In this paper, we present a simple and intuitive approach for designing a new class of space-filling shapes that we call Generalized Abeille Tiles (GATs). GATs are generalizations of Abeille vaults, introduced by the French engineer and architect Joseph Abeille in late 1600s. Our approach is based on two principles. The first principle is the correspondence between structures proposed by Abeille and the symmetries exhibited by woven fabrics. We leverage this correspondence to develop a theoretical framework for GATs beginning with the theory of bi-axial 2-fold woven fabrics. The second principle is the use of Voronoi decomposition with higher dimensional Voronoi sites (curves and surfaces). By configuring these new Voronoi sites based on weave symmetries, we provide a method for constructing GATs. Subsequently, we conduct a comparative structural analysis of GATs as individual shapes as well as tiled assemblies for three different fabric patterns using plain and twill weave patterns. Our analysis reveals interesting relationship between the choice of fabric symmetries and the corresponding distribution of stresses under loads normal to the tiled assemblies.

https://www.youtube.com/watch?v=pdPCP-T-3_A

Augmenting Spatial Cognition Capabilities of Future Workforce to Enhance Work Performance in Altered Environments Using Virtual Reality

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Emerging technologies signal that the future of work is transforming. Such work will involve the exploration of unfamiliar natural spaces such as deep space, low Earth orbit (LEO), deep ocean, and polar regions. Enabling the future workforce to work in such environments will require new research to examine and augment human cognitive ability. This will influence education, training, and performance across a wide array of disciplines. However, current approaches for simulating altered environments and training the workforce are not cost-effective, feasible, and safe. This study will perform fundamental research combining Virtual Reality (VR), eye tracking, and electroencephalography (EEG) technologies to inform design principles for scenario-based simulations and games to train the future workforce to adapt to, and work in, altered environments. Our focus is on spatial-cognitive abilities, which can profoundly influence human work performance as they represent the ability to perceive, orient, mentally manipulate, and navigate in an environment, real or virtual, familiar or unfamiliar. Our main goal is to understand how spatial cognitive processing differs in environments with unfamiliar visuals and/or gravitational properties, and how VR-based games/simulations can be created to train future workforce to adapt to work in such environments. We integrate the principles of information modeling, VR, fixation analysis, EEG, and aerospace engineering to conduct research on spatial cognitive processing in altered environments.
How far outside our disciplines should we venture in search of innovation through interdisciplinary collaboration? This presentation will discuss how unlikely partnerships between psychology, psychiatry and architecture are leading to creative solutions that advance well-being in and out of the workplace. The Texas A&M Health Science Center Telehealth Counseling Clinic (TCC) provides virtual counselling sessions to their clients with mental health problems. TCC has established the community-based participatory model to increase access to services by working with the communities, especially those in rural, remote areas with no mental health professionals. The counselling sessions are currently delivered in traditional offices with teleconferencing equipment. The College of Architecture and the Center for Health Systems & Design have involved in the development of an open-office setting with telehealth booths, which can maximize space without sacrificing the well-being of clinicians and the quality of counselling service. The collaboration started with a graduate architectural design studio where the clinicians and designers closely worked together to create the prototypes of telehealth booths. The prototypes were tested by undergraduate researchers funded by the College of Architecture Summer Research Grant. The booths are currently under construction at the Automated Fabrication & Design Lab. A post-occupancy evaluation will be conducted after the booths are put into use in an open-office setting. This presentation will describe a feasible way to integrate interdisciplinary research into design studio projects, and the roles and responsibilities that all parties play in a successful Design-Research-Build project.
Immersion in Virtual Reality in Planning and Landscape Architecture Education: A Case Study of Bonn, Germany

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Field studies and experiential learning are critical in urban planning and landscape architecture education. However, traditional field trips or study abroad programs are often costly and can be inaccessible to financially disadvantaged students. Further, in the face of the disruptive impacts of the COVID-19 global pandemic on international travel, there is a need for alternative equally-engaging educational approaches. Recent advancements in virtual reality (VR) and augmented reality (AR) offer new ways to support novel educational infrastructure and instructional delivery methods. The objective of this study is to develop and evaluate an innovative virtual study abroad experience via “human-digital-context-time” interaction (HDCTI). By utilizing advanced 3D and VR technologies, we develop an interactive digital twin of the city of Bonn, Germany to provide an immersive platform for students who are unable to travel abroad. The Bonn study abroad program is offered yearly in the College of Architecture (CoA) and is therefore used as a testbed for developing and evaluating the VR platform. The research provides contextualized, real-time in-situ instruction, self-directed data gathering and sharing, and immediate feedback on student actions.

After working with multiple agencies and organizations to gather digital modeling data, the immersive VR platform was constructed in three steps. First, based on comprehensive evaluations of the efficiency, compatibility, and model outcomes of digital 3D modeling tools, a workflow was developed to integrate multiple software packages (e.g., Geographic Information Systems (GIS), CityEngine, and Sketchup) and construct a detailed large-scale digital 3D urban model of Bonn. Second, the model was imported into Epic Unreal engine for high-quality texture, ambient adjustments, and detailed rendering. Third, a tour was configured based on the city’s existing Heritage Trail to resemble real-time visits, where users wearing an Oculus Rift device can freely explore the urban landscapes within a predefined perimeter. Interactive widgets are currently being tested for movements between key destinations, displaying learning materials related to each site, and allowing students to store their own textual and media data. Role play game (RPG) features will be also included to encourage active participation in the learning process and allow students to directly upload metadata and add ground truth information as sites are visited in real-time.

Our findings so far show that the VR experience can achieve the desired visual quality and interactivity that support the learning objectives of a study abroad tour. Although the project is still ongoing, we have identified several key capabilities of the platform that strengthen planning and landscape architecture education. The interactivity features allow students to provide real-time metadata, ground truth information, and conduct lessons related to the digital information provided. Beyond a single timeframe, the platform also creates a digital spatial database for students who physically or virtually participate in the study abroad program, which can be analyzed and remodeled over time. This can also act as a dynamic design tool where new planning and design solutions can be experienced, and design alternatives can be compared, which supports scenario-based design and offers new channels for empowering community members in design decision making. Finally, the process integrates disciplines related to computer science, construction science, landscape architecture,
Video Production

architecture, urban planning, and visualization into a single platform, thus encouraging collaboration between students within and beyond the CoA.