A catalog of Urban Interventions: Investigation through Digital Design Architecture Studio

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Abstratct

This paper discusses the explorations and learning outcomes of an architectural studio conducted with the help of digital and parametric tools. The intention was to find a new studio framework for digital architectural expression, urban form-finding, and unique design methodology. Three different urban areas of Lahore have been selected to study their prevailing problems in detail. Students were then required to provide architectural solutions with the help of digital and parametric tools. Participants in this study were fourth-year architecture students who initiated the research by searching for the existing urban issues with the help of site surveys and interviews. Their creation and exchange of ideas are reinforced by the rules of a design studio within a recurring design-investigation prototype. This paper confers three different interventions in the city and learning outcomes are gathered based on how a student has perceived, taken up the study, and has finally come up with the proposed solution. A fleeting summary is provided of the theoretical part of the studio, in-class design exercises are discussed and the end product is visually illustrated. Outcomes of this study lead to propose a studio framework methodology for introducing digital and parametric tools.

Key Words: Urban interventions, digital design process; parametric tools, digital architecture education

1.   Introduction

Urban spaces in any city are direct reflections of their residents and their design directly impacts the living conditions of their people. The first component of this research-based studio was the study of the relationship between users, architecture, and the succeeding consequences of interactions between them. It necessitated students to dig into the existing urban issues in Lahore and propose solutions with the help of design and digital technology. Three major areas in Lahore were selected namely, Ravi river and Kamran's Baradari, Ichhra, and Liberty market Lahore. The basic reasons to choose these locations are the presence of similar and unattended urban issues ad challenges, their dense population, and traffic. The second major reason was that through this research authors wanted to find out the strategies for up-gradation of the existing environment. The second important component of this studio was an emphasis on digital architecture education, which is the most pertinent contemporary issue in architecture these days. Information Technology in architecture has completely transformed the role of an architect and change the process to design. Innumerable members of the public outside of an architectural education remain somewhat unaware of the various technological advancements, able to be implemented collaboratively within an architectural design methodology [1] Software and hardware are advancing rapidly to a situation where many still believe some systems are entirely futuristic, when in fact they are now becoming a reality [2]. In light of this impacts of merging the digital tools in an architectural studio are analyzed. This research would help the author to propose a framework for the digital design pedagogy by:

a.   Comparing the results of the conventional studios with this one.

b.   These tools are being introduced in a Pakistani architectural school for the first time so student's responses to them will be observed and interviewed.

c.   Teacher's and juror's observation throughout the studio.

The search for new educational frameworks is due to the pedagogically unique impacts of digital design. Various researchers and educators have begun to address the need to integrate digital design in architectural design education investigating various forms of pedagogical agenda [3]. The author has initiated this process in the architectural studio at the University of Engineering and Technology, Lahore Pakistan. The results and its implications of the studio work will be discussed here.

2.   Literature Review

According to Henri Lefebvre, humans create the space in which they make their lives; it is a project shaped by the interest of classes, experts, the grassroots, and other contending forces. Space is not simply inherited from nature or passed on by the dead hand of the past or autonomously determined by the law of spatial geometry as per conventional location theory [4]. Further talking about the philosophy of space Bill Hillier starts his argument by describing a human society as a spatial phenomenon. Space is produced and reproduced through human intentions even if unanticipated consequences also develop and even as space constraints and influences those producing it. "Society must be described in terms of its intrinsic Spatiality and Space must be described in terms of its intrinsic sociality" Relationship between society and space by careful forethought and conscious control of both the physical environment and the spatial form of the society can be made more efficient, pleasurable and supportive of the workings of the society. Spatial order in society is dependent on the different types of social formation just as different types of spatial order require a particular social formation to sustain them. The new theory on urban transformation has called upon all the assumptions which have been explained earlier for instance separation was good for the community, that hierarchization of space was good for relations between groups and that space can only be good for relations between groups. There is no theory which purports to show how a society of its very nature gives itself one form of spatial order rather than another [5]. Furthermore, the second major issue explored in this research is technology interpretation; as technological innovations continue to redefine relations among people, relations of capital and the organization of world economies, education's relationship to technology becomes all the more important. The use of new tools continues to provide excitement and challenges, especially during the past 10 years with the availability of the Internet and the World Wide Web [6]. New research developed that utilizes parametric methodologies within the creation of urban design, ultimately reframing the question and proposing new answers and methods of design thinking [5]. The main objective of this research-based studio is that technology edification consciously cross-examines what gets demarcated as important. It should remain perilous of the relationship between context and education and help novice learners to understand themselves as conversant patrons of technology. Technology education must do more than provide service economy employment and instead be able to nurture the development of professionals who can design, develop, and evaluate a myriad of information technologies. Furthermore, to continue innovation and development, technological fields require people who can use sophisticated hardware and software tools to model, simulate, and solve complex scientific problems. In other words, technology education needs to aim higher [6]. On the other hand, if we talk about the second component of this research the urban interventions: We must note that urban design is not preoccupied only with big things; often it deals with rather small things (such as paving of local streets, planting of trees, regulating signs). It is not a question of scale, but an approach. Large-scale architecture mustn't be automatically urban design; a major difference that urban design is implemented by many people (decision-makers, public and private investors). Also, it is concerned with the processes of transformation, where evolution is inherent. Despite its role in delivering environmental quality and unlike in architecture, there are only a very few 'big names' in UD practice. In part, this is because good UD is unobtrusive, it blends and 'disappears'[6].In this research to resolve existing urban issues in the city three different domains of the learning process were adopted: forming attitudes, collecting information, and developing skills(digital). For installing urban sensitivity to these novice learners all three phases of this process are tested and emphasized. A major trial of this research experiment was to develop a curricular content that will prepare future architects to the sensitivity of the context – to better recognize the issues and opportunities that exist in cities; and – to empower them to design positive interventions to improve existing public areas of the city. Each of these teaching strategies acted as a vital part of the design process. They spoke and articulated certain aspects of design development. A holistic discussion about design, form, function, and development was recognized, which is significant not only within an architectural studio, but it also helped in evolving teaching style for the instructors as well.

3.   Studio Methodology

To elaborate on the digital design methodology in the studio and to understand that how it differs from traditional design approaches, three projects and sites will be discussed here that helps to describe the theoretical mechanisms and set of instructions provided to the students. Students were introduced to digital tools (Rhino, Grasshopper, and Para Cloud Gem population) taught through class exercises and lectures. The aim was to make them internalized the techniques, and

once they appreciate their worth, hopefully, they will use them appropriately. Although, there have been many cases where students have used these techniques casually, mainly because they have not been introduced to digital theory earlier. The studio is structured as a weekly lecture and demonstration of about one and a half hours on how to handle digital software and tools followed by a studio of three to four hours in the department's computer lab. It was established that students are already acquainted with three-dimensional computer tools (3D max). The method taught to them involved hand-in-hand teaching of digital software techniques. One of the unique learning outcomes of this studio is the design of modules that can be assembled/clustered/aggregated to form a larger spatial component. The emphasis was laid on a design of a module-derived from the research that was conducted and it is then populated into differentiated component systems shown in Fig 1a and 1b.
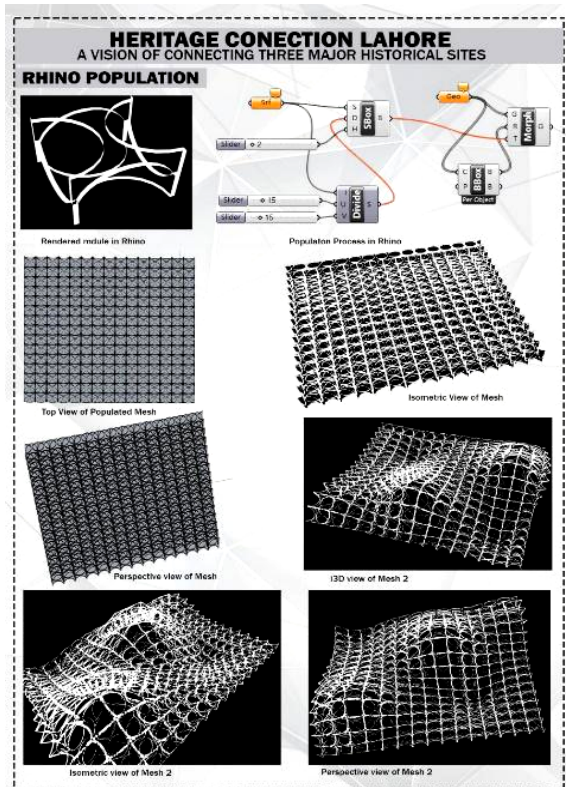

Fig. 1 a: Component population on Para Cloud Gem

The other very pertinent section of this studio focused on the understanding of parametric design perceptions and the learning of skills for a design evolution process that allows parametric and rule-based three-dimensional design. Participants were trained intensively during studio-time for the use of
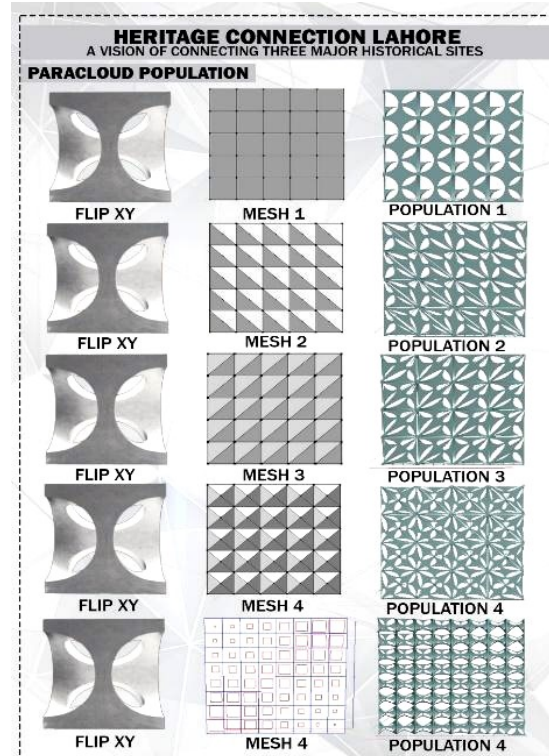

Fig. 1 b: Population on Rhino (Grasshopper)

Grasshopper (Rhino) and ParaCloud Gem. This simple yet technical soft-ware and modeler applications allow users to not only create three-dimensional models but also establish aesthetically pleasing facades for their creative proposals in the city. It allows visualizing and modeling of highly complex forms that may offspring from non-traditional design-data, such as noise-data or pedestrian flow. Students used their own parametric and design data collected with the help of surveys and questionnaires and subsequently applied the use and handling of this new software for the development of the parametric and generative design. After three weeks of interactive studio training, the students reached an advanced level of skills that enabled them to use digital tools in the development of their design. The module is populated with Grasshopper (Rhino Plugin) and Para Cloud Gem with varied configurations. This exercise introduces and developed initial parametric thinking skills among students: the course is based on the understanding that solid hands-on experience in digital software techniques goes together with design strategies. There was a total of thirty-five students in the studio. Three different sites were introduced to the students and selection of the site was optional and on personal choices. Almost more than ten students were researching on one site for basic data collection and interviews. The basic aim was to gather as much information as possible for a better understanding

of the area. Only these three projects are discussed here, the selection criteria were based on:

- These projects are illustrating the step-by-step research and design process, the rest of the project's complete process was missing.

- The architectural solutions of these projects were much more intriguing and interesting.

- These projects are depicting the abstract and metaphorical transformation of research into an urban challenge.

- Lastly, extensive use of digital software and the plugins can be seen in these three cases as compared to other projects.

4.   Intervention1: Liberty Market Lahore

The research started with the site surveys and interviews of the users at one of the very populated and depleted liberty markets of Lahore. Liberty 'U' shape market is composed of 36 plots in total. These plots vary in size and were originally proposed as the first commercial area of Liberty. At present these plots have been further divided. It provides a variety of services. These plazas vary in height and purpose. There is a 50 feet wide walking corridor that clenches myriad activities other than walking. Major activities include eating, shopping along with stalls, and for some people sitting in a park for mere time pass and relaxation. The main aim of this

exercise was to develop a curricular content that will prepare future architects to better understand the challenges and opportunities that exist in cities and to enable them to identify positive interventions to improve public places. To achieve this student was a case study analysis has been conducted that helped in enhancing critical thinking about urban spaces. This particular student identified the major problems in the market area and enlisted them to develop an outline of constraints for their design exploration. This student identified three major issues in the Liberty market after rigorous site surveys and interviews with the users. No proper placement of various stalls (food, clothes, and jewelry) was witnessed which leads to circulation issues on the public aisle. Properly designed stands were required for these stalls. The second important issue was the non-availability of shaded areas for people to enjoy the food from these stalls. Moreover, these stalls were found to consume space for circulation and pedestrian movement and the throwing of waste on the roads which is one of the leading causes of pollution there. There are

interactive spots available all around the market but these are not maintained properly and hence are problematic.

Fig. 2 a: Diagrams showing Stalls placement. Source: Hafsa Ahmad (student)

Fig. 2 b: Stalls and circulation linkages. Source: Hafsa Ahmad (student)

Fig. 2 c: Staff parking. Source: Hafsa Ahmad (student)

Another problem was the staff parking which is located within the walking aisle and shopkeepers do not utilize the parking area. This causes a problem to the user while shopping because of various circulation issues. The central landscape is currently not being used properly because of a lack of proper design. There is no activity or sitting spaces or pavilions to attract the attention of users to this huge area Fig 3a and b.

To address these issues inspiration was taken from the concept of the magnetic field as the stalls were acting as a magnet that attracts people. The student decided to create a push and pull situation through design. For module design, different patterns of a field generated by a magnet were studied Fig 4c. The main design was generated keeping the following constraints in mind.

- People get attracted to stalls that have a good quality of products and food.

- Stalls are placed at multiple points creating multiple spaces within the aisle

- Forces of attraction and repulsion exist in between opposite and same kinds of stalls respectively. People wander from one stall to another stall and they form various movement pattern creating

The magnetic field seeks the path of least resistance between opposite magnetic poles. In a single bar magnet, as shown in Fig 4(a), they attempt to form closed loops from pole to pole. They never cross one another. Opposite poles attract each other and like pole repel each other. Considering these characteristics, the overall form and module design has been perceived. The form of the stall has been derived from the concept of magnet field and keeping in mind the constraints at a site (Fig 4 b). Grasshopper a plugin in Rhino has been used to design these parametric stalls all over the market (Fig 5b). Different parameters are set on grasshopper for parametric bench depicting multiple magnetic lines from the concept. The bench geometry is transformable depending upon the desired look and design.

Fig. 3 a: Existing aerial view of the liberty market

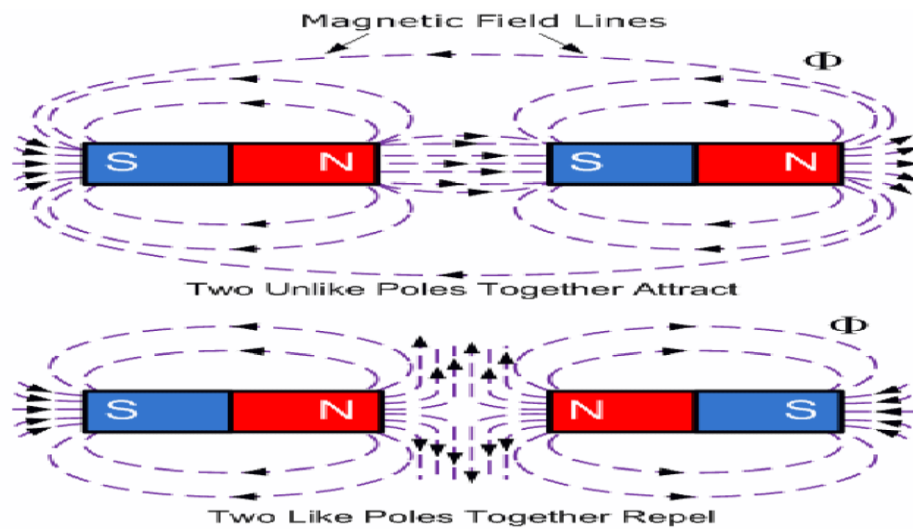**Fig. 3 b:** Stall situation at liberty market

Fig. 4 a: Magnetism attempting to form closed loops from pole to pole. Source: Hafsa Ahmad (student)
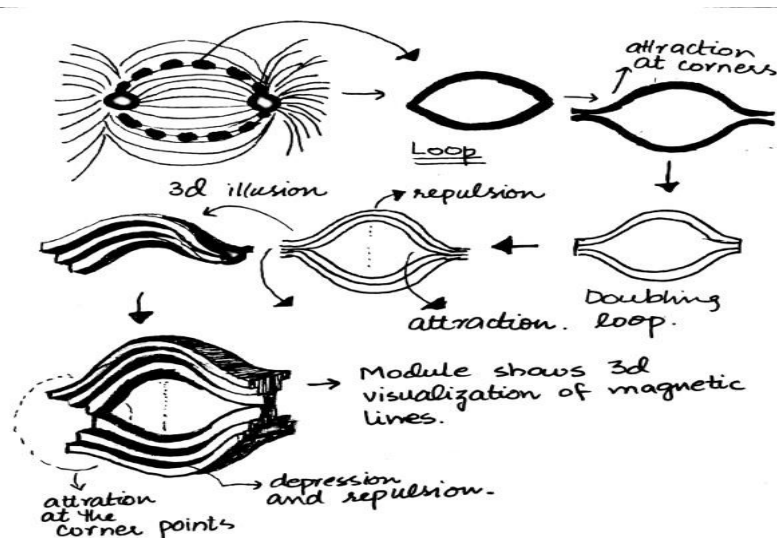

Fig. 4 b: Process of module derivation. Source: Hafsa Ahmad (student)
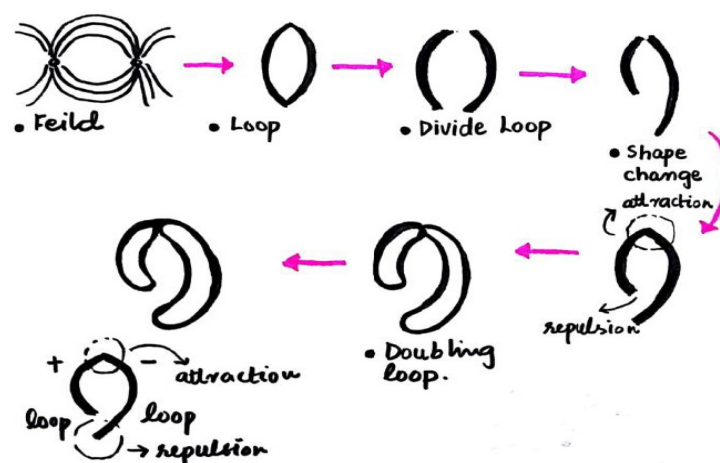

Fig. 4 c: Process of module derivation. Source: Hafsa Ahmad (student)

The first-class assignment was a series of hand sketches incorporating site constraints and user requirements at the site. The second being the design of a module based on any research area of their choice. The purpose of designing a module by adding a concept to the project is to learn how to narrow down the bigger research into a smaller component i.e., module in a simple way. The next submission was a design proposal to resolve the issues already identified at the site. It was meant for a formal mid-term review, which provided an opportunity for feedback not only on digital strategies but also on a design evolution from critics that are not necessarily familiar with the details of digital modeling and tools. Submissions after midterm included model, four posters, and final renderings. These deadlines made sure to pace the class for the final presentation and jury. It also helps to discourage work that was attempted the night before the jury.

5. Intervention II: Ichra Market Lahore

Ichra Market Lahore started as a small shopping zone surrounded by residential areas. Gradually the market grew and got sub-divided into various bazaars; each offering a variety of particular household products. The market got developed to include a definite entrance into 24 feet wide main 'Ichra Road' which subdivides into narrower streets moving on. Currently, the market is divided into smaller zones based on the type of items they sell and the period in which they were developed.

Fig. 5 a: Proposal for the different stall placement around liberty market. Source: Hafsa Ahmad

Fig. 5 b: Grasshopper function used to design stalls. Source: Hafsa Ahmad

As you enter it and start looking for items you tend to buy, you kind of get confused and seem to be entering the same alley again and again. The problems identified by this student were as follows:

- There are scattered food points throughout the bazaar that are located within un-named, narrow streets.

- These food stalls not only disturb the customers shopping in their vicinity but also create a problem of unmanaged food waste and are exposed to vehicular pollution.

- There are hardly any proper seating areas for the customers to sit and eat.

The existing concept of a Dhaba or eating spot in Ichra is that of a space that appears admits a typical market lane without warning and causes disruption in the flow of people coming in with an aim of shopping. This dhaba breaks the continuity of a function. The existing food spot thus can be said to be a parasite to the typical market street. It takes the structure as a home and brings in a function of its own. The concept proposed tends to reimagine this concept of a parasite space and use it in a modified way. The structure itself will be a parasite to the existing facades. It will bring the parasitic function of the food stalls to one spot and translate this concept into a form that will become a parasite, taking its structure as support to generate a function of its own. Taking into view the fact that the structure for the sitting space will be attached to the existing building, a pattern was derived from the idea of different flavors one feels when food enters the mouth this led to several interesting sketches to reach a final one. All four flavours were placed together to figure out the concentration areas of each flavour on the tongue. Each flavour that we consume impact the tongue differently and each one has a specific concentration point. Four modules (sweet, sour, salty and bitter) have been designed by mapping the concentrations on the tongue and the pattern created is adopted to design the placement of the module on the façade Fig. 6.
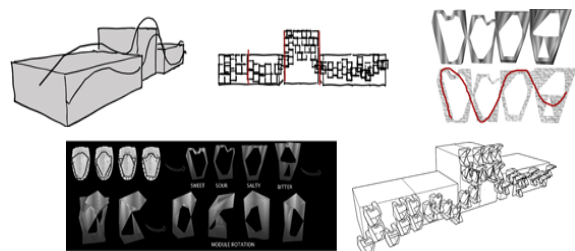

Fig. 6: Module application and Module derivation process by studying the concentration of flavours on tongue. Source: Aqsa shafique

For the population in Paracloud gem, the module was taken in different views and populated on the mesh to obtain different outputs Fig 7(a). Other than that a surface for the population was created in Rhino and using that surface as a platform the module was repeated on it. The function used enclosed the module in a box and this box was fitted in each square of the grid on the surface, creating a populated surface. The final form devised the pattern and brought it on top of the pods as a covering from the street and to avoid pollution the placement of the pods on the façade not only provides an opportunity to overlook the bazaar street while enjoying food, just like in the traditional dhaba. The planning was done keeping in view the type of pods that will be generated. The pods will have three different types of functions: Private pods, Public pods, and Staircase pods. Private pods are located on the second level of the structure and are placed there so that they are segregated from the passage of the public from one pod to another. Public pods are located on the first level of the structure and are spaces designed for shared sitting. These pods allow people to pass through them to go into another pod. These pods are mostly interconnected. They have raised floor sitting with a central table that encourages combine sitting. Staircase pods contain stairs that will take a person from a public pod to a private pod i.e., from level one to level two and then finally to the rooftop. Three-level plans were designed at level 1, level 2, and level 3 Fig8 (from left to right). Level one contains all the public pods and the staircase pods whereas level 2 has all the private pods where the passing crowd will not disturb the people sitting in it. The third level contains the rooftop sitting and the walkway. The rooftop on the right leads to the interior sitting plan on the ground floor. The structure is attached to the building façade; therefore, it has certain layers that combine to form the final form Fig (b). The structure consists of three layers: The existing building, the attached pods, and the final parametric mesh. Each pod consists of some layers that combine to form the final output and helps it become more durable and attach well to the façade. The project included plans, sections, elevations, section-perspectives, and renderings as a by-product resulting from the three-dimensional model developed during the design evolution. The proposal involved the placement of different modules on the existing facades as an interesting intervention in the market.
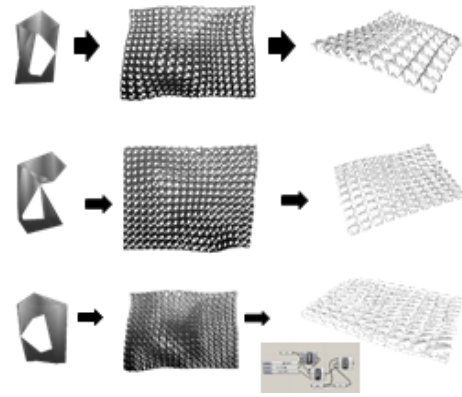

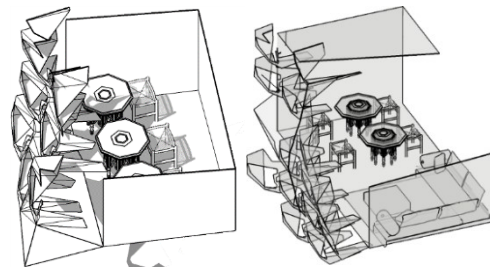**Fig. 7a:** Population of the modules on ParaCloud Gem and Grasshopper Source: Aqsa Shafique

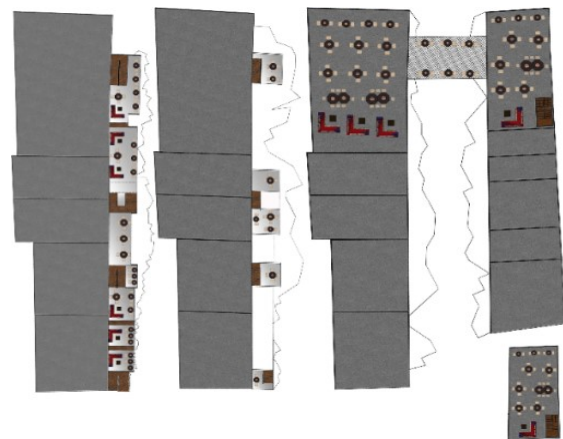**Fig. 7 b:** Different type of pods. Source: Aqsa Shafique

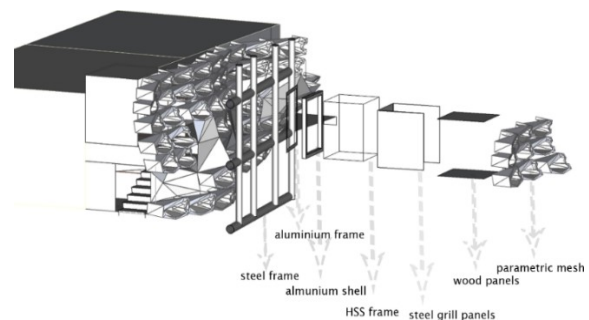**Fig. 8 a:** Plans at three levels. Source: Aqsa shafique

Fig. 8 b: Structural study. Source: Aqsa shafique

6. Intervention III: River Ravi and Kamran's Baradari

River Ravi and its surrounding is the entryway to the city of Lahore. One of the main access to the city through the national highway with a view of Kamran's Bara Dari but what one witnesses are slums and garbage sprawling all over. Being the river around which the city grew, it was a site worth developing. The factors that made it unpleasant were mainly the slums and the accumulated garbage. This unpleasantness was taken as a target and the project is proposed to turn the area into a wander through the design proposal. Looking at these issues, the project that was taken up by this student was an interactive Detailed climatic and site research was conducted and results were presented during the mid-jury.

The concept of a module is inspired by the interesting structure of flavobacteria- a bacteria that lives on the water and has no color in itself. The module is designed by looking at the arrangement of bacterial elements. These rods like structures are stacked in layers and tend to be organically set along with each other. The module is designed by mimicking the organically placed lines and then twisted them to form layers which would then be placed along with each other in a bacterial manner. Structural coloration is the production of colors by microscopically structured surfaces fine enough to interfere with visible light, sometimes in combination with pigments. The interference, in this case, is caused by a diffraction grating which is exhibited below using a module. The twist in the module can be decreased and increased. The structure plays with colors and reflects the wavelength of its lights to determine the color it will be to the human eye. The structural arrangement inside the bacteria is so pavilion for the city. Detailed climatic and site research was conducted and results were presented during the mid-jury. The concept of a module is inspired by the interesting structure of flavobacteria- a bacteria that lives on the water and has no color in itself. The module is designed by looking at the arrangement of bacterial elements. These rods like structures are stacked in layers and tend to be organically set along with each other. The module is designed by mimicking the organically placed lines and then twisted them to form layers which would then be placed along with each other in a bacterial manner. Structural coloration is the production of colors by microscopically structured surfaces fine enough to interfere with visible light, sometimes in combination with pigments. The interference, in this case, is caused by a diffraction grating which is exhibited below using a module. The twist in the
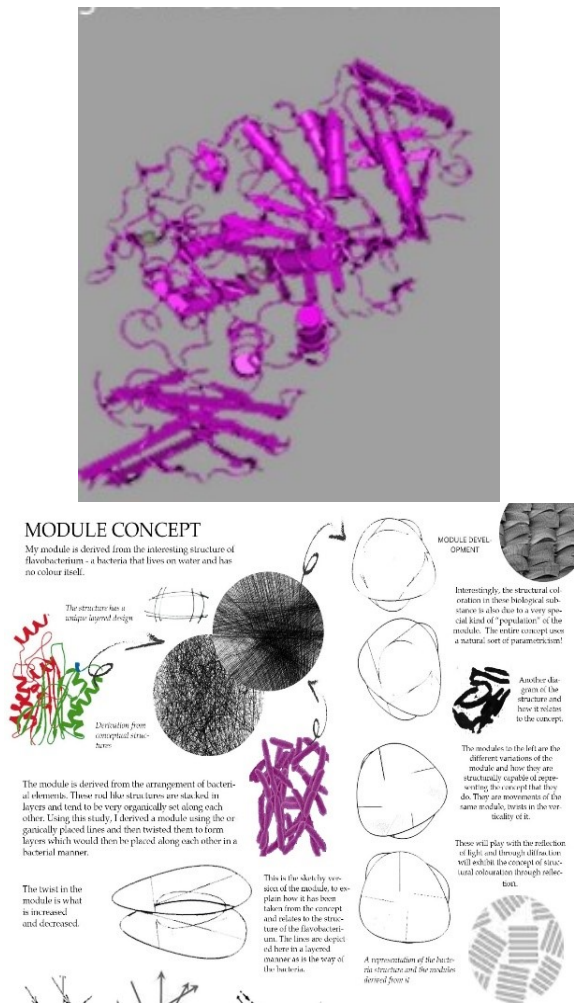

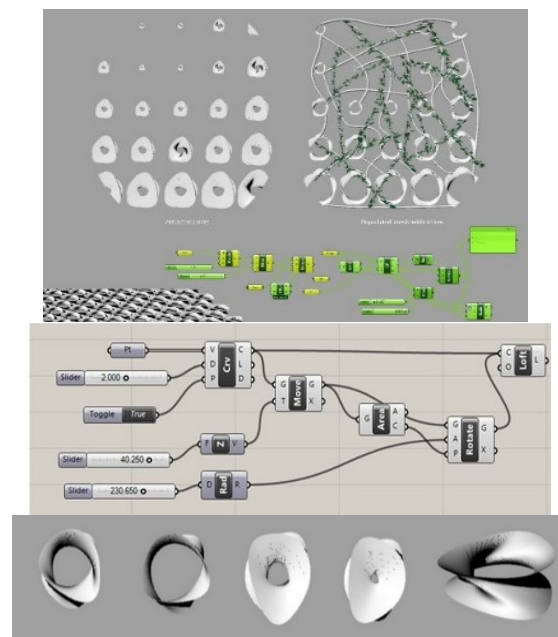**Fig. 9 a:** Module concept/research. Source: Mahnoor Fatima

Fig. 9 b: Module population and its variations. Source: Mahnoor Fatima

module can be decreased and increased. The structure plays with colors and reflects the wavelength of its lights to determine the color it will be to the human eye. The structural arrangement inside the bacteria is so complex that reflects light off differently. In different areas, creating several different colors at the same time. The population done on the facade will have all four kinds of modules and they will be integrated to form a mixture using attractor points. The modules will be placed according to the amount of view given and the water levels needed to be shown. The meshes below show the different ways the modules are populated as the tunnel winds its way through the different curves as shown in Fig9a and 9b. The proposed building pavilion opens with step well-like stairs leading the visitor down the levels. These levels will slowly go in deeper into the river as the water level ends and the surface beneath the water begins. The water level varies between 4 and 10 feet for the location and hence is not very deep. As the stairs go under the river, a mazelike area was designed. These tunnel-like windings will lead the visitor through various exhibits. The entire pavilion either surfaces or goes below water according to the kind of activity that takes place inside Fig10a and 10b.
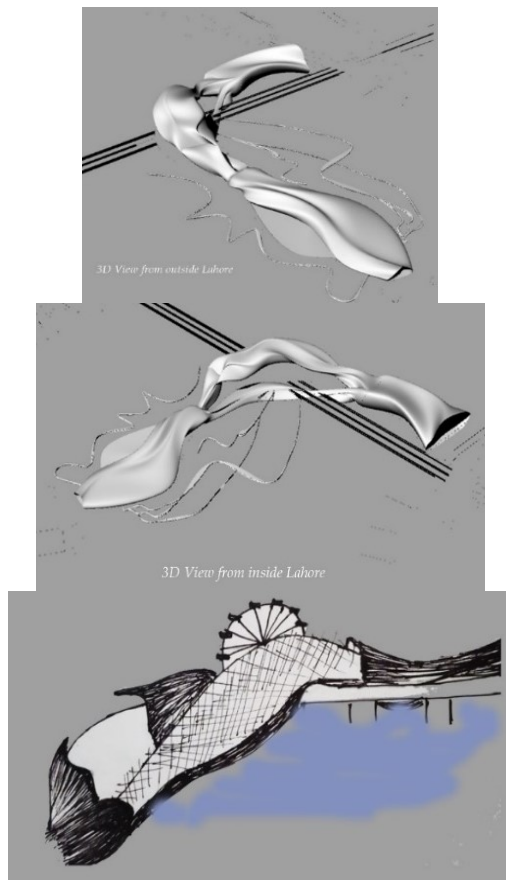

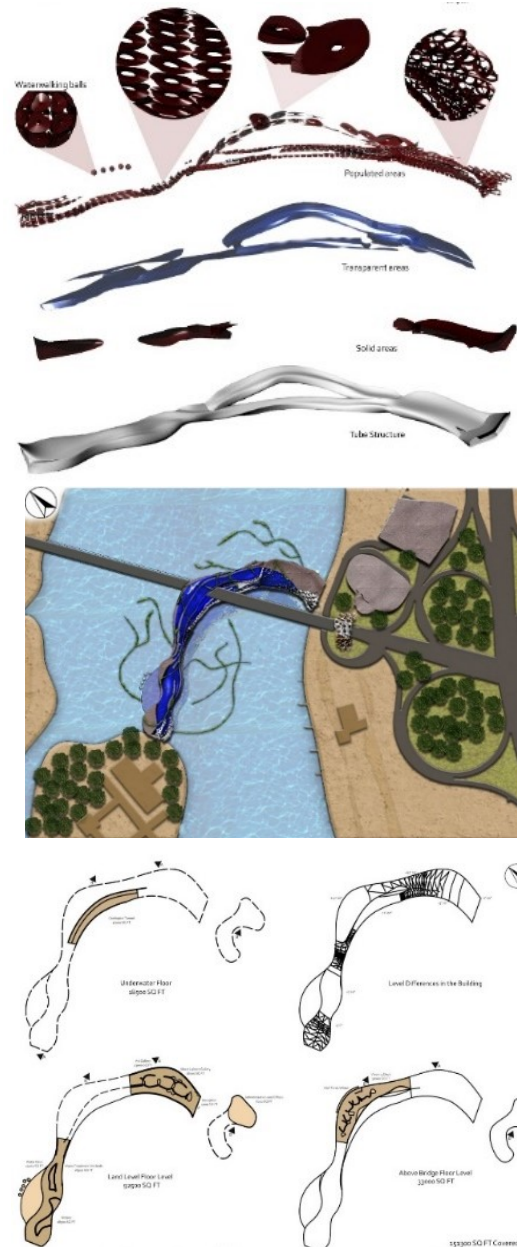**Fig. 10 a:** Design development Process. Source: Mahnoor Fatima

Fig. 10 b: Final 3d and plans. Source: Mahnoor Fatima

7.   Discussion and Analysis

The learning outcomes of this studio experimentation can be defined with the help of three major components. The first component included the collection and understanding of facts that are collected from the site. This went beyond the traditional 'site-analysis' and required students to relate data and dig interests in the site problems. Students were asked to explore the issues and problems that they think should be resolved immediately. Most of them did develop the questionnaires and conducted site surveys and interviews to explore the issues in depth. These parameters not only informed about the site but also

allowed a description of the site based on dependencies and interconnected relationships of users and needed transformation. This component concluded after two weeks with presentations of data, parameters, and distinct interpretations of the site. Throughout the semester, research via experimentation was conducted with digital tools and is critically reflected upon the viability of a vast range of evolving digital design tools available. Parametric systems differ from traditional systems of digital design for maintaining the ability of the model to change during the entire design process and to allow for generating and testing a large number of versions within a controlled environment designed from a simple change of a specific parameter value. They are really powerful computational tools such as Generative Components (GC) and Digital Project (DP) as well as Maya Mel Script and Rhino Script, among others, that allow the parametric modeling via script (SILVA & AMORIM, 2010). The end product of this exercise proved that the dynamic implementation of evolving tools can create complexity and richness of a design outcome. Experimentation and exploration of digital tools define the second outcome. The attempt to reach an optimal pedagogical strategy was both enriched and complicated by the constant change due to the lack of ability to use digital software to their fullest capacity and the use of simulations was hardly tried. Still, it was possible to draw some useful conclusions. With the help of online tutorials and class lectures, students have mastered themselves in the grasshopper population of their component. The third component of the learning outcomes concentrated on the design creation and reflection of urban design proposals, which was worked on for approximately ten weeks. By using the facts from the first component and the skills of the second the students started to establish and visualize their design proposals that created spatial expressions of their findings and explorations. However, the studio was grounded on improvisation of the built form by creating dependencies and parameters that define the current urban spaces of the selected areas. All three sites explored, were highly challenging urban sites and it involved in-depth study to propose the appropriate design solutions. Other outcomes included student's attention to the relationship of pedestrian-flow, users, and specific attraction at existing urban spaces with their responsive structures. They also considered the influence of light and the need for comfortable outdoor space facilities that relate to user activities within a day keeping in mind the hot weather of Lahore. In the different phases of the studio, the students presented an in-depth cluster of multifaceted design proposals for the given sites. The students revealed a high level of thinking processes that ended in complex design generations. Each student underwrote both, micro and macro scale, to produce a design solution. The plans, sections, elevations, and even structural study were also conducted. Studying design processes allows the architect to explore the benefits and hindrances for certain tools (Wiggins 1989), combining the art of study and practice provides viable inputs and outputs to create a successful design cycle or framework within the architectural design (Schnabel 2004).

8. Conclusions

The projects discussed above had their unique concepts and constraints. The research conducted on these important urban areas of Lahore help developed the understanding that how architecture can play its role in reshaping the community and how good architecture can help resolve the user needs and requirements instead of only being posturing. On the other hand, Digital tools exploration made the student realize that they have learned something new and different. Unfortunately, this time none of the students worked with any simulations, and neither the theories of computer-aided architectural design are incorporated in the projects mainly because it was a novel concept for the students and at times, they seem intimidating. Apart from that, this studio methodology had learning opportunities for the beginners as they were exposed to parametric tools and theories which opened new horizons of thinking for the students.

The major trend which was witnessed amongst students was that due to the pressure of deadlines, few students do shift back to traditional ways of designing two-dimensionally and creating 3-D computer models only for rendering purposes. Other than that, as sustainability was not a categorical requirement of the main studio project students did not incorporate or use plugins like a ladybug. Few students also explored GIS (Geographical Information Systems) for site analysis. It would have been more helpful if the course instructor had been facilitated with a teacher assistant to help students learn the new software as a part of the full-time studio teaching team. Consequently, when difficulties arose, the use of digital tools was sometimes abandoned or highly intermixed. At the same time, others took risks. It was amazing to see some students use Grasshopper for an amazing population of modules. The framework for this studio methodology can be explained with the help of Fig 11.
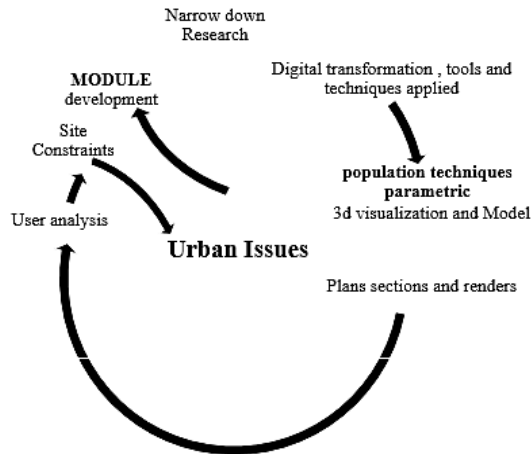
Fig. 11: Framework for the Studio Methodology

Overall, the students seem to like this studio work which is verified by the quality of the work and by their appreciation for a design methodology that was new and interesting for them. It is likely that with closer integration of the digital tools and its monitoring the outcome would have produced even better results. Integration of the software's learning with the studio learning has made it compulsory for the students to explore them which in turn has produced complex design solutions. Several milestones designed for this studio allowed multiple opportunities for feedback. The students produced a variety of individual design proposals as well as one large design-cluster as their overall proposal on the busy site. They created rules and parameters that allowed the generative design to emerge. These highly complex representations, however, cannot be communicated using traditional planning methods or tools.

9. Acknowledgements

10. References

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