



LEARNING BY DOING:

APPLYING VEGETATED ASSEMBLIES IN ARCHITECTURE STUDIOS

BY KENNETH BLACK

INTRODUCTION

The process of understanding the building envelope is developed in the experiences we have as students and, later, as professionals. Everyone starts from a beginning and uses experience to create a foundation for design, which in turn helps us to form our decisions and ideas. We began as students of our disciplines—in this case, joined by the design and performance of the roof, the wall, and the foundation: the complete building envelope.

The decision-support framework proposed here and tested in an academic architecture studio is a visual graphic for the learning process students could have when working with green (vegetated) roofs or walls. It is the beginning for gaining experience that students can use to bolster their design processes using vegetated assemblies (such as roofs and walls), color theory (colors and how they interact), and plants (in this case, those commercially available in the Blacksburg, Virginia, area). As students become familiar with the framework, they gain a greater understanding of roof, wall, and foundation design considerations.

A PERSONAL RETROSPECTIVE

This process starts as a personal retrospective. It is critically important to understand that opportunity and mentors combine to provide experience. I became involved with building envelopes and their design with Dr. Elizabeth Grant, my advisor and assistant professor at Virginia Tech, through her research involving

stormwater runoff in vegetated roofs. From this introduction of vegetated roofs and with her help, I received two RCI Foundation scholarships to attend RCI International Conventions in Dallas and Orlando to learn more about what being an architect meant in the context of building envelope consultants.

These opportunities showed and reminded me that the building envelope must be more than a line on the page for architects, and that it can be more than simply a protective shell for the interior and its occupants. With the connections that I made at the conferences, I was given the opportunity to work at Oak Ridge National Laboratories using WUFI modeling software before starting my master's program. These experiences combined to solidify my interest in how we teach others and help them to design and construct useful, appropriate building envelopes and interfaces. This process is specific to students, but applicable to anyone interested.

This research stems from being given the opportunity to explore the building envelope through others and then using what I learned to share knowledge with other students who are also interested in the application of vegetation at the building's interface. Students are just beginning their professional careers, and to expose them to building envelope and vegetated assembly projects and all that they offer is paramount in their ability to design projects effectively and to develop professionally.

AREAS OF INQUIRY FOR THE FRAMEWORK IN STUDIO

This research is a series of topics brought together to assist a designer or consultant in conceptualizing a vegetated roof or wall. These include the adaptation of color in the assembly, plant species, building material, and representation. We can begin to use this inquiry as a support for designing a building envelope that contains the variety of colors that nature has to offer. Color is important, as plants often express different colors cyclically throughout the year with their leaves, flowers, and fruit.

Color Theory

Using color theory for vegetated roofs and walls, we can distill the descriptions of the colors we use in our drawings and in figures for clients and other professionals into three main topics:

- **Hue:** a color in the visible light spectrum, ranging from red to violet, which is used to initially describe color¹
- **Saturation:** How vibrant does that color appear to the eye? Color can appear bright or washed-out.¹
- **Value:** This is the amount of black or range of depth, which can either make an image look flat or give it depth.^{2,3}

We use graphics, such as drawings (either by hand or with the computer) to show our ideas to others.⁴⁻⁷

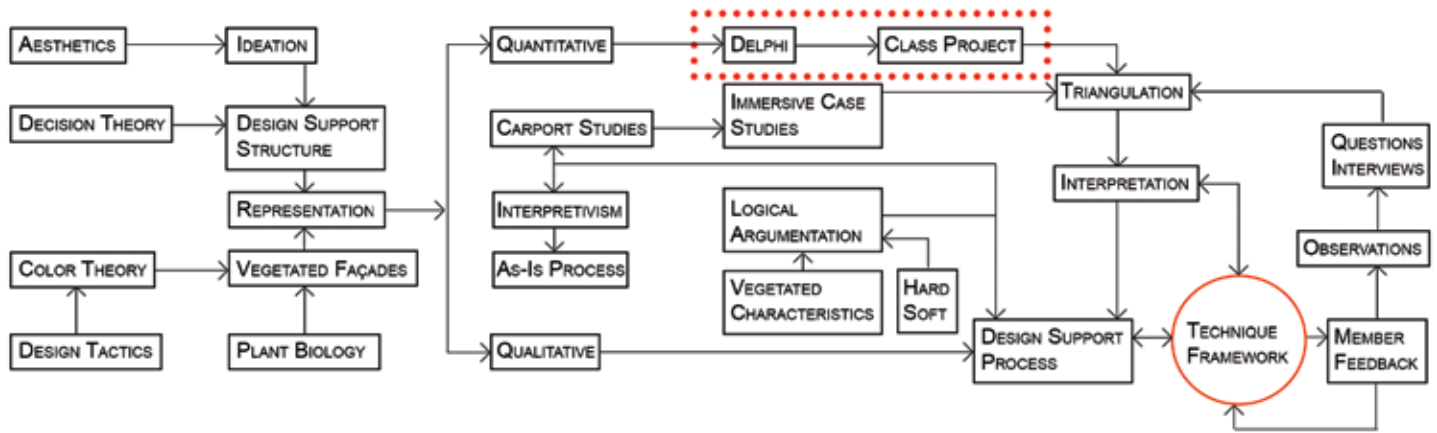


Figure 1 – Theory map for the research and studio methodology; the dotted rectangle shows the work of this study.

Plant Species

Next, we must select plant species for the vegetated roof or wall, considering the following factors:

- **Location:** Species have survival needs, such as hardiness levels and native zones. Is the plant grown commercially in the area?⁸
- **Climbing mechanism:** The building envelope can be adapted to match the climbing mechanism of the plant to the wall; if these are not considered, the system may not work.⁸
- **Time of year:** The color of the plant may change as it goes through its seasonal cycle.

Building Materials

The interaction the plant has with building surface materials is also critical to the design method and the compatibility of the plant, and the assembly is critical to the design. The following aspects of the assembly must be considered:

- **Masonry and nonmasonry walls:** Some kinds of plants can damage mortar over long periods of time.
- **Wood:** Wood can rot under increased moisture from plants near the wall.
- **Assembly surface:** Twining or wrapping vines may not travel effectively over some types of structures.

STARTING THE BASIC VEGETATED ASSEMBLY FRAMEWORK

These design criteria are combined in visual representations (drawings and models) that clients or other professionals can develop, applying further technical knowledge and skills such as color theory, to produce another representation with hand-drawn or computer-assisted graphics.

The work shown further on in this arti-

cle was completed by students in a day-long design studio as part of a larger methodology to verify that this decision-support process is useful to students as they develop into future professionals. Figure 1 shows how the background topics of vegetated assemblies, with the adaptation of color into the assembly (to the far left) combine with performance questions of the building assembly (second column from the left).

This particular part of the methodology,

called a Delphi (shown inside the rectangle in Figure 1), is a small group of “student experts” using methods adapted from Groat and Wang.⁹ The belief is that students would troubleshoot using the framework to determine not only if it proved useful for them, but also if there was something important missing in the design process. Figure 1 is adapted from a presentation made at the Architectural Research Centers Consortium (ARCC 2015).¹⁰

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FRAMEWORK FOR VEGETATED ASSEMBLIES: EXPANDED

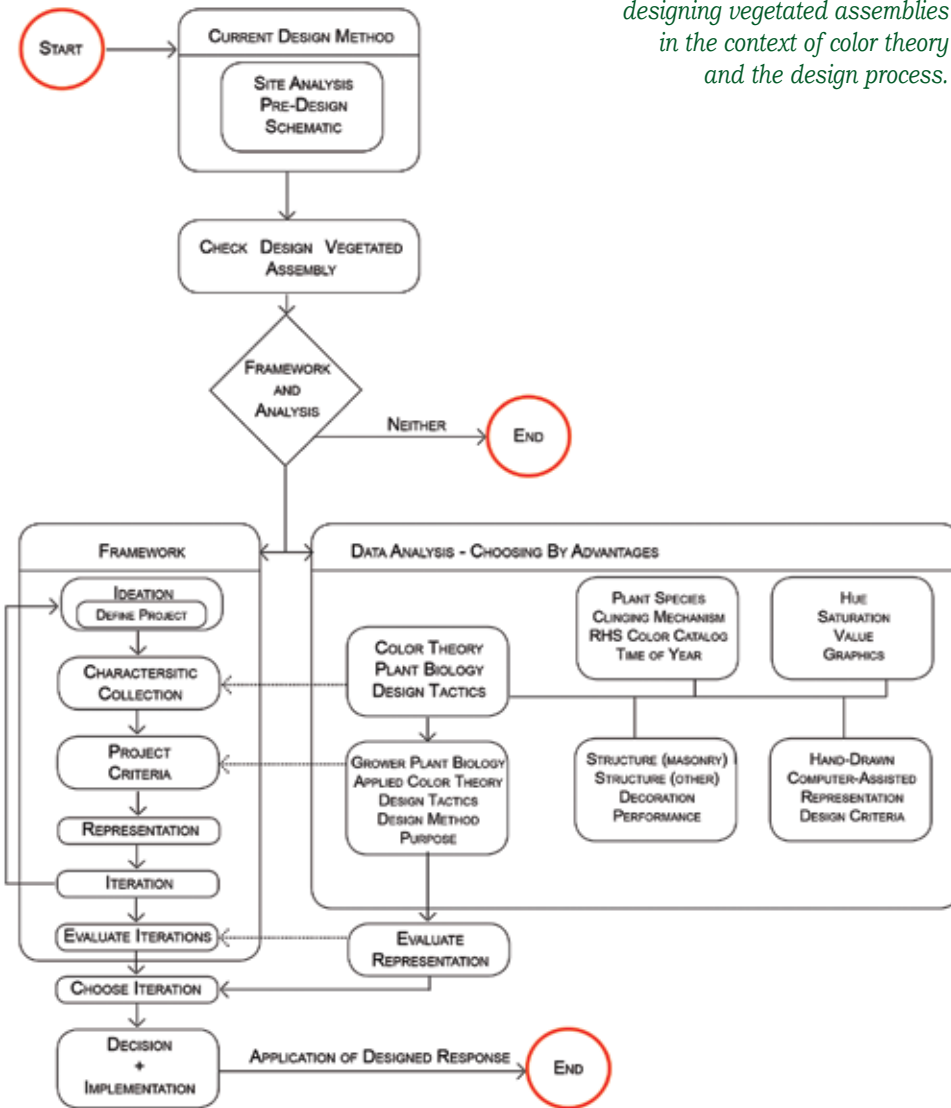
Figure 2 – Framework for designing vegetated assemblies in the context of color theory and the design process.

SPEAKING THE SAME LANGUAGE

From the process of learning how to assist someone in designing a vegetated assembly and studies in determining if developing a framework would be useful to students, a study was devised for student design.¹⁰ It attempts to combine the knowledge of designers and roof consultants in designing a vegetated assembly. It is currently used to collectively address concerns of building envelope performance and aesthetic design using color theory and commercially grown plants available in the Blacksburg, Virginia, area. The framework uses the Business Process Modeling Notation (BPMN) to organize the decision-support processes, essentially as a flowchart.¹¹ As such, it serves as the start to show topics of consideration that can be researched in-depth elsewhere, shown in Figure 2.

The framework helped students to:

- Consider vegetated assemblies early in the design process, so it is important to the design.
- Combine the two tracks during the brainstorming and troubleshooting steps, moving between the framework (the general design process) and the data analysis (reference materials).
- Collect technical information and do not ignore it.
- Compare options using “choosing by advantages” as shown in Figure 2, determining the most desirable option for the situation.¹²



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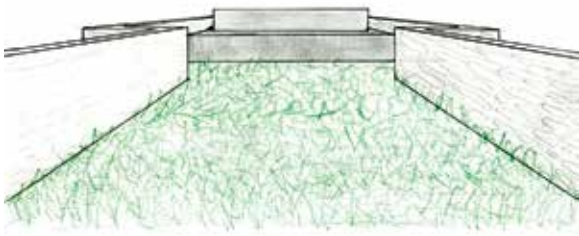


Figure 3 – An example of student work—a raised platform with a vegetated walkway. The thought process in designing the retreat was creation of a calming walk through the space with a central gathering place.

- Choose an option for implementation from the full design process to construction.

This process of choosing topics and in what order to approach them keeps decision-making and not the technical material in the realm of the designer, utilizing two simultaneous tracks during the design process. This framework assists students but should not make decisions for them. If the framework made the decisions for a designer or consultant, then there would be no need for professionals. Therefore, it serves to support the design process while not making decisions outright.

PRELIMINARY RESULTS OF USING THE FRAMEWORK

This Delphi stage was used only for schematic designs and took place over two hours on a single day. Examples of the framework-inspired iterations are presented (Figures 3 and 4) and discussed in the context of decision support and usability in the design process in the next section. The prompt was: “Design a retreat space for community members at the nearby amphitheater using vegetated assemblies using an aspect of color theory and the framework.”

Figure 5 is an example of work from someone who is familiar with the framework, done in 10 minutes.

LESSONS LEARNED

By talking with the students after troubleshooting the Delphi framework, these main lessons about how to improve the framework to assist students in the future emerged:

The Framework

- The framework needs some basic explanation or guide

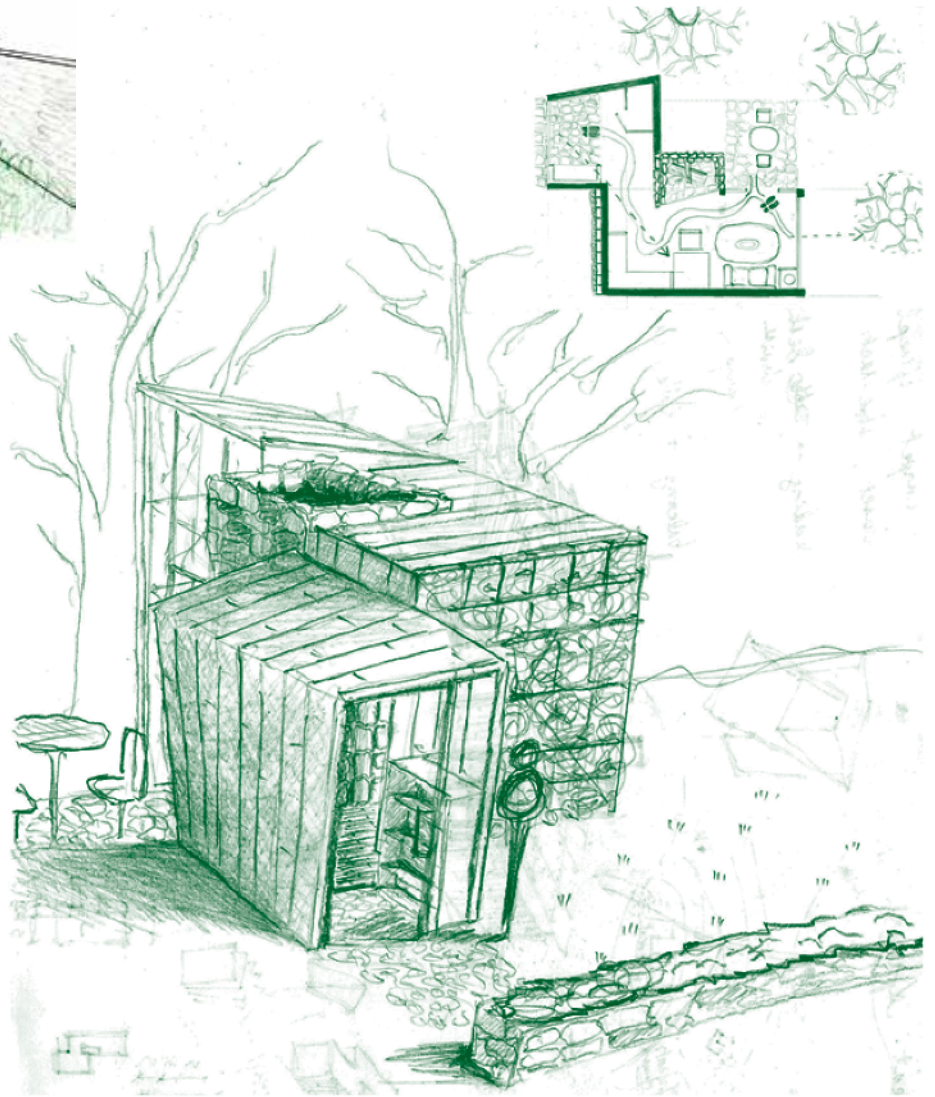


Figure 4 – This retreat space used two volumes or rooms with different roof slopes to create a sense of privacy, incorporating the vegetated wall as an enclosure method. Establishing the fireplace as a central core and choosing appropriate material keeps the retreat space at the scale of the person for relaxation.

for first-time users.

- It needs one more layer of detail explaining each topic, without being overwhelming.
- Other topics—not only color theory—should also be tied into decision support over time.
- More performance-based topics should detail vegetated assemblies by location, not just for Blacksburg, Virginia.
- The vegetated assembly should be seen as a feature that was integral to the design, but did not dominate the project.
- Use it early in the design process, and be familiar with its capabilities.

Group Design

- Work in a group to design these systems.
- This could help the designer and consultant to bridge gaps in design communication.
- The ability to find and effectively use support systems together can help designers and consultants.
- It should support design and project communication.

Digital Framework

- There should be multiple methods for showing and explaining information to designers and consultants.
- The paper appendix system, switch-

ing between pages, was confusing to some of the first-time users.

- Another platform should be used in conjunction with the appendices.

FUTURE GOALS OF THE RESEARCH

The framework outlined here is in development, and with more input, could be transformed into a tool such as a linked PDF file or website for use in the field, office, or studio. Future goals are to:

- Gain some more layers of depth and support for student designers.
- Allow students to make informed decisions about the building envelope.
- Allow students to have working knowledge when interacting with consultants.
- Develop students as the future of the profession.
- Have students gain comfort

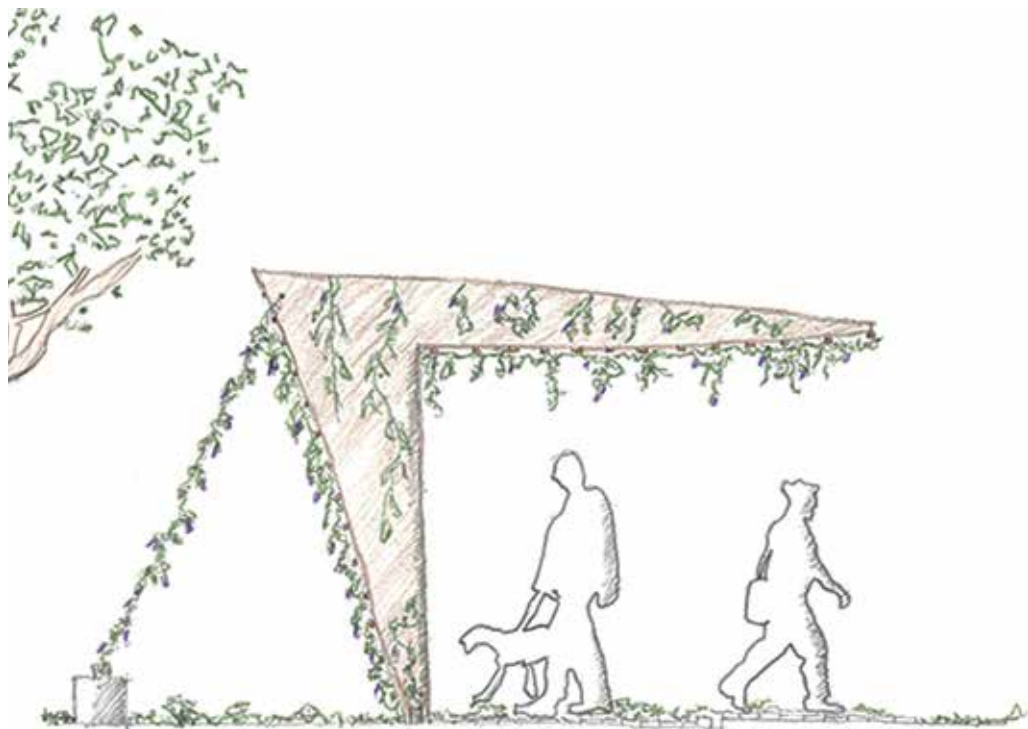


Figure 5 – Tensile repeating frame structure with vegetated walls and roof comprised of twining vines over metal mesh. The project was described as having edible plants such as vining grapes that would travel the suspension system and between the frames.


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with systems and use them as professionals.

- Incorporate more varied topics into the framework, broadening its possible uses. 

ACKNOWLEDGMENTS

I would like to thank the other students for working with me to explore these concepts. The work they provided is invaluable in understanding the architectural design process that fuses research and the performance of building envelopes with an architecture studio.

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Kenneth Black is a doctoral student in architecture and design research at the School of Architecture + Design at Virginia Tech in Blacksburg, Virginia. His research stems from prototyping wall sections with reclaimed materi-

als and design support frameworks for vegetated assemblies using color theory. This approach seeks to combine research with teaching and hands-on learning.

Proposed Update on Delimiting White-Collar Exemptions

The Department of Labor (DOL) is proposing to update the regulations governing which executive, administrative, and professional employees (white-collar workers) are entitled to the Fair Labor Standards Act's (FLSA's) minimum wage and overtime pay protections. The DOL last updated these regulations in 2004, and the current salary threshold for exemption is \$455 per week (\$23,660 per year). With this proposed rule, the DOL seeks to update the salary level required for exemption to ensure that the FLSA's intended overtime protections are fully implemented, and to simplify the identification of nonexempt employees, thus making the executive, administrative, and professional employee exemption easier for employers and workers to understand and apply.

The DOL proposes to:

1. Set the standard salary level at the 40th percentile of weekly earnings for full-time salaried workers (\$921 per week, or \$47,892 annually);
2. Increase the total annual compensation requirement needed to exempt highly compensated employees (HCEs) to the annualized value of the 90th percentile of weekly earnings of full-time salaried workers (\$122,148 annually); and
3. Establish a mechanism for automatically updating the salary and compensation levels going forward to ensure that they will continue to provide a useful and effective test for exemption.

Should this proposal be adopted, employees who earn less than \$47,892/year will be entitled to overtime pay no matter what. This minimum level would increase to \$50,440 in 2016.

NEW LOW-TEMP ASPHALT STANDARD IN THE WORKS

ASTM International Committee D08 on Roofing and Waterproofing is in the process of developing a new standard, WK45660, *Low Temperature Application Asphalt Used in Roofing*, to address two types of asphalt with significantly lower application temperatures than most other asphalts. These asphalts are used to install low-slope roof systems, and would reduce air emissions, save energy, and benefit workers by lowering their exposures to asphalt fumes. Subcommittee D08.03 on Surfacing and Bituminous Materials for Membrane Waterproofing and Built-Up Roofing is working on the standard. For more information, contact Dave Trumbore, 773-746-7282, or Joseph Hugo, 610-832-9740.