



Plants as a Case for Creative Collaboration: Designing the Interactive Art-Science Exhibition *Meaningful Beauty*

Christopher Ault^{1,5}
Wendy L. Clement^{2,5}
Anna Bergen²
Michael J. Donoghue³
Dianella G. Howarth⁴
Leann Janzekovich²
Siya Kakumanu²
Robert King²
Ria Shah²
Mansa Srivastav³
Shania Welch²
Haley Wright¹
Jingbo Zhang⁴

¹Department of Design and Creative Technology, The College of New Jersey, Ewing, NJ 08628

²Department of Biology, The College of New Jersey, Ewing, NJ 08628

³Department of Ecology and Evolutionary Biology, Yale University, New Haven, CT 06520

⁴Department of Biological Sciences, St. John's University, Jamaica, NY 11439

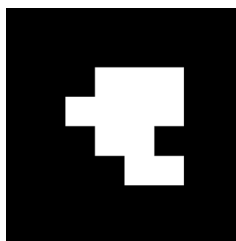
⁵Co-authorship and corresponding author: ault@tcnj.edu, clementw@tcnj.edu

KEYWORDS

animation, augmented reality, Caprifoliaceae, interactive media, fusion, graphic design, honeysuckle, *Lonicera*, science communication, undergraduate education



Scan this code with your phone camera to reveal augmented content throughout the article.



Keeping your phone's browser open, scan this and the other black and white symbols throughout the story.

Exploring Plant Diversity Through Exhibit Design

From the perspective of a botanist, one might describe honeysuckles (*Lonicera*, Caprifoliaceae) as a group of nearly 140 species largely distributed in the northern hemisphere, boasting an array of diverse leaf, flower, and fruit forms. To the general public in North America, however, awareness of honeysuckle is usually limited to the sweet smells of *Lonicera japonica* on summer walks through the woods, or perhaps the tenacious creep of *L. morrowii* into their yards and gardens. Inspired by the ongoing research of a multi-institutional team studying honeysuckle evolution—substantially informed by the work of a graduate student at Yale University and led by faculty at The College of New Jersey (TCNJ)—a team of nearly 50 undergraduate students collaborated to develop an art-science exhibition that invited participants to view plants through a variety of lenses. This collaborative opportunity provided science communication training opportunities for undergraduate students in science, interactive media, art, and design. Our students used their strengths to broaden awareness of plant diversity and share novel research outcomes on evolutionary studies of honeysuckles through the design and display of the exhibition. Ultimately named *Meaningful*

Beauty: The Vibrant Vocabulary of Honeysuckles, the exhibition featured a rich blend of artistic and scientific imagery, while employing digital and interactive technology to augment information and personalize the experience for each visitor. The exhibition was first on display at the TCNJ Art Gallery in Spring 2022, followed by the Arnold Arboretum of Harvard University during the summer.

Project Development



The exhibition's content, design, and overall visitor experience grew out of a months-long collaboration between student and faculty scientists, artists, designers, and creative technologists at TCNJ. Over the course of the project, scientists and non-scientists embraced the opportunity to share with each other the knowledge, objectives, processes, and tools of their respective disciplines. The primary conduit for this collaborative work was a course in *Interactive Exhibit Design*, offered by the college's Department of Interactive Multimedia, and taught by Associate Professor Christopher Ault, as well as a summer undergraduate research experience.

Interactive Exhibit Design assembled a diverse group of student illustrators, animators, programmers, graphic designers, writers, and more. First offered remotely in the Spring of 2021 due to the pandemic, 16 students collaborated to conceptualize various approaches to increasing the public's appreciation of honeysuckle diversity, while also communicating specific insights from the science team's ongoing research on honeysuckle evolution. Students received institutional guidance from former TCNJ students and the gallery directors from both TCNJ and the Arnold Arboretum. The course was offered again the following semester. Now in person, the course's 17 students had access to the college's "makerspace" to finalize designs

and fabricate the components of the exhibition. A key improvement over the previous class was to recruit two biology students as "learning assistants." As the interactive multimedia students developed artwork, text, interactive interfaces, and code, they could dependably turn to the learning assistants to clear up any uncertainty about the science. Some examples of this cross-disciplinary peer teaching included deciphering and creating floral diagrams, assisting navigation of resources such as GBIF and iNaturalist, and commenting on the visual interpretation of fusion in honeysuckle leaves, flowers, and fruits. One of the learning assistants—Biology student Robert King—described the collaboration:

"Communicating with a group of students who had little to no biology background was a challenge, but it allowed me to increase my science communication skills along with my own understanding of honeysuckles. One example was explaining to the artists the orientation of flower morphology. Although I was a scientist on the project—not an artist—I am a visual learner, so I sketched all the flower morphologies as part of the process. It helped the artists understand the key concepts and keep the botanical accuracy intact. It also helped me appreciate the more than 140 species of honeysuckles."

Between the two offerings of the course, the exhibition made significant strides through a summer research program at TCNJ that included two interactive multimedia students and four biology students. Anchored by weekly readings and discussions of Beronda Montgomery's *Lessons from Plants*, both groups together considered some of the factors behind plant visibility—or rather, invisibility—on the part of the general public. The science students on the team were challenged to communicate their knowledge, methods, vocabulary, and tools to the non-science students, one of whom had a primary interest in animation, and the other in user experience design. Armed with these insights, the non-scientists conceived

of possible ways to communicate those ideas through art, design, and technology. As the science students came to understand both the goals of the exhibition as well as the tools and processes of their peers in interactive multimedia, they began to share their own ideas for what approaches might be effective for a gallery exhibition. This intensive summer effort established the framework for the entire exhibition and set goals for the exhibit design course in the fall.

Interactive multimedia student Haley Wright held the dual roles of project manager and major contributing artist, while participating in both the summer research program and the fall course. Of the collaboration with science students, Wright says:

“We gained a better understanding of the bio team’s research by visiting their labs to observe their work, examining honeysuckles growing on campus, learning how to decipher and create various diagrams, studying images of live and pressed honeysuckle species online, and discussing what we can learn from honeysuckles and plants in general. We pushed each other to think differently about our work and how it can be communicated to those outside of our field. As designers, I believe this project helped prepare us for working with a wide variety of clients in the future, as it challenged us to infuse creativity into a subject in which we were not an expert ourselves and developed our ability to design iteratively with the feedback of a client.”

Through the two semesters and summer, the student collective generated a style guide—including a color scheme, font, and tone—which guided all decisions for development of all pieces included in the gallery. Ultimately, the exhibit was organized around six walls exploring themes including regional diversity, morphological diversity, and fusion through a combination of illustration, animation, and graphic design made interactive through augmented reality. Here we describe how various forms of art were combined with scientific content to sustain engagement of

visitors in an exhibition meant to communicate the diversity of forms and function of plants.

Animations



Animation is a prominent area of interest in the Interactive Multimedia major, and several students in the *Interactive Exhibit Design* course embraced the opportunity to apply their skills to a project

that would be seen in person and at a large scale, as opposed to a more typical platform like a YouTube channel. Both animations were projected to fill entire walls, using short-throw projectors to allow visitors to view this “animated wallpaper” up close without casting shadows (Figure 1D). After considering various areas of the science that might lend themselves to striking visuals, the students arrived at two stylistically distinct approaches that effectively blended science with an aesthetic experience appropriate for the walls of an art gallery.

One animation was inspired by herbarium specimens, displaying black silhouettes of fused honeysuckle leaves against bright colored backgrounds. Elements of the silhouettes moved and morphed, reminiscent of early abstract animation where shapes were painted directly on film stock. The other animation put into motion original botanical illustrations from one of the digital artists in the class, featuring honeysuckles swaying in the breeze, with hummingbirds and bees floating from flower to flower. Close collaboration between the botanists, illustrators, and animators led to a discussion on the nocturnal nature of hawkmoth activity and how to portray this in the wallpaper. As a result, when the scene shifts from day to night, the hummingbirds give way to hawkmoths, and fireflies blink like a midsummer evening. At full size, the animation was so striking that a group of visiting children put their noses right up to the wall and wondered aloud whether it was a movie or a painting.

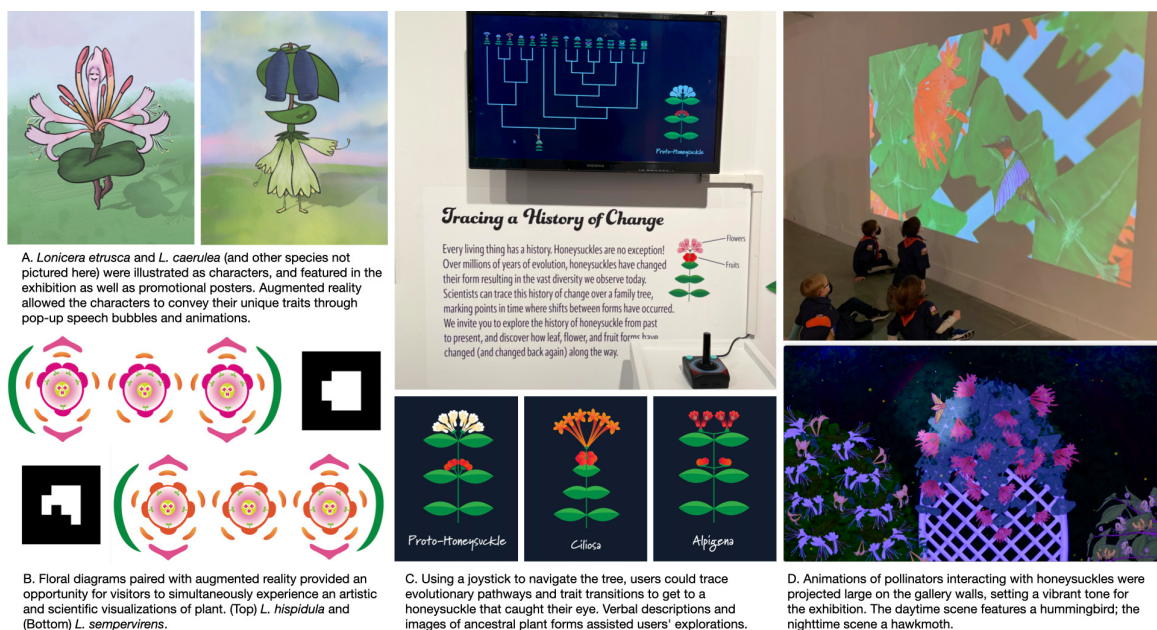
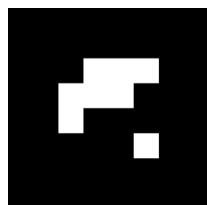


Figure 1. Selected works from the Meaningful Beauty exhibition at The College of New Jersey.

Augmented Reality



Augmented reality, commonly shortened to AR, is a technique by which digital, virtual content is layered on top of a real-world, physical environment. AR is most commonly experienced through phone screens—when a user scans a special symbol with their phone's camera, the phone continues to display the “real” elements of the scene visible to the camera, while integrating digital content on top of it. This content might range from 3D objects that appear to be actually present in the space, to 2D text boxes offering “pop up” information about one’s surroundings. Early in the conceptual phase of the project, the team recognized AR as a sort of magic lens—a handheld translator—that would allow visitors to move back and forth between the art and science aspects of the exhibition. For example, when a visitor scans a floral diagram of a particular species, a 3D model of that plant extends out from the wall in augmented reality (Figure 1B). When a visitor scans a symbol on a playfully illustrated

tourist-style map of the United States, they’re presented with a digital pop-up of essential facts about honeysuckles common in that region of the country. At the Arnold Arboretum, the team took advantage of an opportunity not available at TCNJ, placing AR symbols with corresponding species of honeysuckle on the arboretum grounds, allowing visitors to scan the symbols and learn more about these plants.

Augmented reality was also key to one element of the exhibition that aimed to establish a connective throughline as well as provide users with hands-on appreciation for the range of morphological diversity in honeysuckles. Through a system the team dubbed *Build Your Own Honeysuckle*, visitors could scan AR symbols at key locations throughout the exhibition and choose from a set of options to create their own personalized, virtual honeysuckle plants on their phones. Tied to the theme of a particular wall—diversity, fusion, plant communication, etc.—one AR location would prompt visitors to choose the arrangement of flowers on their plant, while another location presented a choice of fused or unfused leaves. Once

all choices were made, visitors scanned a final symbol to see their unique virtual plant bloom out of a real-world pot in a real-world garden cart, surrounded by fanciful, abstract cut-outs of honeysuckle-like shapes in other pots on the cart. Designing the *Build Your Own Honeysuckle* system demanded a balance of accurate science communication with engaging user experience. The interactive multimedia students worked back and forth with the biology team to identify the key elements that vary between species and endeavored to portray these elements as accurately as possible in a vibrant graphic style consistent with the exhibition's overall look and feel. After several rounds of iterative design among the scientists and graphic designers, the system included a total of 144 different flower graphics.

Interactive Evolutionary Tree

Many students in the Interactive Multimedia major are first and foremost interested in video game design. And while they might not have enrolled in the *Interactive Exhibit Design* course expecting to apply those skills, the fact is museums and galleries are meeting the demand and expectations of their visitors by providing more interactive content, often employing tools from game design. In working to match students' interests with possible topics to explore, a phylogeny appeared to lend itself to game design and would help communicate novel outcomes from the research of the graduate student, Mansa Srivastav. The interactive evolutionary tree was the product of close collaboration among undergraduate scientists who studied these floral traits from living plants, herbarium specimens, and the literature; undergraduate graphic designers who created a cartoon form of honeysuckles that exaggerated the features that differentiated each species without the loss of accuracy; and undergraduate game designers who united these pieces with code and a simple joystick inviting users as young as 4 years old to interact with the outcome (Figure 1C). In observing visitors, we found many sought to find the path that led to a honeysuckle with a

certain set of features—perhaps pink flowers and red fruits, or white flowers with small leaves, or orange flowers and fused leaves. This suggests users perhaps saw these plants as part of a pathway—that is a tree marked by a series of changes along an evolutionary trajectory culminating at one of 16 species. Our sense is that further development of this particular design element could yield additional innovations to provide users with a much better grasp of phylogenetic trees and their significance in interpreting evolutionary change.

Outcomes of the Exhibition

After two semesters of the *Interactive Exhibit Design* course, the summer research program, and one final flurry of work by the faculty, student project manager Haley Wright and Gallery Director Margaret Pazella-Granlund, the exhibition opened at the TCNJ Art Gallery in February 2022. The exhibit was then reconfigured to fit the multipurpose space in the Hunnewell Visitor Center of the Arnold Arboretum the following summer, under the guidance of Sheryl White, Arnold's Coordinator of Visitor Engagement and Exhibitions.

Feedback from visitors clearly and consistently suggested that the exhibition was effective in terms of communicating the science, including fostering understanding of honeysuckle diversity and evolution, and that the artistic and interactive elements of the exhibition served to increase their understanding. Throughout the development process, the team often discussed where the exhibition fell on a spectrum from a natural history experience to art experience, and visitors expressed appreciation for our hybrid approach. A tweet from one visitor offered:

Is it art?√
Is it science?√
Is it more than the sum of
art and science? √√√

As the students from both disciplines move on to graduate school and/or positions in industry, they do so having learned insights into the challenge of conveying complex information in ways that are appealing and engaging. Furthermore, they can draw from an experience that demonstrated first-hand the value of shared knowledge, diverse perspectives, and earnest support between collaborators. To our audience, the combination of art and science gave permission to see and interact with plants from a multitude of perspectives that we hope increases their awareness and appreciation of plant diversity worldwide.

ACKNOWLEDGMENTS

The authors would like to thank gallery directors Margaret Pezalla-Granlund (TCNJ) and Sheryl White (Arnold Arboretum). We also thank Michael Dosmann and Kathryn Richardson for access to and support for working in the living collections at Arnold Arboretum, and Patrick W. Sweeney for *Lonicera* photography. We thank botanical collectors, arboretum, garden, and herbarium curators as well as citizen scientists for making the honeysuckles of the world more accessible to all through their collections. Funding was provided by TCNJ Center for the Arts, TCNJ Cultural and Intellectual Community Council, and National Science Foundation grants to W.L.C. (DEB-1929670), M.J.D. (DEB-1929533), and D.G.H. (DEB-1929674).