrating traditional art forms seamlessly into contemporary architectural contexts. Rhino emerges as a pivotal tool in the design process of this complex synergy Its robust capabilities and parametric controls enable the student to manipulate Thuluth strokes with precision, generating intricate profiles and architectural elements that resonate with cultural depth and artistic sophistication. Through the iterative exploration of design possibilities, students critically analyzed the process of creative exploration, offering opportunities for innovation and aesthetic refinement.
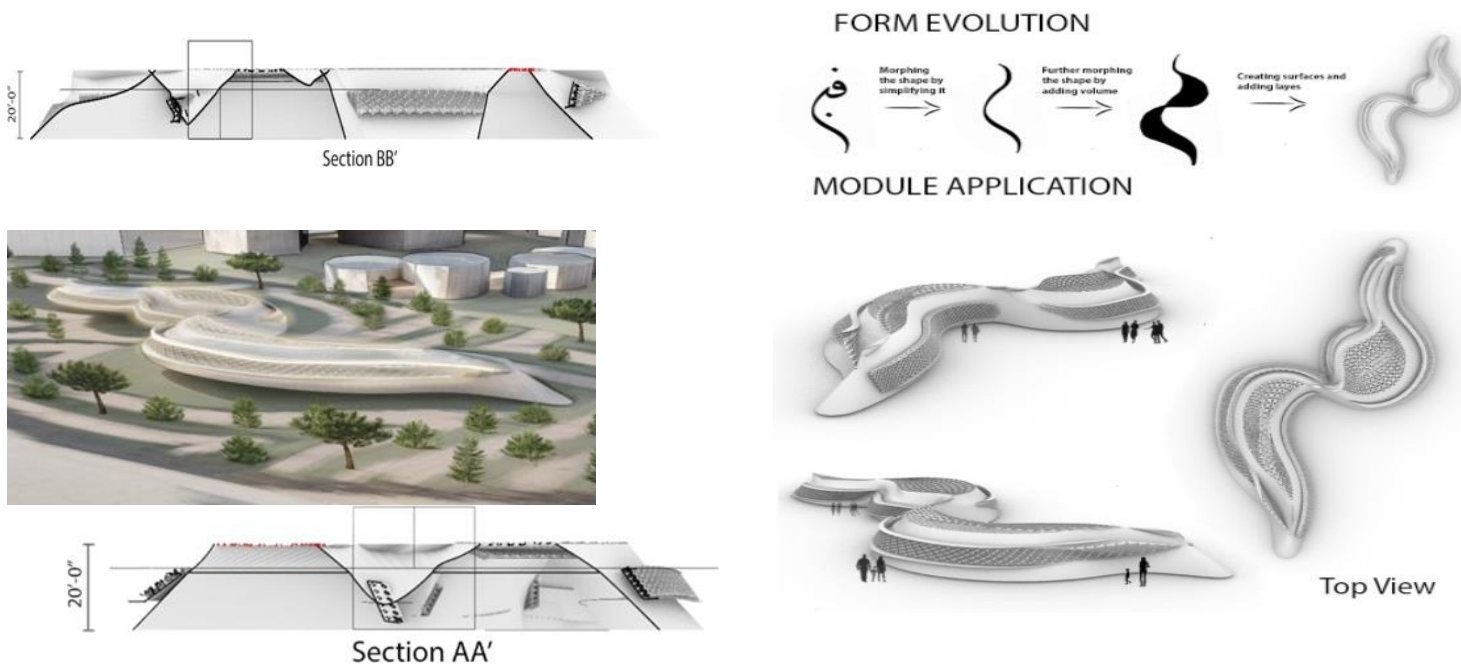
Fig 7 Section and 3d of the first pavilion inspired by the word FANN in Thulth Script

Fig 8-Second Pavilion design process originated from Mahmoud Darwish's poignant quote, "ورةضر الفن ليس ترفاً بل" in Thuluth Script

Reflection:

This second project was different then the first one as it had no limitations in terms of the design scheme to incorporate an existing and old structure, so this student had the freedom to explore creativity in the form to its fullest. The biggest challenge again was the transformation of research into the architectural form. Students found it challenging to incorporate calligraphic details into the design process. The research on the Thuluth script was not practically carried out due to the time limitation that setback is reflected in the final design. The student was unfamiliar with this design methodology where the translation of research is the core of the design process and one has to go back and forth to develop the linkage. This enhances their critical thinking by creating various iterations and solutions to the same process. The integration of calligraphic elements into architectural design requires a nuanced understanding of form, proportion, and spatial organization. In the studio, students learned to experiment with various techniques for seamlessly incorporating calligraphic motifs into building facades, interior spaces, and ornamental details. Rhino and Grasshopper serve as powerful tools for translating calligraphic strokes and statements into the design creatively. The major limitation was the first-time hands-on experience with software like Rhino and its plugin Grasshopper. Students used YouTube tutorials to learn these tools and software which was challenging for them as spent most of the time understanding the purpose of various commands. Students did understand the notion of the experimentation in studio as the instructor's focus was constantly on the process rather than the product. This change in the studio instruction methodology made students understand the importance of experimentation in the studio. Although they find it difficult to unlearn the methods, they have adopted in the last three years of education where the product was given full importance. The use of Grasshopper, as a visual programming interface integrated with Rhino, introduces students to the principles of parametric design and computational thinking. Through Grasshopper's node-based workflow, students could develop algorithms that generate complex geometries and dynamic patterns inspired by

calligraphic motifs which have not been fully explored in this project.

Studio Perception of the Participants:

The challenges faced by students in architecture extend beyond the academic realm, as evidenced in the paper "Architectural Education Today: Cross-Cultural Perspectives" (Ashraf Salama). Navigating cross-cultural differences impacting collaborative learning experiences and grappling with diverse pedagogical approaches underscore the need for recognizing and addressing challenges to enhance the effectiveness of architectural education in a cross-cultural setting.The book "Architectural Education Today," authored by scholars including Ashraf Salama and Kaj Noschis, addresses the ongoing challenges and disagreements within architectural education (Ashraf Salama). This compilation aims to foster discussion and research-based insights, emphasizing the necessity for more scholarly endeavors in understanding and improving architectural education.Ashraf Salama in his book Spatial Design Education talks about transformative pedagogy is an educational approach that emphasizes dynamic, interactive processes, dialogues, and activities between educators and students. This interaction stimulates negotiated and collaborative knowledge creation, fostering an equitable distribution of power. These interactive elements reflect broader social patterns and prepare students for the constant change inherent in today's globalized world Transformative pedagogy involves an engaging and interactive educational process that goes beyond the traditional classroom, utilizing dialogic learning to connect with the wider community. This approach seeks to contextualize contemporary issues as active learning tools, empowering students to respond proactively(Ashraf Salama 2017.). Rooted in real-world realities, transformative pedagogy offers an inductive, collaborative problem-solving alternative to the traditional, deductive domain-knowledge approach. This model encourages students to actively listen, engage in dialogue, take action, and reflect, cultivating well-informed critical thinking and proactive learning. Students are expected to ask thoughtful questions, explore diverse information sources, and take ownership of their

learning and credibility. A transformative curriculum requires students to develop strong information literacy skills, enabling them to effectively search, critically evaluate, contextualize, and apply relevant information to address real-world challenges(Emam, Taha, and ElSayad 2019). Ultimately, this approach fosters a dynamic and engaged learning community, where students collaborate and negotiate meaning with their peers and across different groups.

The study interviewed two participants, engaging them in a dialogue about the methodology employed in the design studio. Their responses were recorded in a format inspired by Ashraf Salama's proposed framework for evaluating transformative pedagogy in contemporary studio teaching. Salama emphasizes the importance of assessing three key domains to understand the success of studio instruction: the Studio Content, Teaching Style, and Design Process. For this research, the participants were provided with these evaluation charts, allowing them to share their perceptions and insights about the design studio experience. The findings reveal that the studio content was structured to foster critical thinking and self-reflection, with an emphasis on contextual and sociocultural factors.

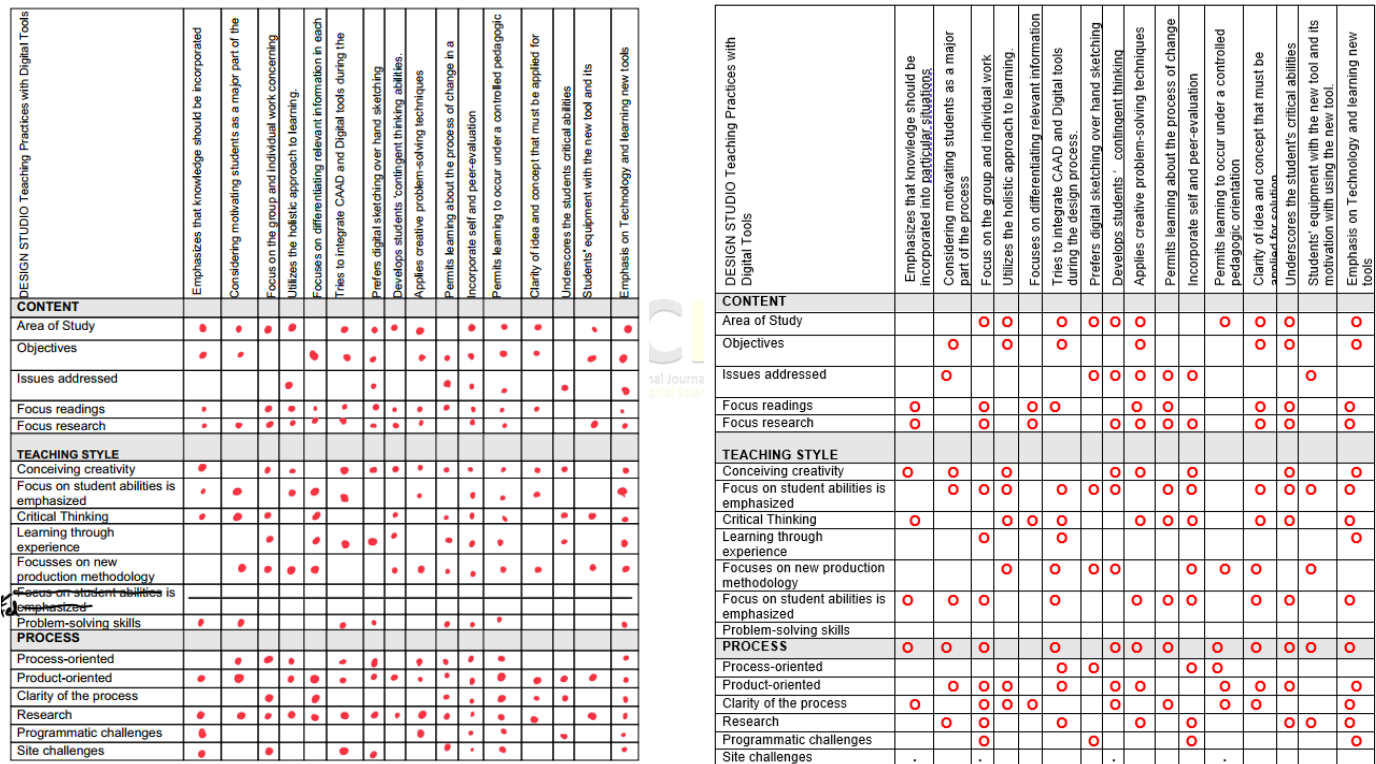and the results are presented in Fig 9.

Fig 9- Perception form: Sameen and Tayyaba (Students)

The matrix organizes content domains, such as Design Process, Critical Thinking, and Presentation Skills," on the vertical axis, and different focal areas, including "Objectives Readings," "Focus on Student Abilities," and "Emphasizing Style," on the horizontal axis. Red dots at the intersections indicate the alignment between content areas and focus areas. For instance, "Design Process" is emphasized across multiple focus areas, highlighting the studio's commitment to developing students' process-oriented competencies. Similarly, "Critical Thinking" receives attention across various content domains, underscoring its significance within the

educational framework. The chart provides insights into the studio's pedagogical priorities, which include the integration of technology and learning tools, the application of creative problem-solving techniques, the importance of clarity in ideas and concepts, the emphasis on students' critical capabilities, and the preference for digital over hand sketching. This suggests that students' learning curve and engagement have been enhanced after going through this studio process.

Discussion and Conclusion:

Learning outcomes of this studio offered a unique opportunity to explore the transformative potential of contemporary digital tools, particularly Rhino and Grasshopper, in seamlessly incorporating calligraphic elements into architectural design(Zarei 2012). These tools facilitated an iterative and exploratory approach to design, enabling students to experiment with form, structure, and ornamentation in ways that were previously inaccessible. Through hands-on engagement with Rhino and Grasshopper, students unlocked new avenues for creative expression and innovation, transcending the boundaries of traditional architectural practice. Moreover, In the studio environment where the learning is based more on explorations and experimentations rather than dictated methods, students can leverage their modeling capabilities to explore the form and structure of architectural elements by manipulating digital geometry with precision and flexibility. In both the projects students can translate the fluidity and elegance of calligraphic strokes into three-dimensional architectural components.

The design process facilitated by Rhino and Grasshopper enables students to refine their concepts iteratively, responding to feedback, constraints, and contextual considerations(Pektaş 2007). By iterating through multiple design iterations, students can explore alternative design solutions and evaluate their spatial and aesthetic implications(Soliman, 2019). This iterative

approach fosters a culture of experimentation and innovation, empowering students to push the boundaries of architectural expression.

Another important learning outcome of this studio includes cross-disciplinary collaboration and knowledge exchange between students with arts and calligraphy. By collaborating with calligraphers, artists, and technologists, students gain insights into the cultural and technical aspects of calligraphy, enriching their design process with diverse perspectives and methodologies. Moreover, they were self-learning through hands-on experimentation and computational exploration of the software. Through the projects discussed above, students got the opportunity to unlock new possibilities for architectural expression rather than just applying traditional techniques to focus on the product only.

Recommendations:

Looking ahead, further studies can delve into specific cultural contexts, user experiences, sustainability implications, and ethical considerations related to this approach. Comparative analyses, historical examinations, and surveys of building users can provide additional insights into the multifaceted impact of calligraphy-integrated architecture. As technology advances, it is crucial to explore emerging tools and the benefits and challenges of cross-disciplinary collaboration. This new era of designing should be taught at architectural schools in Pakistan from the initial years so that they can implement it in the practical field. The creativity of architects should not be bound to it being in manual only because that was the original method. Time changes and so does the way of doing things, if the method of creating projects changes, it doesn't mean that it is invalid. Complex designing is now achievable with the help of these digital tools where infinite deformability and asymmetry are taken as easy to design. Technology in architecture

is a way to improve bodily limitations and Digital tools should be applied to the field instead of just giving exposure to tools in academics

These tools have greatly increased the effectiveness of the architectural process and have the potential to address important issues such as sustainability(Mohamed and Elias-Ozkan 2019). However, there is a need to better understand the extent to which these tools are being used in practice and the impact they have on the symbolic value of architecture. architecture students are aware of the changes these tools are bringing and are interested in transitioning from manual to digital design methods, but they need a proper system of integration of tools into the curriculum. Additionally, there is a disconnect between the use of digital tools in the field and their integration into academic curricula, which needs to be addressed to fully embrace the trend toward digitalization in the industry(Varinlioglu,2022.). As architectural practice continues to evolve, projects like these serve as testaments to the enduring relevance of artistic heritage in shaping the built environment. Through thoughtful exploration and creative experimentation, the integration of calligraphy into parametric architecture opens up new avenues for architectural expression, redefining the boundaries of aesthetics and purpose in contemporary design.

Limitations:

This research has been restricted to the design studio only as the aim was to experiment and explore the synergy between architecture and calligraphy in a very non-influential way. Students were not very familiar with the software introduced to them, so this created issues of fear and acceptability about using the software among them. Lack of trained supporting staff to help and teach software. Calligraphic art has several domains and requires more time for a novice learner to understand the integrities of this style hence shortage of time.

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