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Ambiance and Scale in 5-Microenvironments: A Design-Build Focus Studio

Introduction

The role of digital tools for design representation gradually has become more integrated with full-scale fabrication. There is no reason why the education of architecture would only be limited to design and representation and not embrace construction. With the availability of digital software and hardware, in particular 3D applications in combination with laser cutters, 3D printers, CNC routers, and traditional wood shop, unlimited opportunities are available to explore 'design thinking' and 'visual grammar' along with execution of full-scale physical construct. The concern of safety in construction, as well as duration of completion within a semester's time is now more realistic than before. The objective of this paper is to demonstrate the design, representation, and construction of 5-solar powered functional pods by undergraduate students (3 to 4 students in each group) in an elective design studio within a 12-weeks' time frame.

This studio demonstrated the entirety of a design process from conception to execution using both manual and digital methods to embrace the notions of three-dimensional design thinking, visualization of details, graphic motif, composition of space-form-material-light, use of proper digital tools, calculated budget, and methods of full-scale construction.

Design and construction of a Mini Pod with specified ambiance and function for human use being the main project the studio also asked for construction of a number of artifacts that complements the final Pod and creates a new ambience of the created environment.

Considering the fact that architecture is as much a science as an art, this paper aims at linking and visually applying both arts and science in a full-scale construction of microenvironment (functional pod).

The paper highlights the "Sensory Pod" (one of the 5) designed and constructed by the studio in its entirety, from perception to execution. The concept was to design an ambiance to reduce stress levels through the simulation of five senses, touch, vision, hearing, smell, and taste.

It is to be noted that the scope of the studio was limited only to design and construction and not on follow-up evaluation of its use or effectiveness.

Focus Studio and Design-Build

The Fifth-Year Focus Studios are intended to introduce the student to design research and its application, while adhering to creativity, critical thinking, processes of making, and constructability……All qualified fifth year students have the option to select a studio critic who will broaden their area of interest in a subject-based studio.

DIY vs. Structured Learning in a Design-Build Studio

The effective education comes from experience, be it in architecture or in other professional fields. To define active interactive learning, it can be said that it is a condition in which the course of learning is controlled by the learner. Such conditions may result from the user's action as well as reaction to the environment the learner is dealing with. It has been proven by experiment that people find it easier to learn and remember knowledge visually, and that information stays in that person's memory longer if it is obtained by the learner actively reaching out for and manipulating it rather than fed passively.

DIY is an abbreviation of "do-it-yourself" from 1950s. In architecture it primarily means an activity of construction done by oneself, as a non-specialist or by a person without relevant professional qualifications. While a DIY is the foundation of getting ready to disseminate that knowledge, a design-build formal teaching must be a structured learning and not a random one that leaves room for uncertainty. To test the extents and limitations in a possible design-build studio offering, a 6' cubic garden pod powered by solar energy was solely constructed by the author before creating structured content for this studio (figure 1).

Figure 1: A cubic garden pod powered by solar energy solely constructed by one person, the author of this paper.
Source: Author

Subject of this Focus Studio

This course focuses on creating an ambiance through the design and construction of a functional personal pod that uses sun and wind energy for its primary function. Creating artifacts using motifs of art and applied graphics to create the desired ambience for the pod was an optional task of this studio. The main goal of this course was to explore the link between art and science for creating micro-living environment (figure 2). The four main components of this studio were:

- Arts and Science in Architecture
- Ambiance and Scale
- Functional Microenvironment (self-sustained and solar powered)
- Design process and design-build

Art and Science in Architecture

The Arts of Design-Build

One of the objectives of this studio was to investigate the relationships between art, science and design-build. The basic questions along this inquiry included;

- Defining co-relationship between art, graphics, visual design principles, and architecture
- Defining Art, Science, and Architecture
- Elements and Principles of Visual Design
- Applied Visual Graphics (Geometry and Pattern)
- Texture: Visual and Tactile
- Surface exploration with graphic pattern and texture

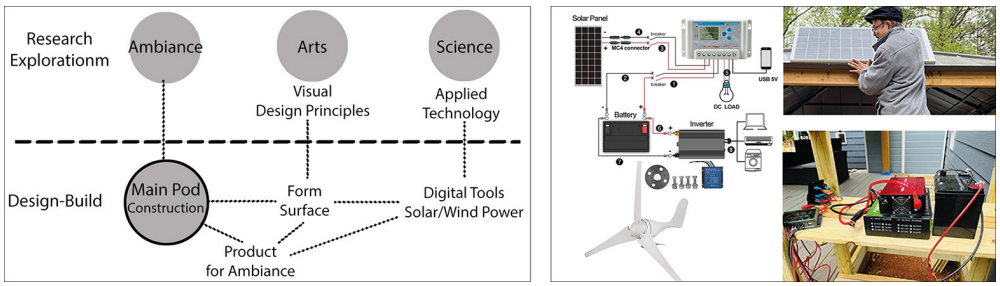

Figure 2: Diagram illustrating arts and science of design-build (left half) and demonstration of 12-volt solar power system components by the instructor.

Source: Author

Art is defined as a highly diverse range of human activities engaged in creating visual, auditory, or performed artifacts, artworks, that express the author's imaginative or technical skill, and are intended to be appreciated for their beauty or emotional power. "Art can employ skill and imagination to produce objects, performances, convey insights and experiences, and construct new environments and spaces."

As an act of art this studio project looked at surface as its canvas to integrate various elements and principles of visual arts to create graphics, texture and pattern.

Students were asked to define "Surface" in physical entities and in architecture. Research and documentation of main categories of surfaces with their physical, visual, and sensual characteristics were to be investigated.

The task was to design, draw, and represent various types of surfaces using principles of visual composition in a 4'x4' surface. This surface could be a single plane, tiled, or modular. The design and construction were intended to express one or more of these visual design principles of Progression, Movement, Gradation, Radiation, Rotation, Anomaly, Contrast, Concentration, Hierarchy, and Focus.

Various combinations of Graphical, Textural, Modular, Porous/Perforated, and Translucent surfaces were to be explored for this segment of studio.

The Science of Design-Build (Applied Science, Technology and Net-Zero)

Science is the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. Modern science is typically divided into three major branches that consist of the natural sc iences (e.g., biology, chemistry, and physics), the social sciences (e.g., economi cs, psychology, and sociology), and the formal sciences (e.g., logic, mathematics, and theoretical computer science), Disciplines that use existing scientific knowledge for practical purposes, such as engineering and medicine, are described as applied sciences.

The technology of energy to run appliances or to control an environmental condition is considered as applied science. To be off-grid and net zero, both solar and wind power are effective sources of applied science through 12-volt systems. While solar system does not need any special considerations (except exposure to sunlight) the wind power system would highly be dependent on velocity of prevailing wind at the location of the wind turbine.

For off-grid power supply the first consideration was the voltage of the power supply based on the function and need. If the purpose is to illuminate the interior space, illuminate reading need, on-screen projection from laptop, recharge a phone, power a laptop, output audio/ music through Bluetooth then a low-voltage power system would be good enough to power individual pods. Since 12v systems are good for many DIY power supplies such as RVs/motorhomes/vans, Camper trailers, Small cabin or tiny home it makes the system versatile and adaptable and safe to work with. For landscape lighting 12 volt is a standard system and various options of LED lights, cable, connectors are readily available to purchase.

The Design-Build Studio

Process

The studio started with the intention of linking proposed construction and creation of ambiance. Additional product design to enhance the intended ambiance was suggested.

Design considerations included a) Volumetric space based on function and ergonomics, b) Interaction with sun, wind, and air through surface articulation, c) Understanding arts and science of micro-environment, and d) Integration of power to run the function of the pod.

Similarly, construction considerations included a) Light-weightiness, b). Cost effectiveness, c) Ease of assembly-disassembly, and d) Quality of surfaces and finishes.

The studio content included five basic premises: a) Research, b) Observation, c) Analysis, d) Synthesis, and d) construction. It starts with the investigation and definition of Ambiance. The purpose was to investigate the relationship of the proposed construction and the quality of Ambiance intended to be created by that construction. Additional product design could be introduced to enhance the intended ambiance. Students were asked to investigate these following items.

- What is Ambience?
- Types of visual and sensory ambience
- Elements of ambiance in drawing, physical model, and 3D rendering
- Purpose and objective of the pod
- Design proposal in orthographic drawing, physical model, and 3D rendering
- Physical objects to be designed and constructed to create ambience, such as artwork, painting, sculpture, wall tile, lighting fixture, dinnerware, time device,

Defining and explaining Ambiance was the beginning of the studio. All 18 students were asked to propose two ideas of proposed structure through scale-drawings, 3d renderings, and physical scale models. Out of 18 proposals 5 are finally selected by votes (figure 3). Then teams of 3 to 4 members were assigned to each proposal for development and full-scale construction.

Surface

Next, students are asked to individually research on "Surface" and its visual and textural qualities. Investigating materials, methods, and techniques to create unique surfaces with texture, pattern, color, and applied graphics was the goal. Graphical, textural, modular, porous/perforated, and translucent surface panels were to be created in panels of tiles by each student.

Structure, Envelope, and Assembly

To understand the primary structure the students were asked to construct a 25% reduced sized physical model to understand the stability and details. Materials of interior, accommodation of battery, wiring, and other systems were also investigated through this model. It was noticeable that most groups were thinking of using unnecessarily heavy material based on their Revit model rather than optimizing the structure. Then they were asked to construct the basic enclosure/envelope in full-scale using low-cost insulation boards to get a good sense of optimized space volume and functional need.

Construction Cost and Funding

Budget was an important consideration which could become a hindrance for design iterations and experimentation. Each group had to research materials and supplies in context to their specific pod design. Each pod started with a construction budget of US $700 primarily for material and equipment. Each group was asked to create a detailed list of itemized materials with web links for purchase options. Based on the accumulated list the instructor raised the limit to $1,000 each requiring a total of $5,000 to construct 5 pods. Consequently, the instructor was successful in securing the total funding from two different sources: about 70% from the competitive Annual Dean's Research Grant and the rest 30% from the Design Communication Association.

Figure 3: Top 5 pod proposals selected for construction based on concept, function, and cost. *Source: Author*

Summary of Constructed 5 Pods and Features of their Microenvironments

Re-Focus (Cost US $ 920): Re-focus is intended to be used for studying and other work-related actions. It is an ambiance pod that puts the user into a focused state by nature of its enclosed layout. The entirety of the pod is only three feet by four feet at its base, stretching up to 7 foot six inches at its tallest on the roller casters.

The Plex Pod (Cost US $ 1247): The main feature is a collapsible structure that allows contraction and expansion of the design. This allows for a difference in size based on the number of users and ease of transportation. The construction is made of dowels and different types of 3d printed connectors.

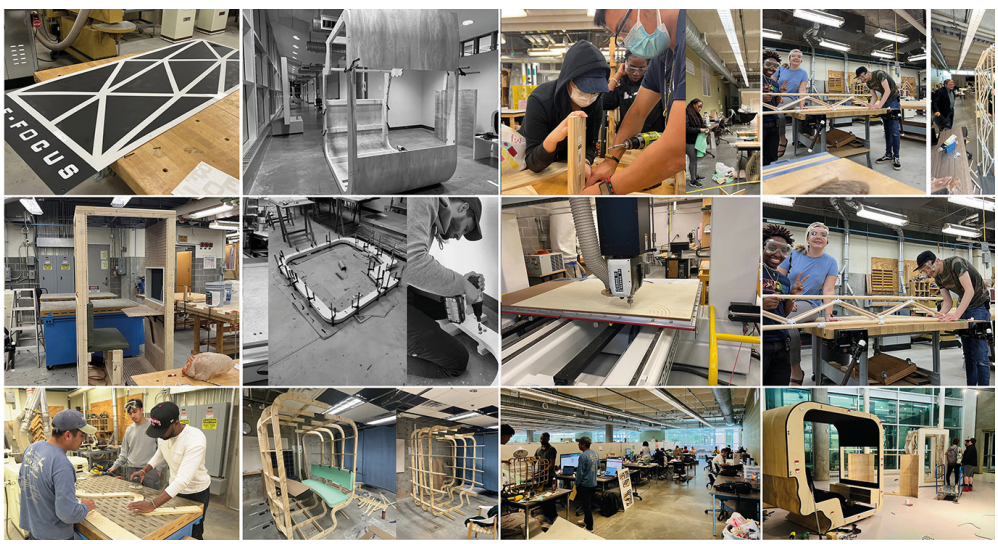

Figure 4: Construction phase illustrating techniques and methods of construction by five groups. Source:Author

FILTR. a sensory pod (Cost US $ 884.93): The purpose of the Sensory Pod (figure 6) is to provide personalized comfort through aimed sensory stimulation. The design incorporated a projector that will have a chosen audio and video, according to

people's mood. Textures to experience vary of feelings through touch, and a scents diffuser to go along with the desired ambiance.

The Zen Pod (US $ 744): The Zen Pod reconnects one's mind, soul, and body. Zen is defined by the state of calm attentiveness in which one's actions are guided by intuition, like meditation and yoga. The form is an enclosed diamond shape that represents direction. The direction to take within oneself.

The Work in Progress Pod (Cost US $ 1100): The concept of the Work In Progress Pod is drawn from a desire to meet the needs of students to disconnect from the surrounding environment to enable them to develop a higher level of focus. While the purpose of the pod is to spur a higher of focus the overall function of the pod is an adaptable space that allows inhabitants to be flexible enough to engage in a variety of activities.

Explanation of "FILTR. a Sensory Pod"

Statement by students:

> The purpose of the Sensory Pod is to provide personalized comfort through aimed sensory stimulation. In our design, we incorporated a projector that will have a chosen audio, according to people's mood, and at the same time will be showing a video or series of images, and this brings us to the second sensory, vision. Studies show that the mind reacts to what it sees, based on a level of physical association. With our design, we want to offer people the ability to choose the video and sound to be displayed on a translucent screen that will be projected to the outside for the exterior audience to experience a bit of the interior ambiance. For olfactory sense, is written in history as being directly connected to the memory function of the brain. One's smell is connected to their memory and can be used to influence emotion. Our design provides a diffuser that personalizes the ambiance, which scent could recreate memories or create new ones at the time that visual and audio are being displayed. Touch therapy can have psychological effects on participants. Touching or being touched specifically relates to increased dopamine release. Human-to-human contact has its effects, so how can materiality be used to generate personalized stimulation? Our sensory pod offers different textures to experience different feelings. By combining specific sensory experiences, a mood can be curated for the users of the pod. This concept is commonly used to describe the combination of audio, visual, and tactile stimuli. We will be applying this concept to use olfactory stimulus to achieve gustatory reactions. The pod uses materiality and technology to offer modes of relaxation for the user. In the pod, there is a cavity that houses a projector aimed at an acrylic screen. This acts as a window to create interaction between the inside and outside of the pod.

Framework of Design Concept

The initial proposal started with defining and correlating ambiance and five senses for a space that would relieve stress and can be used for a variety of functions. Transformation of that sensory concept was suggested through the following methods of material use, technology adaptation, space modulation and designed artifacts.

Touch: Wood roller seating for upper, middle, and lower back to relieve muscles.

Vision: Translucent screen that shows the movement of color according to music vibration. Screen to show ambience/mood inside of the pod reflected to the exterior.

Hearing: Music can be played according to people's mood and vibrations will be reflected in colors on the translucent screen.

Smell: Plants with calming scents to be placed near or around translucent screen to provide relaxing ambience while colors play a role in the plants according to type of music.

Taste: Space and fixtures for dining, to keep the ambience calm.

Figure 5: Ambiance, five senses, and features of ambiance.

Source:Author

Perception and Visualization

The project started with a detailed proposal explaining the purpose, function, and construction methods through drawings, 3D renderings, exploded axonometric and a detailed scale model in 3" = 1'-0". Next, students were asked to investigate materials, methods, and techniques to create unique surfaces with texture, pattern, color, and applied graphics.

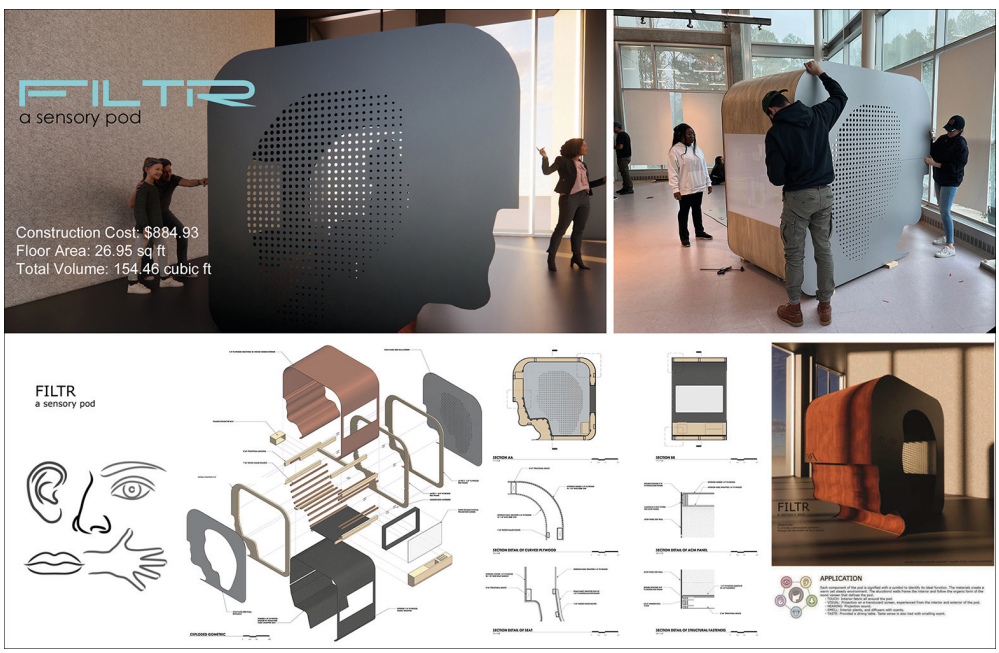

Figure 6: The Sensory Pod proposal with orthographic drawings and a detailed physical model

Source:Author

Scale, Material, Structure, Envelope, Assembly

To understand the scale and structure the students were asked to construct a 25% (3" = 1'-0") reduced sized physical model to understand the structural stability and close-up details. Materials for interior, accommodation for electrical wiring, and other systems were also investigated through this model (figure 7 top row).

For the main structure the two primary profile sides were CNC cut from 2 layers of ¾" plywood and glued together for strength. Then horizontal bracings or studs were then connected with adjustable anchor bolts for easy assembly and disassembly. The organic wrapping envelope using ½" plywood was achieved by scoring and making grooves on the inner side and formed by hot water, glue, and clamps. Once formed in shape and left for a day the shell became stiffened and permanent. This allowed the organic wrapping to be constructed in modules for easy assembly (figure 7 bottom row).

Figure 7 (top row): The development of full-scale construction for structure, envelope, and assembly was based on a 25% reduced scale (3" =1'-0" scale) physical model.
Figure 7 (bottom row): Construction techniques include CNC milled main frame, anchor bolt for horizontal bracing, and scored and grooved plywood for undulated wrapping form.
Source: Author

For exterior finished panels aluminum composite material (ACM) left over from a construction site was used because of its lightweight and sturdiness. A perforated pattern was cut using CNC router. To attach these exterior panels Z-clips were used for easy assembly and achieve clean surface at the exposed area (figure 7 bottom row).

The final pod was equipped with an audiovisual system allowing to use digital devices to charge and project images and videos in its integrated screen that are viewable from both inside and outside (figure 7 and 10). Students were asked to produce a visual logbook illustrating every studio session's progress as part of the final documentation.

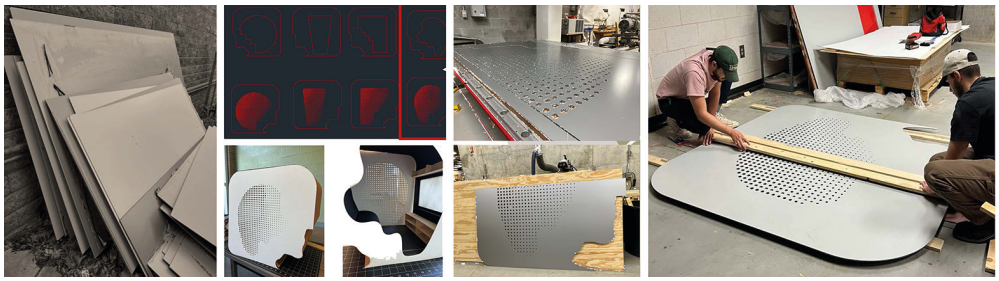

Figure 8: Exterior finished panels from recycled aluminum composite material.

Source Author

Figure 9: Final review showing assembly process and use of the pod by visitors during the curated exhibition.

Source:Author

Observation

In general students are interested in construction and design-build. But they do not necessarily had either the knowledge or the patience to construct a well-crafted construction. For most students' investigation and research were not expected in a design-build studio. The biggest challenge was to motivate students to explore options of unique material, texture, surface and quality of finishes. The sense of scale for initial selection of fixtures was not inspiring.

Some groups were interested in informing the instructor in every step of the work progress, making the communication open to both sides. One such communication on technology test and material cost is sited below.

> "Professor Uddin, Attached is a file we have been using to identify the materials we need and where to find it, each of them have the links. We are planning on starting the real scale model tomorrow, we will work on a more detailed version of the 25% reduced scale model, and we are all in agreement on structure, finishes, and function of the Pod. Also, we tried the projector yesterday and it works perfectly with laptops, androids and iPhones."

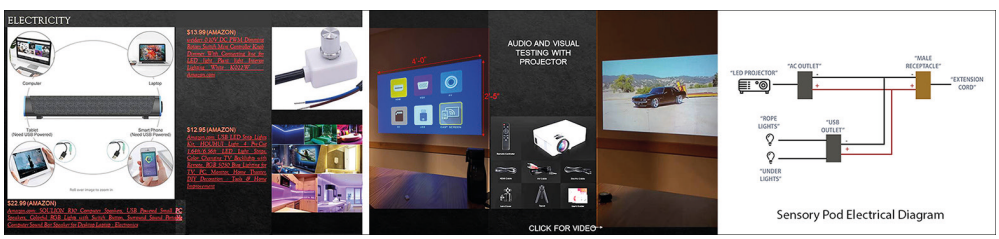

Figure 10: Video-audio test to check projection distance.

Source: Author and Student Andrea

Budget is an important consideration which could become a hindrance for design iterations and experimentation. One group ordered the wrong type of boards incurring additional expenses that the school had to deal with after the semester was over.

In a professional accredited architecture program, a design-build studio must have a balance between investigation, representation, and actual construction.

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