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Alleviating Academic Stress Among 18-19-year-old Older Adolescents Through The Use Of Natural Elements In Indoor Spaces

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ABSTRACT

Mental stress is particularly prevalent among adolescents between the ages of 13-19, and long-term stress can lead to more serious problems such as anxiety and depression. The link between nature and adolescent health has long been a subject of interest. This research study is an exploration related to the theme "mental health protection," exploring how a design intervention could inject natural elements into the interior spaces where stressful adolescents spend their time. This research paper reviews previous literature regarding mental health and adolescents, expounds on the causes and effects of adolescents' stress, how adolescents are exposed to the natural environment, and multiple correlations between natural factors and adolescents' psychological well-being. Based on student feedback, this study proposes a strategy for a prototype design that makes use of gutta-percha, a kind of bio-material from Eucommia Ulmoides.
In order to verify the reliability of the design, alternative yet similar structural material was used for assembly and testing. The result of my testing was positive.
In addition, I was able to define a research gap that separates this work from previous scholarship. Through my work, I also proposed a speculative prospect of integrating plant-human interaction and biofeedback through plant bionics responses to stress.

Keywords: Adolescents, mental stress, natural elements, bio-design, Gutta Percha, etc.

ALLEVIATING ACADEMIC STRESS AMONG 18-19-YEAR-OLD OLDER ADOLESENTS THROUGH THE USE OF NATURAL ELMENTS IN INDOOR SPACES

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

My name is Ting Kang, a 23-year-old design student who came to the U.S. from China six years ago.

I was born in Beijing, a place with a history of over 3,000 years. Beijing is also a place with precious places-of-interests and profound cultural heritage, however it is also a place of intense competition.

I started attending classes in art and music from the age of four. Sitting on a stool that was even taller than me, I practiced Chopin again and again for the National Piano Grading Test. Throughout my life, I've constantly pushed myself under the strict requirements and ardent expectations of my parents and teachers.

While growing up, I realized that I've faced numerous difficult tasks. XiaoShengChu, ZhongKao, and Gao Kao are the standardized academic examinations for Middle School, Junior High School, and College admissions and each of these can play a vital role in the direction of one's life.

In China, we needed to achieve excellent marks at three life stages of adolescents in these once-a-year testing opportunities. By contrast, here in the US students taking the SAT can constantly improve themselves and retake the test multiple times. Growing up in such a tense social environment, I was always told that "you can do better."

These pressures to succeed made me an ‘ambitious kid’ which motivated me to study abroad and see the world. Therefore, in 2016 I enrolled in the Syracuse University Environmental and Interior Design program.

On reflection, the reason why I have such a strong fascination with the built environment and nature is now readily apparent. I grew up in a household where my father taught Biogenetics at Beijing Forestry University. I remember spending hours making caterpillar-like catkins into different patterns on the floor of his lab. Therefore, I realized there is always a strong connection between our environment and our surroundings. In addition, being an artist at heart, I became acquainted with the discipline of design from middle school onward.

Living in a different culture such as the United States, I’ve come to realize that different cultures are shaped due to a multitude of design interventions over time. Also, I’ve learned that human centered design is key to optimizing our daily lives.

From my first college design class forward, I’ve realized that academic stress combined with an underlining desire for perfection has never left me. In the Warehouse with its cold concrete studio spaces, being a design student can be a stressful existence. Not to complain, but these are the reasons why I want to work these common themes to my life. Academic stress, peer pressure, and expectations from family and teachers can wear you down.

However, the stress-relieving tips we find online are generic: “get more sleep,” “do yoga,” “talk to someone close;” even those ‘Chicken Soup for the Soul’ theories seem useful to make your spiritual world a better place: “relax, you can do this!” These anecdotes all seem fine, but they don’t work for me.

Culture shock has also played a role in shaping the new me. Living in China was: ”grass also has life, don’t step on it;” however, when I first came to the US, surprisingly, I’ve observed groups of students having fun (on the grass) in various park settings. Though there are many outdoor landscapes throughout our campus, I’ve noticed that interior environments such as classrooms, dormitories and libraries are devoid of natural elements. Perhaps due to lawn maintenance which can be labor intensive and expensive to maintain.

During my six years at SU throughout our campus, there are still not many interior spaces that incorporate natural elements. However, we can see numerous changes being made. For example, the Shine Student Center has had a major renovation. People no longer stay alone texting on their phones. Based on a series of design upgrades, students are now more likely to interact and communicate with each other within this bright and open space.

In order to dream big, you need to start small!

Sometimes I fall into the trap of thinking “given my skill set, is there anything

specific I should explore and what impact can I really make?" During my 6 years of study, I've engaged in exploratory processes to understand spatial, cognitive, and performative aspects of my work. I've challenged and rethought the built environment by demonstrating consideration for "otherness" and promoting positive change.

During my graduate studies, I've developed skills as a design leader and facilitated a Design Thinking Workshop with students from across the campus. During this time, I've thought back to myself when I had just entered Syracuse University.

My undergraduate study in EDI invigorates my own passion for a connection between design, health, and nature. Knowing that there is an association between nature-based experiences and improvements in psychological well-being, I want to understand more about how natural elements affect people versus how people interact with such situations and the built environment.

All of these factors have led to the question: How might we explore a design intervention that injects natural elements into interior spaces where students spend their time? Since it would appear to be to reduce the amount of academic tasks each student takes on, I've wondered why not start with the spaces we use everyday and create therapeutic installations throughout our campus? In this case, not to replace nature, but to amplify our experience of plant agents in our environment' so as to relax the body and mind.

1. CONTEXT AND PROBLEM

Stress is defined as a normal reaction the body has when confronted with a triggering situation, resulting in physical, emotional, and intellectual responses (Cleveland Clinic 2021). Sometimes these reactions can become problematic and upsetting (NIMH). Mental stress is particularly prevalent among adolescents (Devitt 2016).

The World Health Organization (WHO) defines adolescents as those people between 10 and 19 years of age. Adolescence is the period of transition between childhood and adulthood, and children who are entering adolescence are going through many changes. The end of adolescence is tied to social and emotional factors and can be somewhat ambiguous (Cleverland Clinic 2018). Older adolescents: the 18- to 19-year-olds, most of whom just enter college much prefer to be called "young adults." Eighteen-year-olds become legal adults who are considered fully responsible for their own actions (Sarah 2022). However, 18- to 19-year-olds, though, much preferably to be called "young adults" still remain in the category of adolescents, precisely because they need some time to better go over this transition milestone. According to Michigan State University, 18- to 19-year-old is the age where physically the growth and development has slowed, but, socially and emotionally they are transitioning from what has been somewhat of a routine and protective environment to the unknown (2013). Especially Adolescents enrolled in high-achieving schools live with very high stress and spend long amounts of time working on their academics

(Figure 1). According to a study in the Washington Post, students in high-achieving schools with high standardized test scores are now named as an at-risk group, experiencing higher rates of behavioral and mental health problems compared with national norms (Wallace 2019). Thus, adolescence is a life stage when many physiological and psychosocial changes occur, and one such change is how a person responds to stressors Specifically, "adolescence is marked by significant shifts in hypothalamic-pituitary-adrenal (HPA) axis reactivity, resulting in heightened stress-induced hormonal responses" (Romeo). Sometimes, stress can be a positive reaction (Healthdirect 2021); however, amid various uncertainties such as a new environment and different life stage, many adolescents are unaware of their stresses or they perceive stress is normal, and do not seek or obtain professional help (Figure 2) (Radez et al.). In this way, adolescents' psychological stress can gradually increase, leading to more serious problems. For example,

Figure 1: 18-19 year-old older adolescents, just entering college, spend a lot of time on their academics.

Figure 2: Many adolescents are unaware of their stresses and do not seek or obtain professional help, leading to more serious mental problems.

according to Canada Mental Health, long-term stress increases the risk of mental health issues such as anxiety and depression, substance use problems, sleep problems, pain, and bodily complaints such as muscle tension (CAMH). Therefore, in regard to the unpreventable external-stress that adolescents are bound to experience at this age, a stress-reduction solution for students who already overburdened by stress is necessary.

In response to these problems, studies have shown an association between nature experiences and increased psychological well-being (Figure 3) (Bratman et al.). Walking in nature was proved to be beneficial for individuals with major depressive disorder, and even only viewing natural scenery was found helpful for humans to recover from psychological stress (Mochizuki-Kawai et al.). However,

Figure 3: Studies have shown an association between nature experiences and increased psychological well-being.

teens are spending more time indoors than ever before, and academic responsibilities can take time away from extracurricular and leisure pursuits (Figure 4) (Hood). Given the fact that adolescents are more stressed than ever (Long) and have less direct contact with nature every day, this research explores how a design intervention could inject natural elements into the interior spaces where teens spend their time. Many of the natural elements integrated with design are targeted to an adult audience, and there is little research on the needs and desires of teens. The focus of this project on the teen demographic sets it apart.

Figure 4: Adolescents are more stressed than ever and they spend more time indoors with less direct contact with nature everyday.

2. QUESTION AND OBJECTIVES

Since there are few studies on how natural elements can help academic-stress-reduction in older adolescents, I decided to put forward hypothetical questions and seek solutions from a design perspective.

Question

How might we explore a design intervention that introduces natural elements into the interior spaces within academic environments where stress prone teens spend their time?

Objectives

1. Understand the main causes and effects of academic stress on adolescents.
2. Identify where and when stress-reducing elements are needed and appropriate.
3. Identify the types and forms of natural elements that can help reduce stress in interior spaces for teens.
4. Identify appropriate, safe, and environmentally friendly, materials for the final design solution.
5. Develop and test a design proposal for a stress-reducing nature-based design for teens.

3. METHODOLOGY

This Project utilized a mixture of the qualitative and quantitative methods, along with a Research for Design strategy, an approach that involves actual activities in research, to develop and test a design for a living indoor environment for adolescents who are experiencing high pressure and at risk of mental illness. This is an interdisciplinary project at the School of Design at Syracuse University.

3.1 Literature Review

The qualitative research methods include various research reviews in three main categories through an annotated bibliography approach. The first explores the main causes and effects of academic stress on adolescents (Objective 1), the second explores the design of forms derived from natural elements that can help reduce stress in interior spaces for teens (Objective 3), the third introduced a specific material that could be applied to address the design criteria. The fourth foresees plant-human interaction based on biomimicry and bio-design.

3.1.1 Adolescents' Mental Stress

The Cleveland Clinic defines stress as a normal reaction the body has when confronted with a triggering situation, resulting in physical, emotional, and intellectual responses. According to the Center for Addiction and Mental Health (CAMH), the intensity, frequency, and duration of stress differ for each person,

and numerous factors can worsen stress. For example, when people "have multiple stressors, have limited support, have difficulty regulating or balancing their emotions, lack self-confidence, or interpret the stressor negatively, they feel powerless, overwhelmed or helpless" (CAMH). Psychological stress can build up over time, leading to more severe problems.

Long-term stress can increase the risk of mental health problems such as anxiety and depression, sleep problems and pain, and bodily complaints such as muscle tension; it also increases the risk of medical concerns, such as headaches, gastrointestinal problems, a weakened immune system, high blood pressure, and so on (CAMH). While pressure may cause both psychological and physical issues, it is not easy to measure stress. As the Cleveland Clinic puts it, "stress is subjective, which cannot be measured with tests; only the person experiencing it knows how it feels severely." Despite the challenge of measuring stress, researchers have developed different methods of assessing stress. For example, questionnaires are usually used to learn about stress and how it affects people's lives, and healthcare providers can also evaluate symptoms that result from stress (Cleveland Clinic).

Adolescence is a life stage when "many psychological and physiological changes occur, and one such change is how an individual responds to stressors" (Romeo 1). In his article "The Teenage Brain: The Stress Response and the Adolescent Brain emphasizes," Russell Romeo explains that "adolescence is marked by significant shifts in hypothalamic-pituitary-adrenal (HPA) axis reactivity, resulting in

heightened stress-induced hormonal responses describe the changes that occur in HPA function during adolescence, as well as briefly discuss the possible ramifications of these changes on the developing brain and psychological health" (1).

Pryor et al. indicate that college life is innately stressful, and students do not seek professional help for several reasons. College students are more stressed than ever due to many reasons, such as changes in lifestyle, increased workload, new responsibilities, interpersonal relationships, and so on (7-17). Stress is likely to influence students' physical health, phycological well-being, and academic achievements unless they learn to manage it appropriately. Nevertheless, many adolescents are unaware of their stress and do not seek or obtain professional help. As Radez et al. mention, "mental health disorders in children and adolescents are highly prevalent yet under-treated" (1). The group conducts a systematic review of quantitative and qualitative studies reporting barriers and facilitators to children and adolescents seeking and accessing professional help for mental health problems. Four main barriers were identified in the review: "almost all studies (96%) reported barriers related to young people's individual factors, such as limited mental health knowledge and broader perceptions of help-seeking" (Pryer). The second barrier is socially constructed, for example, perceived social stigma and embarrassment. The third theme is young people's perceptions of therapeutic professionals (68%), including perceived confidentiality and the ability

to trust an unknown person. The systemic and structural barriers are the fourth factor (58%), such as financial costs associated with mental health services, logistical barriers, and the availability of professional help (1).

3.1.2 Nature and Well-being

There is evidence showing a link between ordinary nature experiences and physical and mental health, and exposing oneself to nature is a way to release mental stress. For example, the comprehensive guide, Nature and Mental Health: An Ecosystem Service Perspective, reveals the value of nature experience for mental health (1). In addition, research confirms that healthy adults demonstrate significant cognitive gains after nature walks (Berman and Kross 1).

Though people are willing to insert themselves into nature, they are increasingly concentrated within urban areas and, due to many reasons, become less likely to have direct contact with nature on a daily basis (natural environments and their associated wildlife (Soga and Gaston 1). For example, Andrew J. Atkin et al. find that adolescents are exhibiting greater increases in after-school and weekend sedentary time, which is affected by the quick operating urban mood (1). This article draws a conclusion that intervention strategies can help by reducing weekend screen time, increasing family participation in sports or recreation, and promoting the freedom to play outside. Such strategies would also contribute toward preventing the age-related increase in sedentary time (Atkin et al. 1).

Thus, viewing natural scenery is found to be helpful for adolescents to recover from psychological stress when there is little time to expose themselves to nature. Seeing greenery-based images is predicted to provide a recovery effect similar to that of viewing natural scenery (Mochizuki-Kawai et al. 1). Mochizuki-Kawai carried out a study that investigated the process through which viewing flowers regulates emotion by using psychological, physiological, and neuroscientific techniques. The results suggest that viewing a flower image may "induce automatic distraction from a stressor and lead to a reduction in the amygdala–hippocampus activation and negative emotion, blood pressure, and cortisol release," thereby downregulating physiological responses (1).

In addition, Virginia I. Lohr's study points to the various benefits that indoor plants have for human physical and mental health. Plants' effect on well-being was based on human feeling changes and stress reduction. Thus, the range of benefits that has been documented is broad: air quality is improved based on the monitoring of air pollutants, stress is lowered, recovery from illness is faster, mental fatigue is reduced, and productivity is higher. The author concludes that plants are needed in human lives; they humanize our surroundings, and they have a civilizing effect (Lohr 6). Moreover, different greeneries have different effects on indoor spaces. Lee notes that while plants release oxygen during the day, at night when photosynthesis stops, most plants begin to release carbon dioxide. Orchids, succulents, snakes, and bromeliads, however, do the opposite which makes them ideal indoor plants.

A study led by Van den Berg differentiates between sympathetic and parasympathetic activity by viewing green and built settings. The team takes a step toward sorting these interactions out by focusing on pictures of the outdoors rather than on the real thing (1-12). Thus, it hasn't even been made clear that nature itself is responsible for the greatest health benefits – "they may come instead from physical activity, sunlight or, if you stroll with others, camaraderie "(Van den Berg 1-12).

One limitation of past studies is that they focused on finding the causation and links between nature and human mental stress issues rather than how nature could specifically assist with healthier human psychology from a design perspective. Though indoor plants, for instance, are known to be beneficial to mental illness, there are still very few nature-related as well as stress-relieving devices on the market. Moreover, most of those studies focused on adults, or a large group of people, rather than adolescents. This means that the current study conveys relatively little about how natural elements could assist older teens in alleviating their academic stress. Based on the literature review above, this study will explore a design intervention that could help natural elements into the interior spaces where teens spend their time and could alleviate their academic stress.

3.1.3 Material Exploration

There are a lot of material options that lend themselves to creation a workable design solution such as thermoplastics, cast metals, composites, and glass. Therefore, considering the root geometry and the structural requirements, these demands helped to narrow my options down to a small subset of possible materials to achieve my performance goals.

Gutta-percha is a kind of natural rubber produced from a tree species, called Eucommia Ulmoides. According to Missouri Botanical Garden, E. Ulmoides is a small-sized deciduous tree with ascending branches and a rounded spreading form. It has dark green foliage that appears to glimmer in the moonlight (Gilman, Watson 1), inconspicuous greenish-yellow flowers appear in clusters in spring, and fruits that produced from summer to autumn.

According to the National Arboretum, E. Ulmoides is the only cold-tolerant rubber producing tree which is able to survive temperatures of -30°C. In addition, it could grow with height 18 meters and Spread 10 meters. E. Ulmoides, being the only species in its family, Eucommiaceae, were once widespread in the Northern Hemisphere and survive only in China since the Quaternary Ice Age. It is a well-known traditional Chinese medicine; its barks, leaves, seeds, and even male flowers are commonly used as raw medical remedies. For example, E. Ulmoides's bark and leaf are good for nourishing human liver and kidneys, strengthening

tendons and bones, and calming fetus. Most importantly, E. Ulmoides' bark, pericarp, and leaf veins contain gutta-percha, which is a newly discovered polymer material with a lot of producing potentials.

Qian Wang and her team did research on Eucommia Ulmoides gum-based engineering materials and explored its advanced applications. Gutta-percha, a kind of white filamentous and ropy gelatinoid, is abundant in E. Ulmoides's roots, stems leaves, pericarp, and seeds (Figure5) (Wang 1856). Superior to robber trees, Gutta-percha's thermal-deformation temperature is low. This material, at room temperature, is still a hard plastic with regular shape and rigidity; however, it could be deformed to a certain shape through tensile, compression or distortion in hot water at certain temperature due to its strong plasticity.

Figure 5: Gutta-percha, a kind of white filamentous and ropy gelatinoid, is abundant in E. Ulmoides's roots, stems leaves, pericarp, and seeds (Wang).

In addition, according to Feng Zhu's study and application of Eucommia Ulmoides gum on the Journal of Anhui University Natural Science Edition, three kinds of

gutta-percha materials with different uses can be obtained by controlling the quantitative cross-linking (Figure 6). Stage A: zero cross-linking degree, thermoplastic materials can be produced when the vulcanization temperature is below 60°C; Stage B: low cross-linking degree, thermoelastic materials can be produced when the vulcanization temperature is 60°C; Stage C: critical cross-linking degree, high elastic materials can be produced when the vulcanization temperature is above 100°C (Zhu 90).

E. Ulmoides' shape memory and self-healing characteristic has won itself achieved a certain degree of application in various fields such as aerospace, medical industry, architecture, plastic and robber industry, etc. Beijing University of Chemical Technology (BUCT) has developed personalized gutta percha based

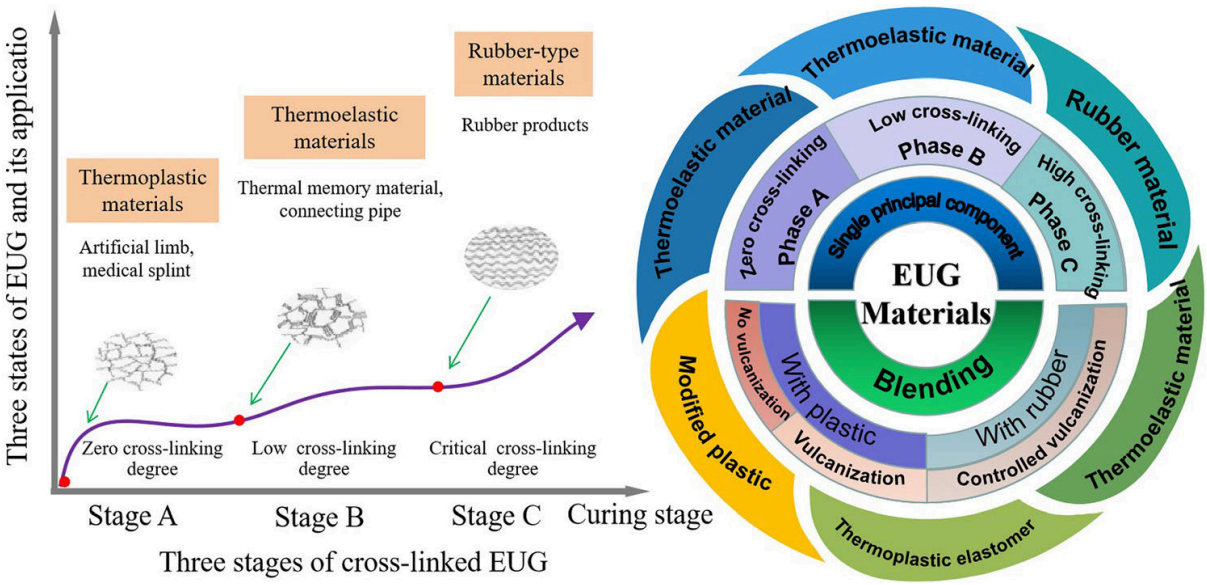

Figure 6: The three stages of cross-linked Eucommia Ulmoides (Zhu).

high-tech products, such as ski leg guards and armor guards (Figure 7). The product is based on the actual body protection needs of alpine ski team athletes during the Winter Paralympics, considering Gutta-Percha's shape memory, high impact resistance, and energy absorption functions. The product has 360 degree all-round high protection while ensures free movement at the same time. Most importantly, it can be easily disassembled to fit different exercise and sports' protection needs, greatly reducing or avoiding injury to athletes during training and competition (BUCT). Also, consider the extendable sports gear for kids who are growing fast: personalized and features can reduce cost for leg pads.

Figure 7: Gutta percha based high-tech body protection product (BUCT).

3.2 Research & discussion

This research created a 15 question survey in terms of a predominantly qualitative research method that examined the cause and effect of academic stress (Objective 1; Q6-8), when and where stress-reducing elements are appropriate (Objective 2; Q15), and the types and forms of natural elements that can help reduce stress in interior spaces based on participants' experiences and opinions (Objective 3; Q14&16).

3.2.1 Survey

A total of 52 valid responses were collected from two major digital platforms, WeChat and Instagram, between Nov. 12th and 24th, 2021 (Figure 8). These two platforms were chosen because they are widely used among students and no permission of the published information were required for the social media groups, thus ease the process of reaching target groups and recruit participants in need. For target groups, specific eligibility criteria that participants must meet include: 1) adolescents between18-19 years old; 2) freshman and sophomore in any type of college program; 3) students' self-identification as experiencing high academic stress; 4) they must be currently located in the United States. Social media posts are linked to an online survey (see appendix) through the WenJuanXing Survey website (wjx.cn).

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Developing a Nature-Based Interior Design for Academic Stress Relieving in 18-19-Year-Old Adolescents

M.F.A Design Thesis

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Scan the code to start a survey

Figure 8: Survey

According to the survey results, ethnically, it covers American, Chinese, Taiwanese, Indian, Thai, Moroccan, Greek, etc. The majority of eligible respondents are Asian or American based in Syracuse, New York, with slightly more males than females. Fifty-eight percent of the participants were facing high levels of academic stress on a daily basis, with a self-rated 7-10 as their stress level. Approximately thirty percent of the participants placed themselves in the 4-6 range, while the remaining ten percent self-reported between 0-3. The Study Issue (88.46%) was the primary cause of stress (Figure 9) for participants, followed by Peer Issues (50%), Work and Job-Related Issues (44.23%), and Health-Related Issues (25%).

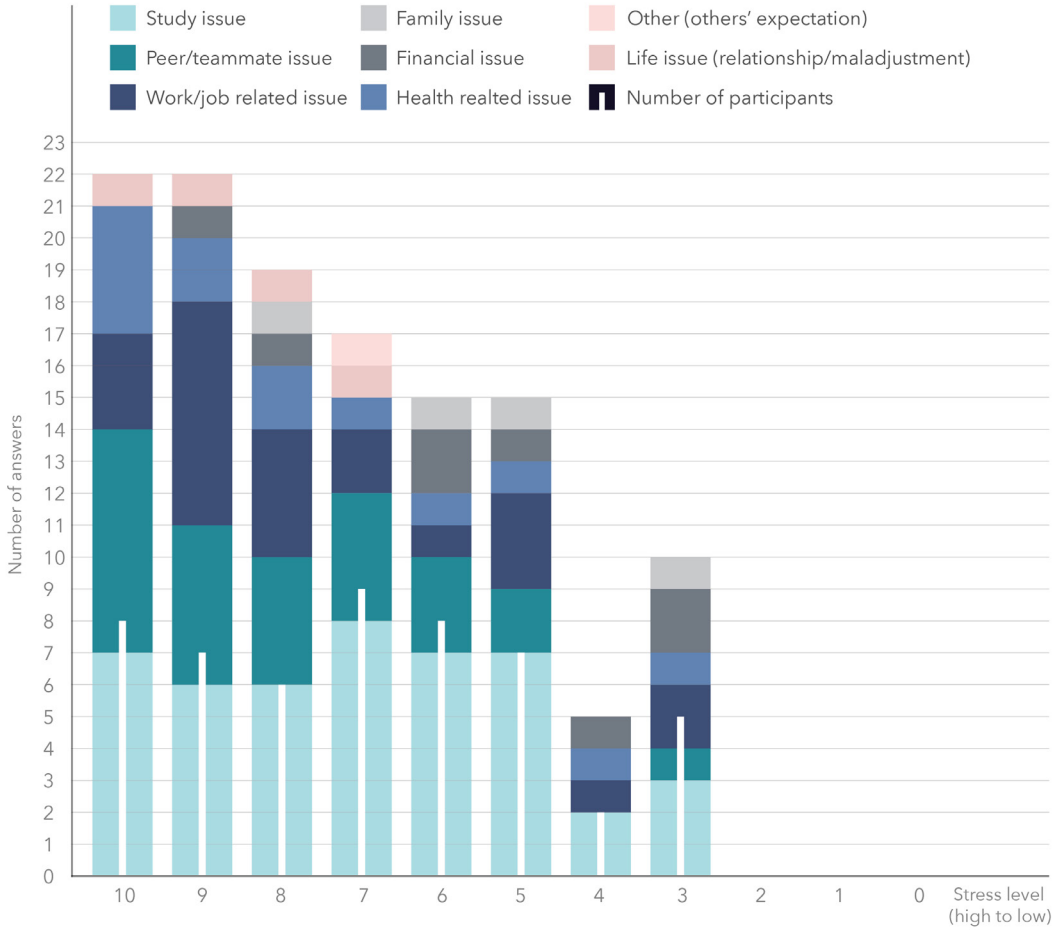


Figure 9: The distribution of stress levels and the cause of stress in different stress levels.

The likelihood of the above stressors happens more among people with higher stress levels. Additionally, financial issues (15.38%) and family issues (7.69%) were more common among adolescents with low academic stress.

To better understand stress among adolescents, the report analyzed the association between their stress levels and their majors. All college majors have been grouped into seven categories: Art, Engineering & Technology, Math & Science, Business, and more (Burrell). As shown in figure 10, Architecture students had the highest levels of stress. Eighty-nine percent of them rated themselves with high stress (7-10), and among them, ten percent self-reported a score of 10, indicating extremely high stress. In addition, participants majoring in STEM, as well as Art, also had a notably high-stress rate. Although all fields of study were not covered, the survey suggests that academic disciplines have a propensity for affecting stress levels.

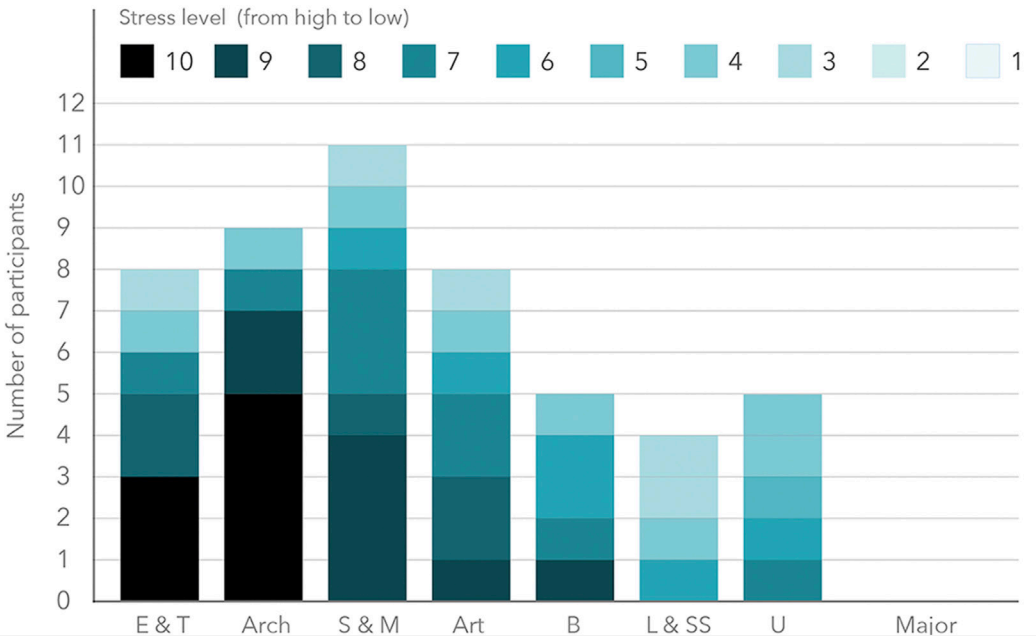


Figure 10: Self-rated stress level vs. 7 categorized majors: Engineering & Technology; Architecture; Science & Math; Art; Business; Literature & Social Science; Undecided.

Academic stress is reflected among student participants physically and psychologically. According to the results, more than ten responses per behavioral effect suggested that participants were susceptible to changes in energy levels, sleep patterns, and difficulty in communication. Additionally, some participants also mentioned breathlessness, memory loss, and decreased efficiency in daily life. From a psychological and emotional standpoint, some common effects of stress on participants were irritability, outbursts of anger, loneliness, depression, and anxiety. Other symptoms include restlessness, low self-esteem, and feeling overwhelmed. Effects such as excessive worry and lack of motivation were also noted in some participants, suggesting that their psychological changes could also affect those around them, leading to more serious consequences such as arguments and break-ups.

Based on Objective 1, in terms of the effects, the participants had their own preferences and ways of dealing with stress. The participants displayed moderate comfort in dealing with academic stress, as shown in figure 11. In addition, the participants with high-stress levels displayed difficulty handling stress (1-4), contrary to those with lower stress levels. Although participants with medium levels of stress (4-9) showed no apparent trend in handling stress, no extreme value (1 & 10) was found in this range.

Though all the stress reduction methods offered by the participants did not determine which activities were most effective, they provided other relevant data (Figure 12). Listening to Music was the only variable present across almost all stress levels.

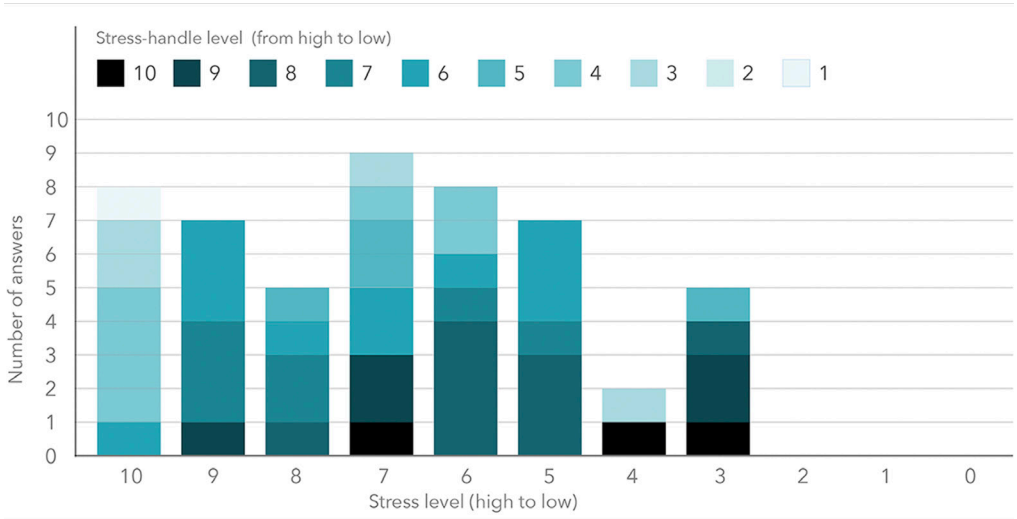


Figure 11: Stress level vs. Stress-handle level.

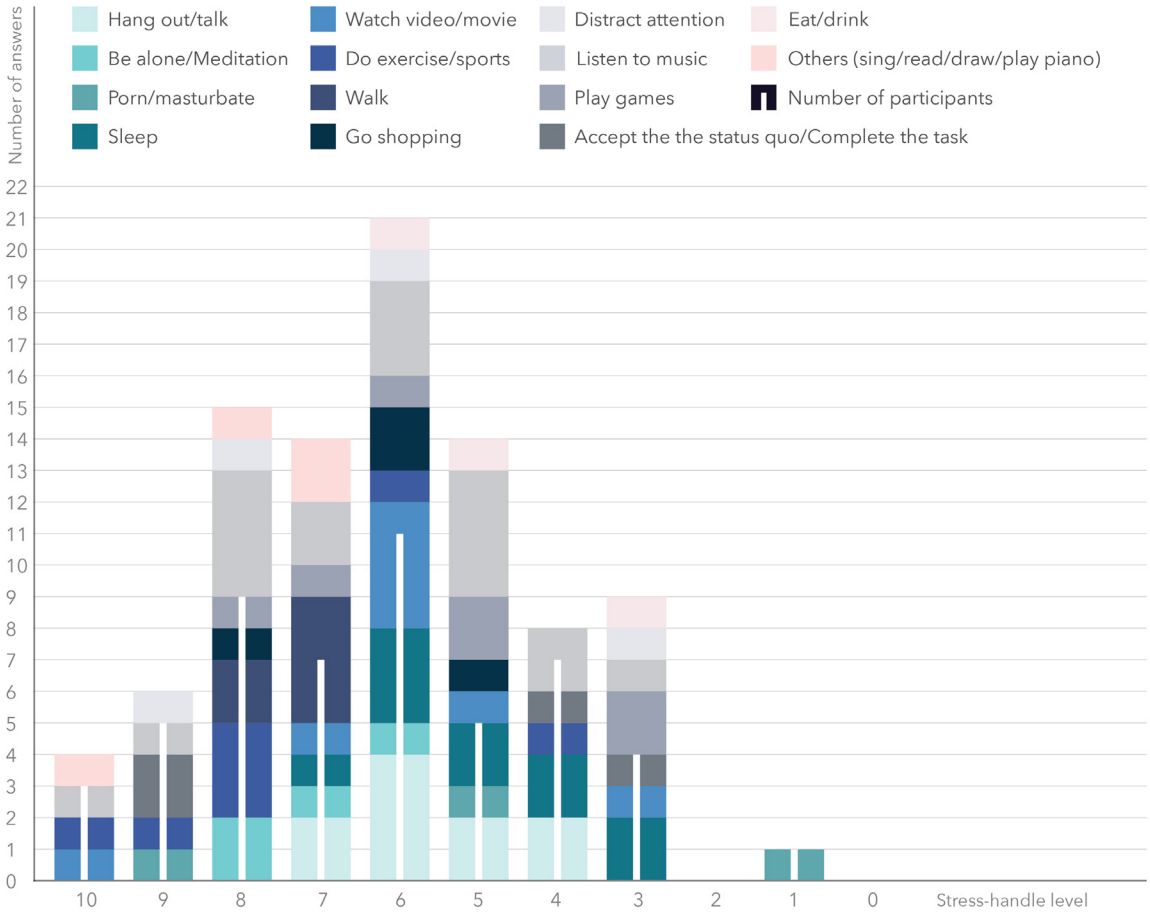


Figure 12: What participants do to release stress and how well they can handle it.

Hanging Out and Talking, Exercising and Participating in Sports, Watching Videos, Playing Games, and Sleeping were also shared ways to relax. Moreover, only participants who handled stress quite well (7-10) engaged in personal hobbies such as drawing, reading, singing, and playing the piano.

This thesis aims to address the stress problem by introducing natural injections in interior spaces. The survey collects the results on the frequency of adolescents walking in nature under stress (Figure 13). A significant percentage showed that students were willing to get in touch with nature when being stressed, as illustrated by the fact that up to seventy-five percent of survey participants either mentioned taking nature walks often or from time to time. Another six percent claimed that

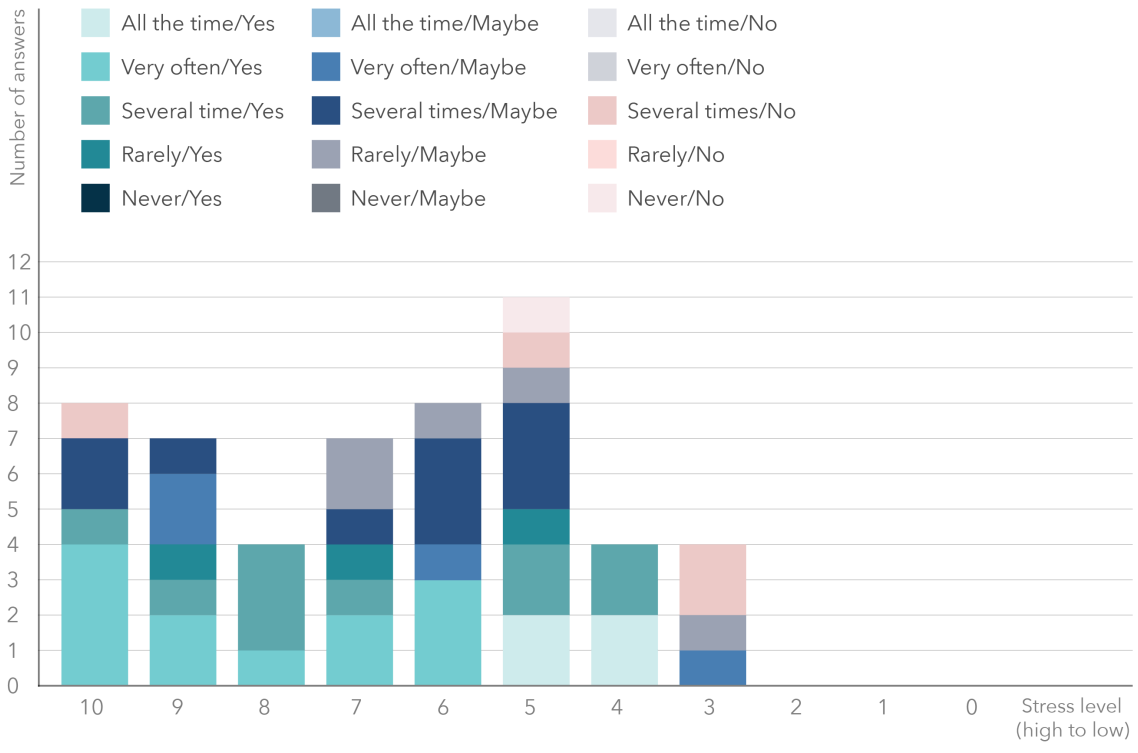


Figure 13: The frequency of participants walk in nature and whether they think it makes a difference in different Stress levels.

they spent time out in nature “all the time.” Surprisingly, adolescents experiencing higher levels of stress walked more frequently in nature, with the converse also being true. As illustrated by the data, nature impacted stressed adolescents positively to some extent. More than half of the participants believed interacting with nature alleviates stress, while only ten percent denied it. Therefore, had any impact, it is clear that even those who did not spend much time in nature still suggested that being outdoors or around natural elements could help relieve stress.

Two open-ended questions regarding Objectives 2 & 3 were collected with a variety of answers. As to when and where nature-based stress reduction elements were appropriate, twenty-seven percent of the participants reflected that they wanted to relax and manage stress alone in a private and quiet space. A few among them prefer this to happen predominantly at night. On the other hand, around one-third of participants mentioned open and public spaces like gyms, e-sports rooms, labs, classrooms, and outdoor corridors. Participants expected immediate relief after taking an exam, for instance, or after having experienced any type of stress on campus. Some specific answers included, “I want to see the blue sky while exercising, so please take off the roof,” “add plants and couches to the bridge to Flanagan Gym plz,” “provide somewhere in this building that I could release stress after my experiment failed” etc.

In terms of the types and forms of natural elements that can help reduce stress in interior spaces for adolescents (Objective 3), many participants mentioned natural elements like sunshine, sky, the natural sounds of ocean and breeze wind, green plants, and fresh air. There is no particular type of natural element that all participants preferred; however, some ideas are enlightening, such as “artificial grass, cave-like rooms, and dim light,” “indoor gardens,” and “a wall with real leaves,” etc.

3.2.2 Co-creation workshop

The last question on the survey also explored Objective 3 by recruiting students to participate in a co-creation workshop. First, a list of all the participants of the survey responses that consented in the follow-up activity were selected, and all responses from participants not studying in Syracuse were removed from the list. Second, the remaining participants were not ordered based on their responses to survey question 5, with those who reported the highest levels of stress at the top of the list. Then, participants who reported their stress level as 1-3/10 were removed from the list. Finally, an invitation email was sent to 5 participants at the top of the list, and reached-out to additional participants every 48 hours if there were no response. This process continued until there was a group of three participants for the co-design activity.

The workshop took place in Room110 Smith Hall, Syracuse University on Nov. 29th, 2021. The whole activity lasted for an hour, with three participants experiencing high levels of academic stress (7-10). Each student shared experiences with academic stress and whether they had handled it successfully or not. Participant A is a freshman from the United States (second generation American born Chinese), 18 years old, majoring in Computer Science. He rated himself a 10 in stress level with study, peer, and health related issues. Participant B is a sophomore originally from China, 19 years old, majoring in architecture. She rated herself a 10 in stress

Chinese Taipei, 18 years old, and has yet decide on his major. He gave himself a 7 in stress level, with study, culture fit-in, and environment related issues. Both Participants A and B could not quickly adjust the emotion brought by stress and needed to be adjusted by external factors, like accompany from others, distract attention, etc. while participant C said that he prefer to digest stress on his own, since others' might not understand his real feeling. Then, their brainstorm engagement with natural elements brought about statements such as "leaf collections," "enjoying the sunshine," "room filled with sunlight," "sound of the ocean," etc. Then, each participant selected a set of color combinations from the Lee Gel Lighting Filters, resulting in three completely different choices in terms of tone and lightness. Participant C was obsessed with dark colors, especially black, which echoes his earlier mention that he enjoys being alone in a "night mode room. While, two others both picked a combination of contrasting color but of different value (Figure 14). Finally, they were asked to draw an 'ideal room' based

Figure 14: Different sets of color palettes selected from the Lee Gel Lighting Filters by participants during the Co-creation process (participant A, B, C from Left to right).

on nature and install natural elements in places they thought would help relieve stress optimally (Figures 15 & 16). The conclusion I draw from this part is not significant, since on the one hand, the three students were somehow introvert, and on the other hand, lacking certain imagination ability as they said. All three expressed a high level of acceptance of plants and a desire to place natural elements within public spaces but preferred it to be for personal use only.

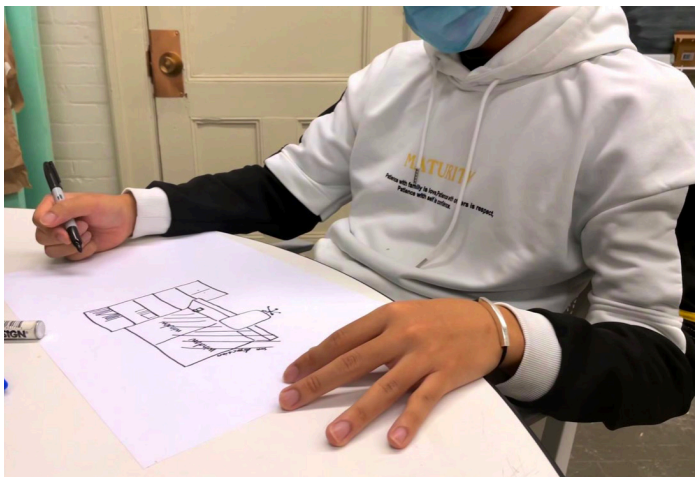


Figure 15: Participant A is drawing a nature-based ideal room.

Figure 16: Participant B's ideal room with natural-based installations.

3.2.3 Summary

To conclude, adolescents commencing university education are already stressed, and their stress levels tend to correspond to their disciplines, according to the survey. Based on what the four people shared at several small events, students all have different ways of relieving stress that is often somewhat effective (Objective 1). Their answers reflected that if stress is not dealt with promptly, it can lead to more serious effects. As mentioned above, feeling tired, restless, and facing difficulty in communication are all physical symptoms of stress. However, Sleeping and being alone are also how they attempt to deal with their stressors leading to a vicious circle. Individuals with psychological symptoms such as loneliness, sadness, and low self-esteem greatly need companionship and encouragement from others. Research reported by Bep Uink suggested that teens may cope with stress better when being with peers." Being among peers during periods of stress may provide adolescents with an open, supportive, and rewarding space that may help suppress the emotional swings that adolescence may bring" (Uink 27). Though few participants mentioned that they did not want to talk to their friends because peers are part of the stressor, many other students were still willing to hang out to relieve stress. Therefore, the choice of the function and location of this interior space is crucial in terms of Objective 2: teenagers need an open area where they can express themselves and a private space where they can self-help.

On the other hand, it is also essential to consider the time adolescents want to engage in the space; for example, some participants mentioned that they wanted to relax right after taking an exam or just knew they did not do well in a test. The Barnes Center Meditation Room on the SU campus functions well; however, the time limits and reservation requirements have made the stress-releasing process even more difficult. What is more, though there are many outdoor landscapes on campus, there are very few indoor spaces with natural elements that can help students to relax at any time or anywhere. As a result, the situation for students to resolve stress in a timely manner is poor.

As reflected in the survey, participants with varying stress levels who spent time in nature when faced with academic stress found it relaxing. Student's responses to the question "what do you enjoy doing in nature?" can be summarized into two categories: Senses and Activities. The result shows that Seeing, feeling, and listening to nature are more welcomed than touching, tasting, and smelling. It is possible that natural elements of any type and form of (Objective 3) can be injected indoors based on participants' preferences. This practice also allows students to engage in their favorite activities in nature or around natural elements rather than engaging with nature itself (Figure 17).

The information gathered from surveying the 52 participants, as well as the answers of the three co-creators regarding details, such as color choice and

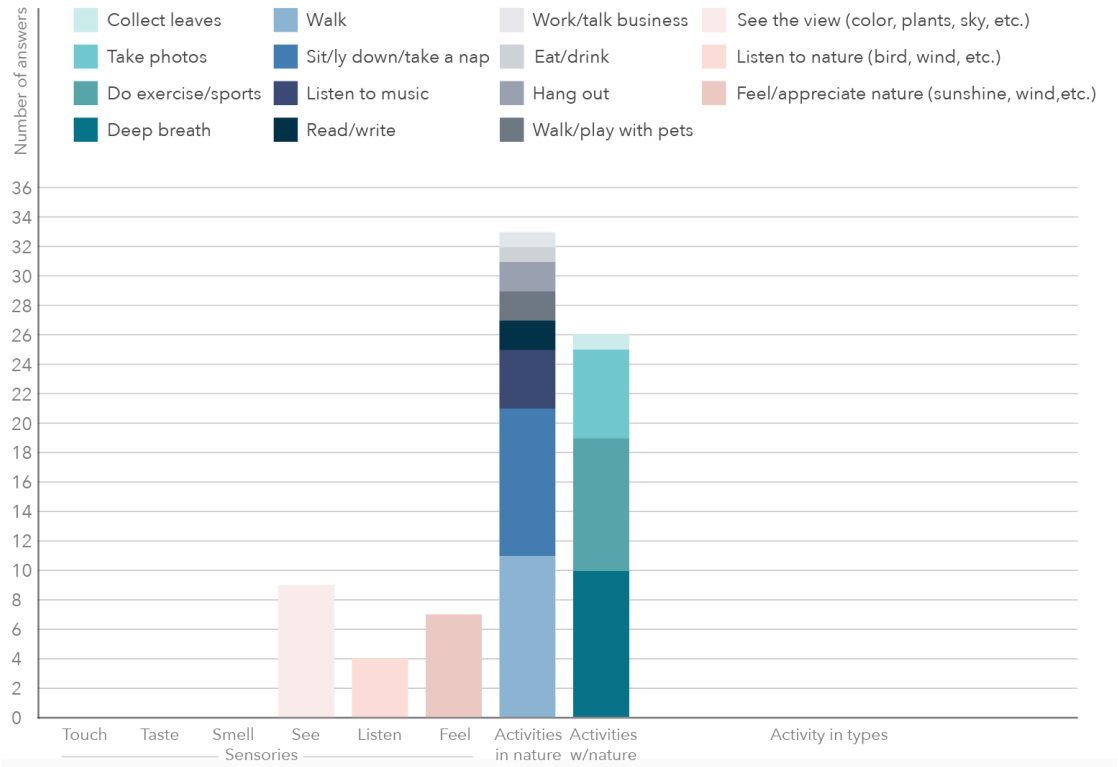


Figure 17: In terms of what participants enjoy doing in nature, all answers were summarized into two categories: Senses and Activities.

preference of natural elements, cannot represent the overall trend. After all, humans are complex and different from one another. On the other hand, the three participants who suit the inclusion criteria were happened to be all of Asian descent, though they were fairly selected. With that said, They have studied and lived in the United States for different amount of time (participant A: 18 years; participant B: 4 years; participant C: 3 months), Whether there are differences in the ability and way different ethnic groups cope with stress, and how this might affect the results. Nonetheless, there is no denying that these solutions counter the vicious cycle of academic pressure older adolescents struggle to deal with and suggest that nature is an indispensable part of human life.

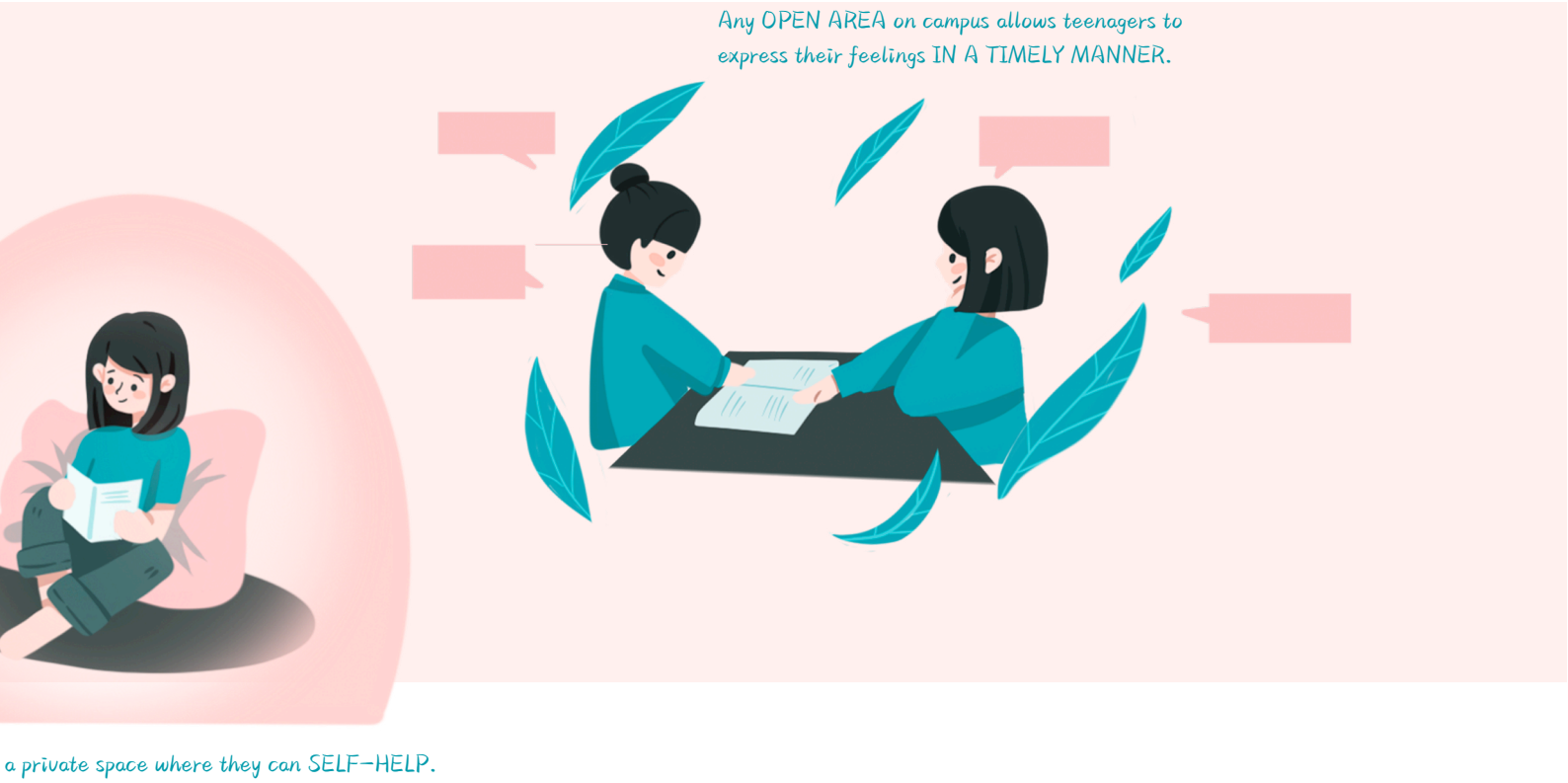
4. PROTOTYPING

4.1 Design orientation

The design provides the foundation for translating these investigations into new tangible solutions. This design aim at creating a nature-based environment in public spaces, where adolescents could relax in time and release pressure with the help of their interests (Figure 18).

Figure 18: Design orientation based on the survey and co-creation

The design provides the foundation for translating these investigations into new tangible solutions. This product creates a buffer that provides comforting effects. In definition, a “buffer” is defined as an aid for the student population to release stress. Currently students cannot find a useful stress-reducing environment outdoors or indoors, so a “buffer” design is a good way to promote psychological healing and self-satisfaction. The product aims at relieving pressure and improving mood, as well as reminding the user to pay attention to their personal health. Thus, it is necessary for the design to distract users’ attention from stress that can arouses negative emotional responses, through its powerful sensory engagement. These ideas achieve the emotion “buffering” goal.



Based on the survey results and conclusions drawn above, the idea came up with a pod shape in various sizes with live plants that could be placed in various spaces on campus. The possible directions of pods are aimed at achieving a high level of holistic understanding of what future designs contribute to the world. What is worth mentioning is Doris Sung's design, Bloom (Figure 19). Made of "smart" thermal bi-metals, it is a sun-tracking instrument with a ventilation system to index time and temperature (Sung). Each unique part makes the whole system work in a more comprehensive way. Therefore, inspired by this breathing architecture, as a speculative prospect, the pod is expected to imply different kinds of plants on each module.

Figure 19: Bloom, made out of a 'smart' thermal bimetal is a sun-tracking instrument indexing time (Sung).

A pod shape was inspired by Mongolian yurts (Figure 20), a dwelling place of Chinese Mongolian herdsmen when grazing on the grassland. It mainly consists of wooden frames, mat, rope belts, etc. The entire frame is made of wicker strips of the same length and thickness, interspaced at equal distances, perforated at the intersections, and joined by leather nails as a wheelbase to form a support structure consisting of multiple diamond shapes. The frame wood is evenly distributed through each mesh so that each piece of frame can withstand the pressure from both the covering mat and wind and snow. This frame allows adjustable size and height of the yurt, convenient for construction and relocation.

Figure 20: Wooden frames of the Mongolian yurts are made of wicker strips which is cross arranged to form a supporting structure composed of multiple diamond shapes (Youtube).

4.2 Design concept

4.2.1 Construction unit

The design needs to consider the integration of a module and plants; the convenience of assembly between each module; and the stability and certain flexibility of the whole construction that can meet various personal needs. Triangles, as part of the diamond-shaped component of the yurt structure as well as the most stable shapes, are the top choice for a real product (Figure 21).

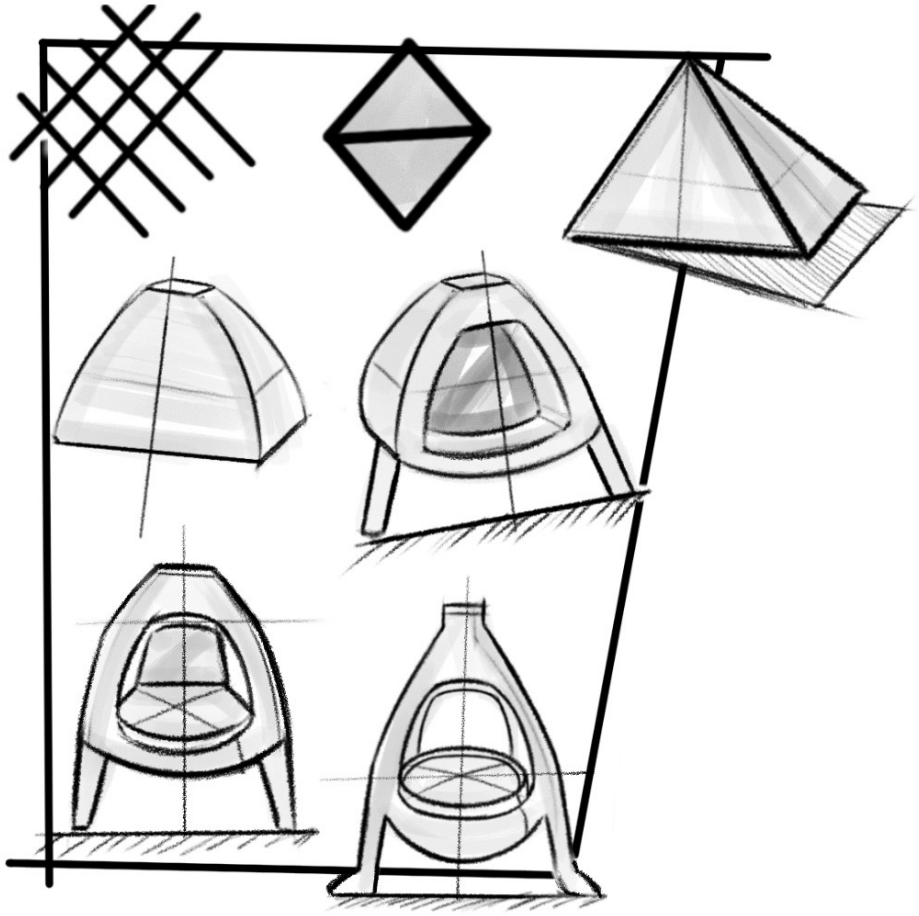


Figure 21: Brainstorm and sketch of a construction unit concept.

A module is around 13 inches tall, 8.75 inches wide, 8.5 inches deep, and with a 50 degree angle of the top point of the module. There are two supporting legs on bottom and a hollowed neck on top of each module (Figure 22). Inside each module cover is a pot where the plant goes, which can be angled to certain degree but always user-oriented. Each module is hollow with a window at the back that allows the leaves to grow outward and natural light to shine in. Considering a piece of a triangular shape is perceived as being edgy, defiant, and powerful, yet increasing human stress, the sharp corners of the triangular product are rounded, giving the component a smooth and slightly cute look.

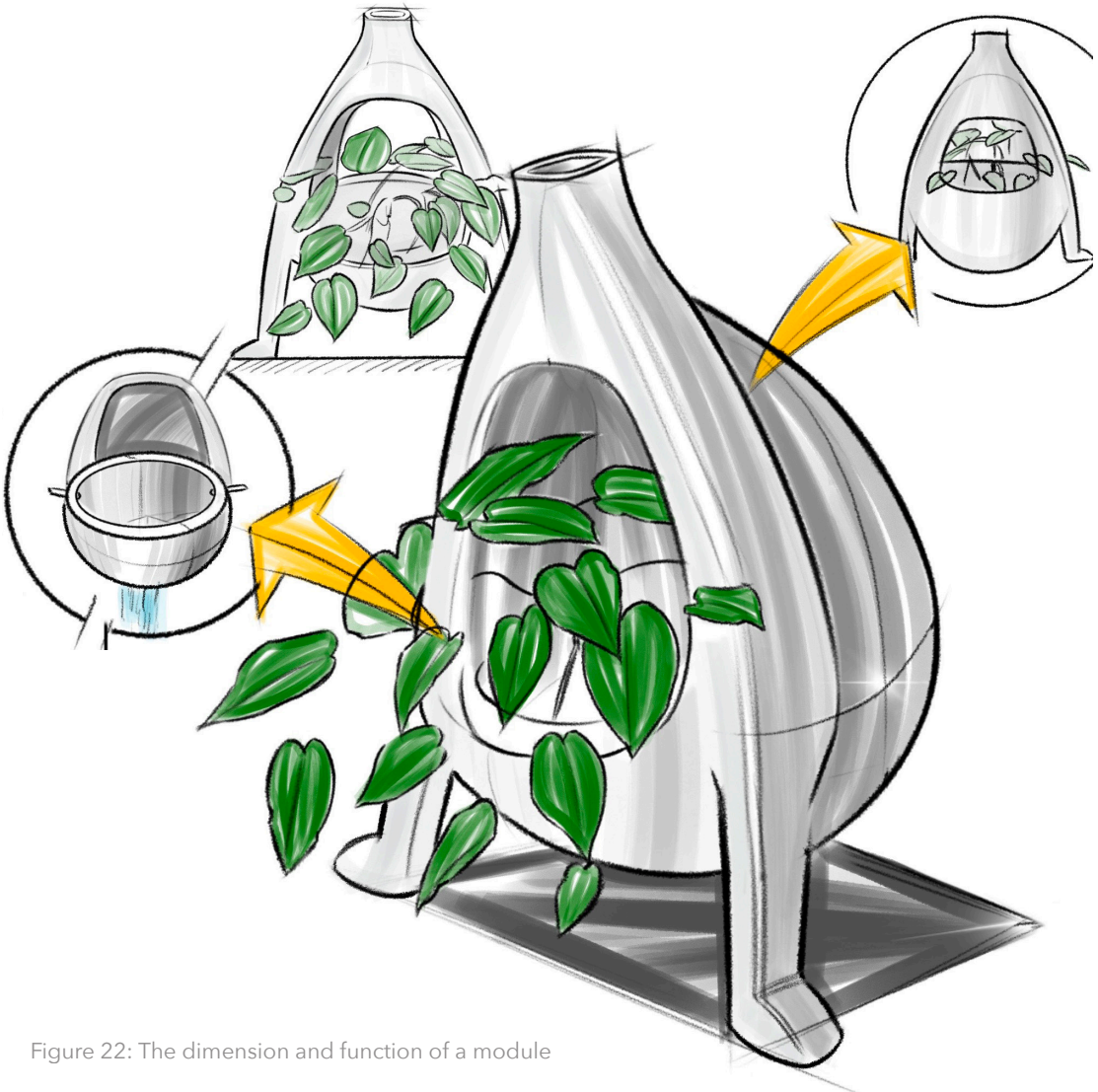


Figure 22: The dimension and function of a module

4.2.2 Structure

The installation is designed by inserting one leg on either side of the top modules into the neck of the bottom module (Figure 23). The pod's structure takes reference from the Mongolian yurt that can be divided into a main central structure, a bottom part for bearing and fixing, and a top part for shielding (Figure 24).

Figure 23: The installation is designed by inserting one leg on either side of the top modules into the neck of the bottom module.

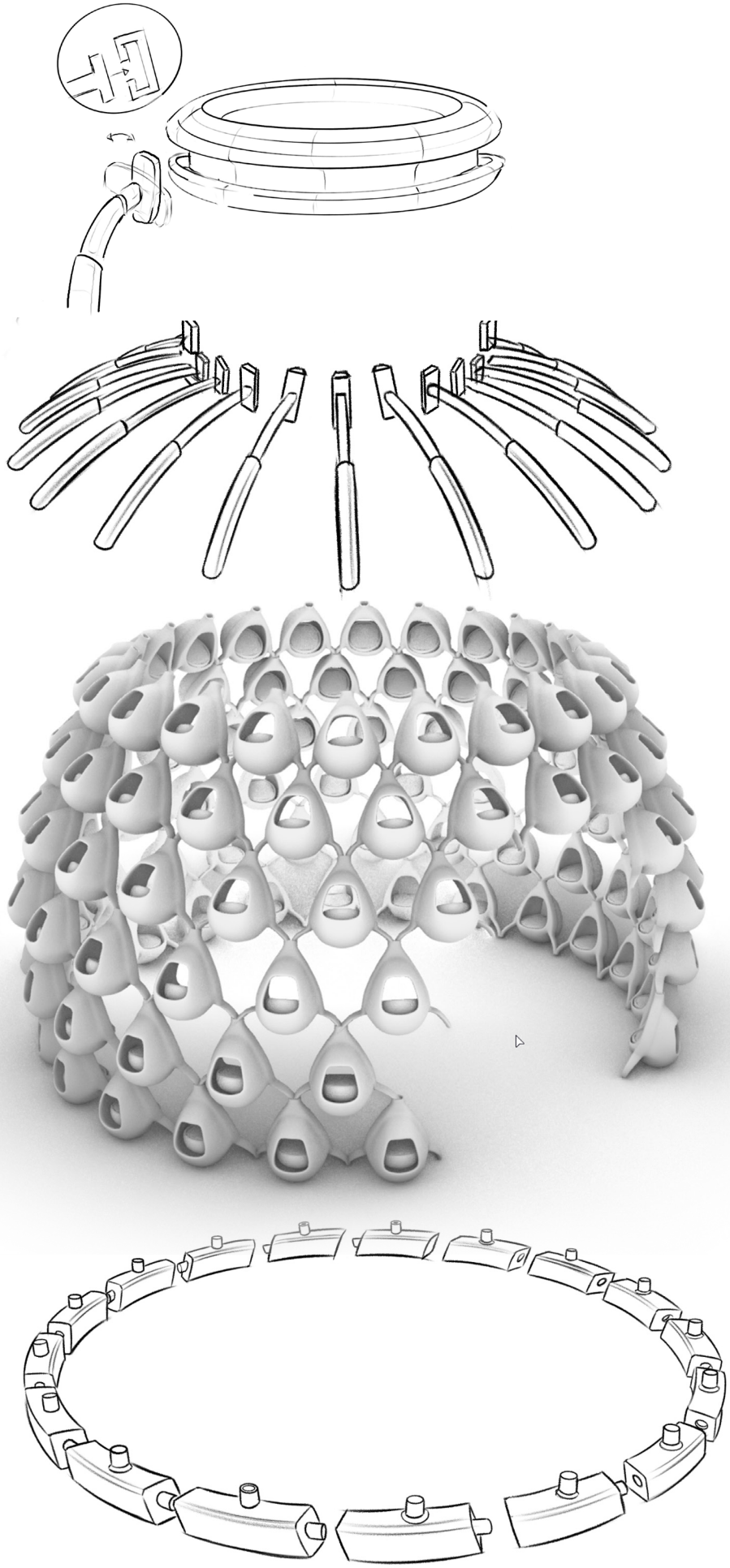


Figure 24: A schemetic image of the pod structure

Considering the bottom first layer needs to support the whole model, a base loop assembled by several interlocking nodes is needed to hold the first layer of at least 18 triangles in place. Each node has retractable slopeswith inclinations up to 12° for accessibility. An upper cover, just like that of a Mongolian yurt, is a round loop with several extruding legs which could be inserted in to the neck of the top layer modules. The legs are 2-sections and interlocking for easy height adjustments. On each top of the leg, there is a steerable head which could be locked by inserting it horizontally and placing it vertically within the loop slot. With that said, the structure allows for different pod sizes and the required amount of extruding legs to be firmly attached to the upper loop.

Building 6 layers of these modules could reach a height at least 80 inches, which also form an enveloping ellipsoid space from the inside, gives users a fun, ‘friendly,’ and non-threatening sense (Postema) Moreover, the triangles also create open voids between them. These negative spaces keep the pod open while ensuring some degree of privacy along with the looming effects of the plants. The voids can also help to indicate if the seat is occupied. In this way, not only can the person inside the pod interact with nature, but passers-by outside can also enjoy the visual experience.

Referring to an interior sense experience, students responded in the preliminary survey that they enjoyed seeing, feeling, and hearing in regards to natural elements. Surrounded by real plants within the pod, students are able to see, touch, feel, and smell the plants; however, sound is not naturally part of the experience. For this reason, the user's auditory needs should be met. According to University of Nevada, Reno (UNR), music is a necessary element that has a profound effect on both human emotions and body. Faster music makes people feel more alert and concentrate better; upbeat music makes people feel more optimistic and positive about life; a slower tempo quiets people's mind and relax their muscles (UNR). A speaker that connect to a voice recognition system can be attached to the head of the upper layer. When no vital activity is perceived, the pod will play music that is naturally relevant, and when someone enters the space, the user can play his or her preferable music.

4.3 Material

A product must consider the relevant properties of the product material. Karana Elvin proposed a "Material Driven Design" idea that facilitate designing for material experiences. In addition, according to "The Role of Materials Identification and Selection in Engineering Design," Deng and Edwards recognized the importance of materials identification and selection for engineering design problem solving. Material is a bridge between designers and users. Beyond its primary function, material can also give users different feelings through its touch, quality, texture, and color. Moreover, environmental friendly and decomposable material is more welcomed nowadays.

In this design, the material has to be strong enough to support the progressive stacking of each row of modules as well as the weight of the plants and soil medium. The modules also need to be flexible enough to create a bending form that meets the feasibility of achieving a spherical geometry while also being suitable for mass production. Given each of these performance needs, the bio-based material called Gutta-percha would appear to be an excellent option.

Gutta-percha is a white filamentous and ropy gelatinoid produced from a tree species, called Eucommia Ulmoides (Missouri Botanical Garden). It is abundant in this tree's leaves, pericarp, and seeds (Yang & Huang 13). Gutta-percha's molecular chains contain double bonds, which means that it can be vulcanized. The process

of vulcanization can also be called cross-linking, the process of chemically joining two or more molecules by a covalent bond under certain temperature and pressure conditions (Vitz). A B-stage Gutta-Percha that its crosslink density is controlled in a certain range is a shape memory material because of its crystallization at room temperature and its elastic deformation after heating (Lu 26). Therefore, this design would take advantage of the vulcanized Gutta-percha at Stage B (Li et al 18). With that said, once it is reheated above the melting point, it becomes soft again with its rubbery elastic characteristic and quickly turns back to its original vulcModification and Application of Nanized state (Yang & Huang 13).

The model will be made entirely of this material, while the module legs and neck, and the top and bottom parts are the most important parts that reflect the features of gutta-percha. The diameter of a module's leg is 0.91 inches, while the diameter of the neck is 1.6 inches. The two legs each has a protruding semi-column foot underneath that helps the leg stick within the neck tightly. Therefore, at room temperature, the two legs of the modules are designed to be of a size that cannot fit into the neck. Taking advantage to the material's plasticity and shape memory feature, warm up the module in 60°C hot water or use a heat gun, and stretch the legs until they are able to be inserted into the neck. While cooling down, the legs return to their previous appearance and dimensions and are able to be stuck within the neck tightly. In addition, considering that the angle of each module needs to be adjusted to meet a geometry need during the construction

process, legs can bend in different directions to a certain extent depend on user needs. For example, to construct a semi-sphere pod, the module place at the very bottom and top of the pod is more closed up together. While, the module in the middle layers are far apart, so the legs of the modules are pulled wide apart.

According to “Research Progress on Modification and Application of Natural Eucommia ulmoides Gum,” E. Ulmoides is an ideal sound absorbing material that can be used in conjunction with certain other materials such as Chlorobutyl Rubber (CIIR) (Leng 55). This composite material may have better sound absorption properties in higher temperature regions. Given that the pods will be located in public spaces that require some privacy, the noise reduction features of E. Ulmoides composite can help achieve this effect.

To conclude, the Pod adopts gutta-percha as raw material ensures the feasibility of this design structure production. The module is potentially light in weight, strong in quality, and solid in connection. It is also flexible in modeling and assembly, convenient in production and transportation, and well capable for sound absorption. Adding on to that, the material provide a great many tailor-made options for users to determine any number of components to be used and any spatial functions to be composed. Beyond forming a pod shape, several modules could build a green wall; a single module itself could be a flower pot or decoration placed in any occasions, such as dormitories, counter tops, classrooms.

On the other hand, an article regarding biotechnology model testing shed light on the impact of incorporating biomaterials in interior spaces which “encourages new further interdisciplinary studies to to search for the possibility of formulating a new complete sustainable interior design” (Akaby 1). as a renewable bio-based polymer material, it is environmental friendly and could fix carbon dioxide under global warming (Leng 57). Thus, using Gutta-percha is of great significance in this human-nature-integration related research.

4.4 Seating

The comfort of seating also determines whether students can enjoy staying in the space. Form, structure or materials in the nature as used for furniture design both for aesthetic and practical purposes. Interior architecture has also been influenced by increasing popularity of Biomimicry (Tavşan). Pebble Pillows, for instance, is a cushion in stone shapes and colors (Pebble Pillows). Several of these pebble cushions can be placed in a pod which accommodate one or multiple people. On the other hand, a single seat can correspond to a modular shape, consisting of two support legs and a seat that rotates back and forth, promoting the space with a certain integrity (Figure).

4.5 Color

Moreover, it is suggested to add certain colors to the raw materials while 3D-printing to provide more color choices. With the interactions between products and people,

colors and emotions are closely linked (Gremillion). According to "Visible light and the eye's response," color is "a psychological and physiological response to light waves of a specific frequency or set of frequencies imping the eye. Physicist Christiaan Huygens proposed that the refractive index of light is affected by wavelength, resulting in different colors seen by the human eye. When light of a given wavelength enters the eye, a chemical reaction is activated that results in an electrical impulse being sent along nerves to the brain (The Physics Classroom). Then, the brain processes the information and form our perception of color. Since red has the longest wavelength (NASA Science), it triggers opposing emotions and is often used in places of warning (Gremillion). Green light's wavelength is much shorter, which means it absorbs and reflects less light and reduces the stimulation of the human eyes. Therefore, the color of a stress reduction product should use short wavelength tones, such as violet, blue, and green. Appropriate color choice and matching can not only satisfy users' visual enjoyment, but also guide and regulate adults' subconscious and emotions.

Based on the results and feedback from previous surveys and co-creation workshops and color analysis mentioned above, the model can consider applying the following options: 1) white; 2) light tiffany blue; 3) light brown; light pink & violet; 5) random gradient color. White is pure and clean; it goes well with green plants, after all, less is more. Light violet and light blue have shorter wavelengths than warm colors. These shorter wavelengths make the colors less irritating, and more calming. Some of these colors have low saturation and do not show a jumpy and intense look.

5. TESTING

Be able to implement a test, the prototype were done through an easily accessible material and were simplified into an easy-assembled triangular module. Each equilateral triangle is designed and made of cardboard, laser-cut, and is one foot in length. Each can be folded along a vertical line, with four notches as joints that are easy to assemble (Figure 25). The malleability of cardboard allows the folding necessary for each piece to be changeable and adjustable according to the splicing condition. On a 6 x 6 round green carpet representing grass (Wayfair), a loop formed by several stretchable plastic strips holds the first layer of 18 triangles in place. Around a hundred triangles were used in this 7x7 foot modular product.

Plants are one of the most common and efficient natural elements, and they are a key component of building this pod. The plants were bought from Walmart, HomeDepot, and Wegmans; among them, Peace Lily, Pothos, Superba Robusta

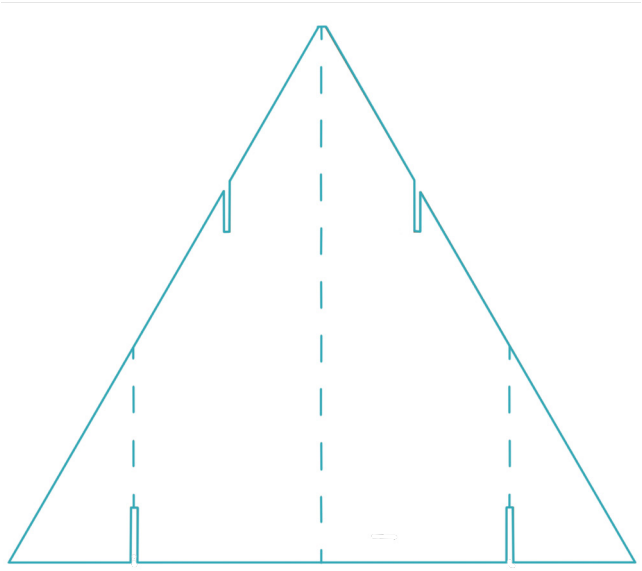


Figure 25: A simplified test module is a triangular shape with four notches; it is foldable along the dash lines.

Snake Plant, White Bird Of Paradise, Sansevieria Laurentii Plant, Dumb Cane, Bosten Fern, and the Majesty Palm Tree. These particular plants were chosen because almost all of them require indirect sunlight, and they are easy to grow in various environments, requiring low maintenance with high drought tolerance, especially Superba Robusta Snake Plant (Monrovia), White Bird Of Paradise (Combiths), and Golden Devil's Ivy (Mahr). They are also good for air-purifying in that they naturally filter harmful pollutants (Walmart). These plants were placed within and around the pod that canopy over the user. Plants with dense foliage are placed in high positions to block the view of passers-by. Plants with large leaves are deliberately placed in positions oblique to where a user sits so that they act as a natural screen to ensure a private space. The close proximity of the leaves to the user also creates a stronger interaction between humans and nature in the space.

Over the course of a month, the pod was placed in two different locations for testing. The aim of this variation was to see whether the pod design has met all the expected objectives of providing a relaxing environment for adolescents. The first test took place between Feb. 21st and the 28th in the first-floor corridor of the Syracuse University Shaffer Art Building (figure 26). Afterward, the pod was placed from March 7th to the 14th by the east window on the first floor of the Bird Library (figure 27). Students of the university were able to sign-up online to test the pods, or random passers-by were allowed to stay 5-7 minutes. Users were not restricted to any form of activities or behavior, including the use of electronic devices.

Figure 26: The first test took place on Feb.21st - Feb. 28th at Syracuse University Shaffer Art Building.

Figure 27: The second test took place on March 7th - March 14th at Syracuse University Bird Library.

In addition to the visual and tactile nature of the experience, the natural smell was considered as well. Every once in a while, the plants were watered, causing an organic compound called geosmin, which lingers around moist soil-water, to release a pleasant rising smell (Flärdh & Becher) that enhanced a sensory experience. Additionally, ear buds were provided during testing, on which students could listen to a selection of audio recordings of nature. Not surprisingly, as summarized in the first survey, students prefer to do activities surrounded by nature rather than in nature. Some students did not feel that natural sound would make them relax; instead, they thought that listening to their favorite music, even the intense one, would fully boost their relaxation mood.

It is important to note that, during this time, participants were asked to wear an Apple Watch to accurately monitor their heart rates. The approach by measuring resting heart rate is chosen based on an article that described seven possible ways to measure stress (Glyn). Thus, before participants entering the pod, they needed to sit still for five minutes to ensure that their heart rate was steady. This is to make external factors at a minimum since breathing rate may strongly influence heart rate variability. Participants were asked to press a button on the Apple Watch (Apple) to collect heart rate data twice right before and after entering the pod. The instinct of most participants was initially to look around before choosing to read a book, play with their phone, or meditate within the space. Twenty students for each pod location were studied in detail. A total of 40 complete sets of data were

collected, including survey results, heart rate changes, and observation records.

According to the SingleCare Team, people's heart rate would go up about 15 to 20 seconds from sitting to standing because their heart had to increase its pulse rate to move more blood to their muscles. Even so, the data from the heart rate monitor, in tandem with the student feedback, indicated lowered stress levels to some extent. In the first test at Shaffer, the heart rate dropped by an average of 4.25 beats per minute (bpm) among the 20 participants. One student exceeded 100 bpm, but only three had an increased heart rate. During the second test at the library, heart rates dropped 4.4 bpm on average, and five of the twenty had increased heart rates (Figure 28).

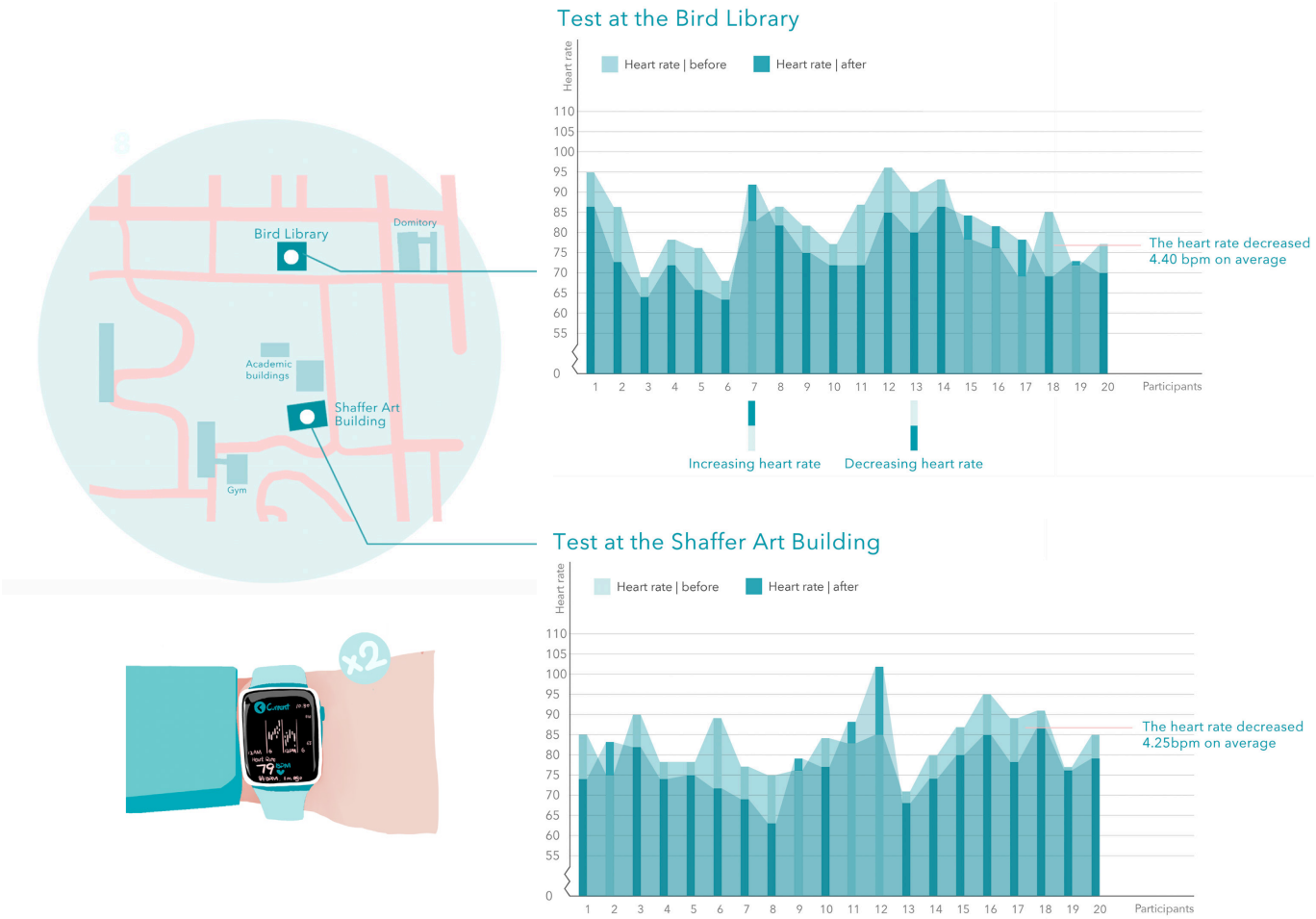


Figure 28: Heart rate changes before and after entering the pod in the two tests at Shaffer Art Building and the Bird Library.

Although the heartbeat is a visual indicator of stress, we should not take it with a grain of salt. Because stress is difficult to measure, it needs to be tested from many aspects. A blood test to check electrolytes and toxicology screening are suggested to assess stress and depression (Bruce). Moreover, according to Kaori Nakanishi, an implication of alpha-Klotho was recently introduced as a biomarker of stress. Thus, only examining the change in heart rate is not enough.

On the other hand, there are still intangible problems that have not been fully verified. For example, the presence of the investigator will possibly make the participant uncomfortable in the environment, so the heart rate may be affected. What is more, since participants were informed about the therapeutic experiment, their expectation of a lower heart rate might also have led to erratic results. In addition, an increase or decrease in heart rate within a certain range during prolonged sitting is considered a normal change. Heart rate is likely to remain constant when people rest, sit or stand (reviewed by Rehman). Therefore, although the heart rate data are of practical reference value, the reduced heart rate does not fully demonstrate a short-term reduction in stress. However, it is worth affirming that most of the participants evaluated this stress reduction device positively both in the post-experiment survey or during the interview. They described seeing, hearing, smelling, and actually being surround by natural elements, that the feeling of relief is real.

Based on the survey and the number of people who completed the assessment, this choice of site was deliberate. The Shaffer Art building and Bird Library were the two places where students mentioned they want to relax the most in the survey. Although the architecture building is also a top vote, especially that the architecture students are particularly stressed out, the space is lacking some diversity in major. For instance, in addition to art students, there are also students majoring in film, design, and music, as well as students who are non-art majors taking elective courses in the Shaffer Art building. Adding on to that, the Bird Library caters for more diversity that not limited to majors. On the other hand, the difference in essential functions between the Shaffer Art Building and the Bird Library is the other reason why the two sites were chosen to test and compare.

During the non-test period, cameras were placed at each site to study the impact of the site on user experiences by observing students' reactions. The first pod was located between the gallery and the auditorium in the main hallway of the Shaffer Art Building. Students' flow varies according to class hours and gallery visits. In this artistic building, where there is a creative and engaging atmosphere, the pod seems to be an interesting and vivid art piece to students. Students, mainly in art majors, appear in groups of two or three and are willing to stop by, discuss, and express their curiosity about the work with excitement. The pod's opening, half of which faces the east gate of the art building, is mostly used by students and gallery visitors for exit (Figure 29). In this way, students would not be distracted by others so that their privacy could somewhat be ensured. Since several students

participated in both sites, they commented on several differences based on their experiences. Bird Library has a quieter learning atmosphere, and the pod was placed near the study and print area. The pod's opening is half facing an aisle, with some large plotters and cutting tables around (Figure 30). The flow of people in that area is relatively even, but the total amount of space is larger than the art building. Instead of appearing in groups, students were more likely to walk by alone and at a fast pace. During the day, a lot of study booths around the pod were occupied. Based on the camera observation and later feedback, those students who were interested in the pod would either speak in a low voice or seem embarrassed and shy if they were the only ones experiencing the pod. It is boldly assumed that the usage of pods will vary according to the flow, location, and environment. If the pod was placed in a discussion area on the basement floor of the library where participants could talk loudly, or on the fourth floor, where there were fewer students around, the feedback would be possibly different.

In terms of seating, students provided a variety of feedback on the comfort of the white sofa cushion used during the test. Some students were not able to lean down since the cushion does not have strong backrest support. The seating is also low for them to easily get up. Interestingly, some other students preferred being low because this would create a more enclosed and private space by having the plants envelop over them. Future accommodations will be arranged based on the size, height, and comfort level of the seating.

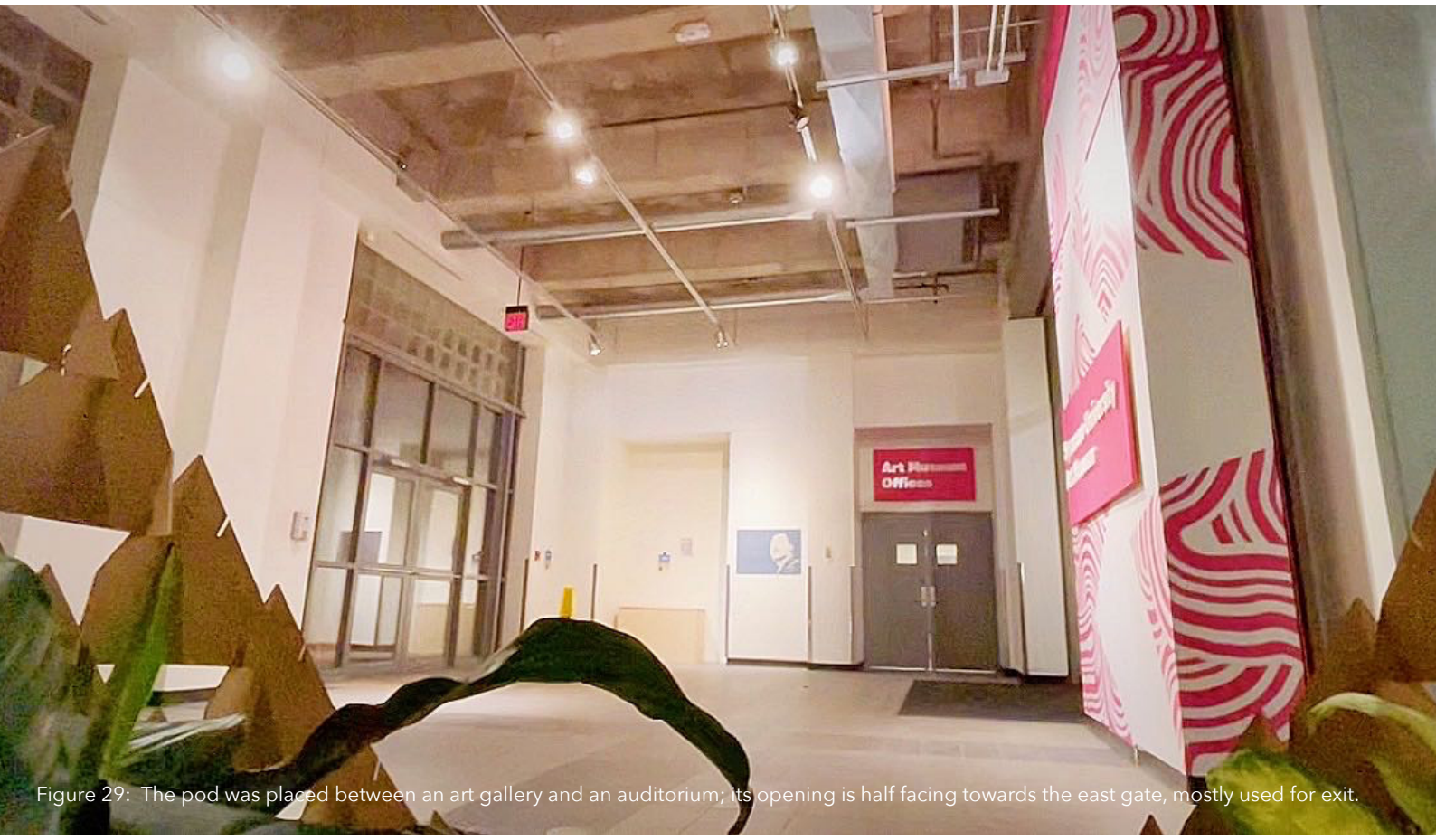


Figure 29: The pod was placed between an art gallery and an auditorium; its opening is half facing towards the east gate, mostly used for exit.

Figure 30: The pod was placed near the study and print area; its opening is half facing the aisle surround by some large plotters and cutting tables.

Interior designs with natural elements to boost mental health are common in the market. Plant walls and artificial lawns are largely being used in offices nowadays to facilitate productivity and well-being. Amazon's Seattle-based building, "The Spheres" (Figure 31) utilizes 40,000 plants to create a stunning urban oasis (Schlosser). The cost depends on the scale and maintenance of the space. In contrast, the product design industry is majorly privatized but lacks natural elements. Small pods, like the Mini Tranquility Pod, costs $30,000 (hammacher.com), and the Evolution Float Tanks cost upwards of $10,000. On the other hand, Archipod (Figure 32) is an environmentally friendly office design costing $20,000 (Garvey). It has a shape and texture of a coconut; however, its biomimicry solution is on the exterior rather than the interior. Therefore, there aren't any natural element-based relaxation pods currently in the market that target use by a younger demographic in public spaces.

Figure 31: Amazon's Seattle Sphere utilizes 40,000 plants to create a stunning urban oasis (Scholosser).

Figure 32: Although Archipod is designed as a garden office, its biomimicry solution is on the exterior rather than the interior (Garvey).

6. FUTURE OUTLOOK

6.1 Bio-Design & Robotic-Plant-Human Interaction

Nature is a gift to humans, providing us with passive forms of energy. As early as 3000 BC, in ancient China, the act of making silk according to the biological properties of silkworms was one of the earliest examples of learning from nature in human history. Silk, therefore became one of the earliest fabrics invented by humans and is widely spread today (Schreiner). However, as technology develops and human civilization advances, human inventions typically require the use of brute force, like mining ancient carbon and a multitude of harmful chemicals (Biomimicry Institute). Today's mission is to think of how to create conditions that are conducive to life, just like nature does. Earth has been developing efficient ways of living for 3.8 billion years (Schreiner) until, in the past half-century, humans began to practice biomimicry. According to the Biomimicry Institute, biomimicry is the practice of learning from nature and imitating strategies in nature to solve human design challenges and find hope. Biomimicry provides an empathetic, interconnected understanding of how life works and where humans ultimately fit in (Biomimicry Institute). "Can Biomimicry Affect Human Psychology" by Deshpande introduces the usage of biomimicry and biophilic in architecture and interior spaces, and the strategy is categorized into five attributes: 1. Environmental features 2. Natural shapes and forms 3. Nature patterns and processes 4. Evolved

human and nature relationships 5. Place-based relationships. Biomimicry can impact the users in both physiological and psychological ways (Deshpande).

Nature nurtured humans, and humans invented machines; however, the effect of machinery on nature depends on human activity. The theorem of peaceful coexistence or complementarity between man, machine, and nature is the most idealized state of the future. Elena Sabinson, a Ph.D. student at Cornell University who works on architectural robotics and is fascinated with emerging technologies and how to implement them so that they increase empathy, self-awareness, and wellbeing (Sabinson). Several of her research study, such as the "large-scale soft robotic surfaces to support emotion regulation," was inspiring. Learning from biology and nature to guide design aimed to facilitate the interaction between robots, plants, and humans of the Pod. A positive example, called the "PlantWave," is an auditory device on the market, which regards to biophilia that affect human. It helps people immerse themselves in nature and listen to the music of plants. This device detects slight electrical variations through two electrodes placed on the plant leaves. These variations are graphed and translated into a continuous stream of pleasing music (PlantWave).

Inspired by these nature reflections through stimuli, in terms of the speculative bio-design, the pod is expected to facilitate interactions between plants and humans through robotic mechanisms with the goal of amplifying a student's experience

with plant agents for subconscious relaxation. Since human heart rate is often an indicator of stress, linking this data to plant behavior in response to stimuli (e.g., plants emit scent when they detect human stress through bio-signals) could be a way to address stress levels. Therefore, this research enacts a system that gathers human responses to nature-based stimuli in the form of real-time biofeedback. Within each module, underneath each flower pot there is an electric-paint-based sensor (Bare Conductive) that picks up signals from the person in the space and feeds this data back, activating the mechanism of the bowl dependent on the vital signs of the individual. If the person in the space is detected under stress, potted plants in different directions will slowly align and turn at different angles, gesturing towards the person with the help of its mechanism base. During this process, the plant moves from an upward position to an angle (Figure 31 no image right now) that not only positions the leaves closer to them but also better blocks the view of the outside world, creating a more enclosed private space. In this new ethical environment, humans will benefit from the peaceful intersection between nature, society, and technology, maximizing the positive effects of biomimicry.

6.2 Cross-Culture Solution

The versatility is highlighted through each pod's user-centric customizable level of the canopy as well as size. The modular system addresses student cultural

differences regarding their comfort in space closeness. A more comprehensive understanding of human behavior and analyze culture. According to Tim Meko from the Washington Post, “how close is too close depends on where people come from. “This is a culture-related discussion; that is to say, people with different cultural backgrounds may define a certain size of a pod differently; for example, a 7 by 7 feet space is perhaps large enough for a Korean but might be slightly small for a Zambian. “Cultures share some commonalities,” said Tim Meko, “women preferred more personal space from strangers than men in almost all of the countries studied. People living in warmer places tended to keep less distance than those in colder climes. And the older you are, the farther away you stand” (4). Since there are many factors investigated in this design, the cultural aspect is not involved; however, it is clearly known that students with different gender or stress levels already have different needs in degrees of closeness, reflecting in the survey feedback. Just like some people are shy to sit in a public massage chair and freely express the comfort they feel, they are instead more concerned if their wallet is stolen after closing their eyes. Interestingly, Willy Chen, a first-year physics major at SU who has experienced the pods twice, commented:” If the private pods somewhat appear in groups, I swear there will be more people joining in.”

Therefore, more pods of different sizes, open or enclosed, will meet the needs of more students than just having one or two isolated pods on campus. Especially given that the United States is a diverse country, both racially and ethnically

(Lumen). This takes into account, to a greater extent, the psychology of introverted students who are unwilling to go to the only pod in a public space viewed by others due to their cultural orientation. All in all, the pod's ability to be injected into a public space as a standalone product is a testament to its ubiquity, making it easy for students to use.

6.3 Disability and Accessibility

In addition to able-bodied adolescents in college, those students who have any forms of physical or mental disabilities face many challenges common to their typically developing peers, stated the Centers for Disease Control and Prevention (Maxey & Beckert). They are five times more likely to suffer from mental, emotional, and behavioral health disorders (Darcel). In this regard, especially for adolescents with disabilities who study and live with able-bodied students on campus, psychological comforting devices, like the pod, would ideally be helpful to them. While the exact situation has yet to be verified. In addition, for adolescents with physical disabilities, the pod are needed to be sufficiently accessible. Though he pod is 7 by 7 ft that conforms to the 5 by 5 ft turning radius of a wheelchair, stipulated in the ADA standard. Nevertheless, it is necessary to consider that the original seat in the pod should be retractable for wheelchair access.

7. CONCLUSION

Adolescents seem to be easily stressed compared to adults, and researchers have paid close attention to their mental health problems. Because of the development of brain regions, the adolescent brain is more anxious than the adult brain (Bellace). This research study is an exploration related to the theme of "mental health protection" in the context of urbanization, resulting in adolescents spending less time in nature and being more stressed than ever before. With exposure to nature proven to ease stress, natural elements in interior spaces such as plant walls and Anji-plant have become part of the mainstream in recent modern interior design. Those natural elements, or perhaps just a photo of a tree (Reynolds), may lighten the psychological burden on adolescents in a stressful situation and benefit all by improving mood, enhancing concentration, pacifying emotions, etc. Given that students are unaware of their mental stress and often do not seek help, it is of great importance for us to heal our younger population through natural measures proven to assist in mood, contentment, and satisfaction.

Therefore, the survey and co-creation played an essential role in obtaining students' needs for nature as well as considerations of nature applications in interior spaces. A large proportion of students, already stressed, expressed their willingness to be with nature. In addition, many people want a public space where they can spend time managing their emotions and "buffering" their stressful lives.

The types and forms of natural elements result in sunlight, green plants, fresh air, natural sound, etc. The investigation results in an indoor pod shape that originates from the Mongolian yurts. What sets this pod apart from other designs is the idea of easy-to-install modularity, which can be tailored to accommodate a variety of spaces. In addition, the pods come in different sizes from an inclusive and holistic perspective, and they are adjustable depending on the available space. The ease of production and the quick assembly/disassembly may better facilitate users' needs. Each plant operates in either an open or closed state, many with broad leaves for maximum privacy when necessary.

Material plays a crucial role in design. Gutta Percha, an environmentally friendly bio-material is selected as the basic component material of this pod product. After heating, B-stage Gutta-Percha with a shape-memory and elastic deformation properties can help to realize geometric spaces that are difficult to achieve with commonly used materials. During the assembly or removal process, the neck of a module is heated and is able to be deformed at 60°C so that it wraps the two legs of the other modules and fixes them after cooling down to room temperature.

What is more, testing a prototype helps us gain a greater understanding of adolescents' expected level of closeness or proximity if one pod to another, location of placing the prototype, and the need for any sensory-based interaction with nature.

Finally, there is still room for improvement in this research and design. The ideal pod has a dome-shaped upper ceiling. The test pod does not have that enclosed effect, which may make a difference to the students' experience. What is more, issues associated with manual watering and maintenance are not a long-term solutions due to the fact that pods will be put into use in batches. A drip irrigation system can not only save water but also keep the soil moist for a long time In addition, water may distribute evenly in each plant and can prevent overflow (Jarwar 29). Prospectively having small water pipes buried within each module can be applied to ease monthly maintenance. Alternatively, self-cleaning paint could also be put into use in the future. Adding colloidal silica to paint enhances its self-cleaning properties and makes it last longer while keeping sustainability in mind. From a biomimicry point of view, it is referenced from the lotus leaf, which is waterproof and dust-free (AkzoNobel).

Although the product is aimed at 18-19-year-old older adolescents, its beneficiaries can extend to any group of professionals who have been exposed to high-pressure work environments, as "relatively simple adjustments in working environment may possess important preventive effects" (Frank 2022). In addition, placing pods in commercial buildings is expected to promote people's working efficiency. While placing pods in other public spaces, such as shopping malls and airports, also improves customer satisfaction and comfort. The pod could also be a fun place for young children to play, suggested in an article, "Spatial Design of

Childcare Facilities Based on Biophilic Design Patterns." Moreover, participants in hospital rooms with indoor plants reported less stress (Dijkstra K et al.).

All in all, the pod has great potential based on this study in the field of children, mental health, sustainability, and biophilia. This is a year-long program that aims, through design, to interact with environments both built and natural so as to release stress plaguing our adolescent population. Such a green pod makes the interior space on campus brighter, more lovely, and more vivid and addresses the need for private relaxation enclosures in public spaces throughout our campus.

8. APPENDIX

Survey for Developing a Nature-Based Design For Academic Stress Reduction in 18-19-Year-Old Adolescents 1

If you have already fill out the survey in the past, please check this box and go to question 16.

*** 1. What is your gender?**

Female
Male
Prefer not to say
Other (please specify)

*** 2. What is your year of birth (e.g.., 1998)?**

Message box

*** 3. What is your major?**

Message box

4. What city are you studying in?

Message box

*** 5. How stressed do you feel on a daily basis during the academic year?**

Not Stressed at All 1	2	3	4	5	6	7	8	9	Most Stressed 10

*** 6. If you are stressed, what are the usual causes? (Select all that apply)**

Study issue
Work (job-related) issue
Family issue
Peer/teammate issue
Financial issue
Health related Issue
Other (please specify)

*** 7. What are the usual BEHAVIORAL effects of stress you've noticed on yourself in school?**

Message box

*** 8. What are the usual PSYCHOLOGICAL or EMOTIONAL effects of stress you've noticed on yourself in school? (Select all that apply)**

Message box

*** 9. What are your personal methods to relieve stress? (Select all that apply)**

Message box

*** 10. Overall, how able could you handle stress when using the method selected from the list above**

Not Able at All 1	2	3	4	5	6	7	8	9	Very Able 10

*** 11. How often do you walk in nature when you are stressed?**

All the time
Very often
Several times
Rarely
Never

*** 12. According to Q10, does it make a difference to your stress level?**

Yes
Maybe
No
Other

*** 13. What do you enjoy doing in nature?**

Message box

*** 14. Could you think of any types and forms of natural elements that help you with reducing stress in interior spaces (e.g Angi-plant; plant wall; a photo of a flower etc.)?**

Message box

*** 15. Where and when do you think a stress-reducing element is needed and appropriate (e.g in my dorm when I want to blow off steam; at the Barnes Center after I experienced peer pressure, etc.)?**

Message box

*** 16. What color(s) makes you relax?**

Message box

Would you like to participate in a in-person space testing for the follow up? A model based on this research topic will be taken place in the gallery of the Shaffer Art Building between Feb 21st and 23rd. please leave your contact information below only if you would like to participate and leave some feedback.

Name you prefer:
Email Address:
Available time:

Survey for Developing a Nature-Based Design For Academic Stress Reduction in 18-19-Year-Old Adolescents 2

Feedback

*** 1. Could you please use a a few words to describe the space/your feeling?**

Message box

*** 2. How stressed do you feel now after experience the space?**

Not Stressed at All 1	2	3	4	5	6	7	8	9	Most Stressed 10

*** 3. How able does the space help to make a difference to your stress level?**

Not Able at All 1	2	3	4	5	6	7	8	9	Very Able 10

*** 4. Do you want to have a space like this on campus?**

Yes
Maybe
No
I don't care
Other

*** 5. Where do you think a space like this is needed and appropriate on campus?**

Message box

6. If you have any feedback, please leave more comments here.

Message box

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10. CURRICULUM VITA

Ting Kang

April, 5th 1998
M.F.A Design
College of Visual & Performing Arts
Syracuse University

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China 100086

Education

M.F.A. in Master of Design, Syracuse University 2020.8 - 2022.6
GPA: 3.82/4.00 New York, USA
Course highlights: inclusive design, service design thinking, bio-design, art therapy
Honor: 2022 Master's Prize of School of Design, 2020 Forever Orange Scholarship

B.F.A in Environmental & Interior Design (EDI), Syracuse University 2016.8 - 2020.5
Minor: Management Study, Whitman School of Management New York, USA
GPA: 3.33/4.00
Course highlights: interior architecture, sustainable design, data-visualization, vulnerable group study, painting
Honor: Fall 2016 semester Dean's List of College of VPA

Competencies

Language: English, Mandarin (first-language)

Software: Graphic design: Adobe Photoshop, In-Design, Illustrator, AutoCAD, Sketch, ProCreate
3D modeling & rendering: Rhino, SketchUp, Grass-Hopper, Revit, KeyShot
Film editing: Final Cut Pro
WPS: Microsoft Word, Excel, Powerpoint

Hand Rendering: Pencil sketching, acrylic/oil/watercolor/Chinese-ink painting, sculpting, paper quilling, etc.

Intern & Work Experience

Beijing Jingneng Real Estate Leasing Operation Co., Ltd. **Engineering & Design general management** 2022.8 - present
Beijing, China
- Carried out relevant procedures in the early stage of each project, such as preparing the notice of award, contract, etc.
- Participated in regular meetings with designers, supervisors and construction parties during each project to ensure smooth and safe construction
- Controlled monthly payment nodes of different projects, and prepaired and integrated required document

David J. Tucker Architects **Project Member** 2019.9 - 2020.1
New York, USA
- Carried out field research, site analysis, measurement, and design for the Syracuse 119 Jasper Street refugee housing reconstruction project
- Conducted 3D-modeling via Revit and floor-plan drawing via AutoCAD, in strict compliance with ADA Standards
- Responsibled for customizing space arrangements and selecting color schemes, and interior furnishings according to the needs of refugee users
- Composed and edited construction and contract documents

BLVD Architectural Consulting Co., LTD., Beijing branch **Interior Designer's Assistant Intern** 2018.5 - 2018.7
Beijing, China
- Participated in the commercial-to-residential design project of Sanya Vanke DaDuHui Metropolis Villa by 3D-modeling with SketchUp, and floor-plan drawing with AutoCAD and Photoshop
- Drew floor-plan, selected furniture, coordinated with other departments for the bidding project of HuaXiaXingFu Hilton Hotel of NanXun

Tsinghua Culture Industry Planning Design & Research Institute **Intern** 2017.6 - 2017.8
Bejing, China
- Composed the cultural industry plan report (more than 50,000 words) of the Xigaze City Government of Tibet Autonomous Region of China
- Completed the project documents and assisted the project leader with presentations

Beijing ShengbaoLong Garment Co. LTD **Fashion Designer's Assistant Intern** 2017.5 - 2017.6
Bejing, China
- Assisted fashion designer with body measurement for the bidding project of Rosewood Sanya Hotel, Wanda Hotel, etc.
- Used advanced Photoshop skills in Fashion Design, and applied theories of aesthetics to practice

Campus Work Experience

Newhouse School of Public Communication, Syracuse University **Graphic Assistant** 2020.10 - 2022.2
Guided undergraduate graphic-design students with graph editing, formatting, composing, & video-editing in Adobe Photoshop, Illustrator, InDesign, Final Cut Pro, etc. (one-on-one tutoring time more than 100 hours) New York, USA

- Assisted students in developing aesthetics, commerce, and concept related projects; looked over hand renderings and provided feedback, and developed individualized plans for students

Design Thinking Workshop, Syracuse University **Student Founder/ Speaker** 2020.10 - 2022.1
Co-founded the Design Thinking Studio with Professors Don Carr and Kate Hanson. New York, USA
Engaged in the study of the Humanities and promoted Service Design Thinking strategies to students and faculty from college of Visual and Performing Arts and College of Arts & Sciences

- Studied the use of Design Thinking from a multidisciplinary perspective and promoted the application of design thinking to individuals, schools, communities, and other disciplines

Finance Coaching App Design Project, Syracuse University **UI/UX Designer** 2021.2 - 5

- Participated in a Finance App Design called "Coiner," regarding daily financial tracking and personalized counselling New York, USA
- Conducted preliminary research and built the APP framework, formulated alternative design plan using Service Design Thinking strategy

Product Design Communication's Project, Syracuse University **Professor's assistant** 2021.4 - 5

- Assisted Professor Isabel Prochner in her research on the use of different chest corsets in the transgender population by conducting preliminary research, market analysis, and classifications, etc. New York, USA
- Drew research literature illustrations via ProCreate software

Thesis & Book Chapters

Kang, T. (2022 - Present). Master Thesis: "A Study and Design for Alleviating Older Adolescents' Academic Stress Through the Use of Natural Elements in Indoor Spaces"

Kang, T. (2022. 5). Public lecture at Beijing MoGu Art Gallery: "Healing Through the Arts During Post-epidemic Era."

Kang, T. (2022. 4 - 6). "A Stress Releasing Pod." 2022 M.F.A Thesis Exhibition — Steady/Retcon at the Point of Contact Art Gallery, Syracuse, NY.

Prochner, I., **Kang, T.**, Chen, Z., & Lu, H. (2021). "Casual sex during the COVID-19 pandemic: risks, recommendations and spaces for design intervention. In E. Tsekleves (Ed.)," *Little book on global health: Special edition on COVID-19* (pp. 48-51). ImaginationLancaster 2021. The Little Book of Global Health 1- Design & Covid-19.

Don, C., **Kang, T.**, Zhang, Y., Kang, Jy., Tabatabaeimanesh, F,. Lu, H., Chen Zr,. Yung, Pt. (2020). The "Inclusive Capsule" Design -- An interdisciplinary effort to promote independence and move from binary to inclusive transportation solutions. Research proposal for DOT Inclusive Design Challenge held by the United States of America Department of Transporation.

Kang, T. (2019). Undergraduate Senior Thesis: "A study and Design of Color Implications and Spatial Arrangements in a Kindergarten That Affects Children's Physical and Mental Health."

Kang, T., Zhai, Wy., Wang, Bn. Ma, Zw., Luan Nq. (2014). A Chinese U.M.P Patent: "A New System and Device For Nutritious Gardening Water Production." Nq. Application No. 201420323338.6.

Competitions and Awards

Master's Prize, 2022 Syracuse University VPA College School of Design 2022.5
Forever Orange **Scholarship**, 2020 Syracuse University 2020.5
Dean's List in recognition of superior scholarship for the Fall 2016 semester, Syracuse University 2016.12
Gold medal, 2014 Germany, Nuremberg International Juvenile Invention Exhibition (iENA) 2014.10
Second place, 2014 China "Solve for Tomorrow" National Youth Science Innovation Experiment Competition, Beijing Division 2014.9
The first inventor of the Chinese utility model patent "plant nutrient liquid preparation device." 2014.9
Level 9 (1-9) in pencil sketching, graded examination for Fine Art in Society China Academy of Art 2008.5

Extracurricular Activities

President & team player of the Syracuse University Badminton Club 2018.9 - 2022.6
Miscellaneous award in Mixed doubles, Women's doubles, & Singles, Division A or B, Crystal City Badminton Open, Rochester University Badminton Open Tournament, etc. 2016.9 - 2022.2
Designer & Editor at the Promotion department of Syracuse University Electronic Sports Club (NACG) 2018.3 - 2020.5
Graphic Designer of "iBranch," an official Graduate Student Organization of the School of Informational Studies at SU 2018.3 - 2019.9
Ranked 5th in the YONEX "YuLinZhengBa" Badminton Team Tournament, Beijing division, China 2019.6
Level 9 (1-9) in Piano, graded examination for Music in Central Conservatory of Music (CCOM) 2008.5