A Pedagogical Retrospective: Gamifying the Konza Prairie through an Interdisciplinary Studio

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Abstract: Recently we embarked on developing an interdisciplinary pedagogical approach that integrates concepts of virtual reality and gaming design to leverage these technologies' potential to influence how we interpret, visualize, design and analyze environments. The approach was developed as part of an advanced studio at Kansas State University led by two professors and represented by students across three different disciplines: landscape architecture, education and computer science. The entire project consisted of a core studio, buttressed by a seminar and technical module. We refer to the courses and project as "Studio Konza." This retrospective paper highlights why this effort was undertaken, what resources were required, how the game was conceptualized and developed, what milestones were achieved, and what challenges remain for continued development and application.

Keywords: Pedagogy, gaming, virtual reality, Konza Prairie, unreal gaming engine

1 Introduction

The emergence and incorporation of virtual reality (VR) and gaming engines into landscape architecture is relatively nascent. VR technology continues to accelerate with a rapidly growing outlook and adoption across numerous industries. As the hardware becomes more readily available, cheaper and better, the integration of VR enabled architectural software has become more common. However, for landscape architects, forays into VR landscapes offer some viability, but are generally limited to small area sites which are not vegetation heavy (SONG & HUANG 2017, HILL 2019). Large area and plant intensive landscapes which mimic complex and diverse ecosystems remain a challenge. Overall progression of VR/gaming technology has been unprecedented in the last decade, but integration within landscape architecture studio pedagogy has been attempted but is not widespread (SLEIPNESS & GEORGE 2017). The slow uptake into studios is not simply due to hardware and software capability and cost; but we suspect, due instead to the lack of a systematic understanding of the challenges, benefits and actualization of the technology within a pedagogical philosophy.

The purpose of Studio Konza was to develop an interactive computer game in a VR world enabling students to learn project management and visualization skills while aiming to bridge research and outreach taking place at the Konza Prairie. The Konza Prairie Biological Station (KPBS) is located just outside of Manhattan, KS. KPBS activities occur over nearly 3,500 hectares of the largest tallgrass prairie research effort of national significance in the United States. KPBS aims to study key issues facing the remaining 4 % of the original extent of tallgrass prairie (SAMSON & KNOPF 1996). KPBS is one of the original six National Science Foundation's long-term ecological research (LTER) sites. Our aim was to develop a virtual Konza Prairie thereby encouraging online visitors to "virtually participate" in the KPBS activities because it is quite remote and access to many activities is restricted to the public.

Apart from supporting the educational goals of the KPBS, we believe the learning outcomes of Studio Konza entailed broader significance by educating landscape architecture students

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who will soon enter the professional realm to assume greater societal leadership roles as synthesizers, integrators, and shapers of environmental knowledge and public engagement with nature. This includes both placemaking in the built environment and being advocates for better understanding and protecting threatened natural landscapes like the tallgrass prairie. In *The New Landscape Declaration*, leading voices communicate the skills and perspectives that landscape architects offer for the twenty-first century: "…we learn to work in *transdisciplinary teams* where we will blossom as *synthesizers*, as generalists with a specific skill: (spatial) design." (SIJMONS 2017, 129); landscape architects are *integrators of the qualitative* "…wherein qualities of place, identity, experience, interaction, and exchange enhance a profound human sense of belonging, community, and enrichment." (CORNER 2017, 66) [written in context of cities, but we think equally applicable to natural landscapes]; and "Landscape architects have opportunities to take on representation beyond the *static image*. Rather than an afterthought to design, contemporary media can help *shape* our design and research processes and create better links to the place that the built [or natural] environment holds in the mind of the public today." (KARAMAN 2017, 144) [all italics by author of this paper].

This paper highlights our pedagogical retrospective. We wanted to provide insights into how we approached developing a video game-like experience that focuses on the interpretation of the landscape and prairie research activities taking place. Throughout this process, students learned vital skills about the storyboarding process and gameplay development in an interdisciplinary context. The course followed various parallel activities: exploring theoretical foundations of game development, integrating Next Generation Science Standards (US-based federal educational program), and learning VR immersion in a short-course technology laboratory. In consortium with students, we developed a better understanding of the software suite necessary to establish a large project, by identifying how common software available to most educational institutions can be integrated in developing similar projects.

2 Planning and Conducting the Interdisciplinary Studio

2.1 Studio Inception

The origin of Studio Konza traces back to a master's project and report by WEBB (2015) in which she envisioned a virtual tour of the Konza Prairie where visitors would hike between research stations featuring various aspects of the prairie ecosystem (Permian geology, prairie flora/fauna, etc.) and earn "badges" after participating in prairie research activities. For example, one such activity was monitoring weather conditions to initiate a controlled prairie burn. In total, over 39 "story points" were developed and spatially located via Geographic Information Systems (GIS) to build out the education narrative and guide future game development. The storyline was also graphically defined with an aesthetic "look and feel". These initial efforts provided an inspiration and baseline from which Studio Konza was conceived. Several parties were interested in continued development, including the Kansas State University Beach Museum and the Flint Hills Discovery Center (a gateway experience to the Konza Prairie).

2.2 Studio Planning and Organization

Two threshold goals were set for developing the game: 1) create a virtual prairie that accurately represented topography, habitats and dynamic aspects of the prairie (e. g. wind, fire, grazing, sounds), and 2) develop game play that highlighted various aspects of research taking place at the KPBS to stimulate STEM interest in K-8th graders as end-users. Pedagogically we were also interested in placing university students in a highly interdisciplinary environment where problem solving, distributed development requiring close coordination, and subject matter outside their normal area of familiarity were all sought.

After reviewing WEBB (2015), it was apparent that a gaming engine was required to facilitate the extent of player/environmental interaction that we desired. Precedents for Unreal (JOHNS & LOWE 2005), Unity (SORIA et al. 2018 and HAYEK et al. 2016), and CryEngine (BISHOP et al. 2012 and HAYEK et al. 2016) gaming engines exist for landscape architecture projects. We selected Unreal because lighting and shading are optimized for large vegetated environments and its blueprint-style interface is similar to Rhino/Grasshopper. Further, Unreal provides existing code snippets from Unreal's self-produced "A Boy & His Kite" project complete with YouTube-based video training and free highly realistic environmental assets.

The entire studio approach was developed into a single semester course bundle that included a formal studio (5 credits), a seminar that was highly interdisciplinary (2 credits) and a skills-based, student-led computer lab (2 credits) to support student learning of software and hardware (Table 1). The studio consisted of over a dozen students from three departments across campus: landscape architecture (LA), education (ED), and computer science (CS) who were all enrolled in different courses with an equal focus on the common project. Group dynamics and project ownership played a key role in ensuring active participation across students and taught valuable lessons of multi-disciplinary projects. While building 3D games does not typically fall within the scope of the disciplinary practice, the storytelling and application of technology offers essential skills for the next generation of landscape architects.

Table 1: "Studio Konza" coordinated course bundle and associated topics

Studio (5 Cr) – Game Dev	**Seminar (2 Cr)** – Ecology Ed	**Lab (2 cr) –** Technical Skills
Review of WEBB MPR	Educ. Gaming/Storytelling	Getting Started with Unreal
Brainstorm (gaming genres)	Instructional Design	Model Meshes & Lighting
Gameplay (game concepts)	Park Management & Visitors	Ecosystems & Plant Assets
Survey: Team Preference	Konza Ecology & Fire	Unreal Topography & Realism
Check-in 1: (Workplan)	Soils, Topo, & Konza History	Photogrammetry & Modeling
Check-in 2: (Konza VR)	Insect Ecology	Plant Creation
Check-in 3: (Game Activities)	Wildlife – Avian & Bison	Procedural Foliage
Final Product Delivery	Environmental & Ag History	Game Time! (mini-games)

2.3 Game Development

The wealth of research emanating from the KBPS is vast which made it difficult to prioritize what aspects of the prairie students wanted to include in the game. To help facilitate this process and increase prairie ecology knowledge among our students, we organized over a dozen guest speakers across numerous fields to present their areas of expertise. Topics ranged from environmental history, grassland ecology, geology, weather and climate, fire ecology and others. Students filtered these topics into specific tasks within the gameplay environment. The first task students developed was intended to mimic conservation efforts to account for changes in bird populations. The pedagogical process facilitated the need to prioritize important and programmable tasks ensuring that students from all three disciplines (LA, ED and CS) could contribute to the outcome. Task tracking was done through Microsoft Teams.

The creation of the video game began by having students research and present the range of different game-types, from educational to epic adventure games. Next, they developed their own storyline, game art, and gameplay activities (Fig. 1). Students adapted these into the Unreal gaming engine by combining models made in 3D software, procedural landscapes and terrain optimization techniques. Several different elements were included in the game: realistic and autoscaling terrain (Fig. 2), vegetation (Fig. 3), character animations (e. g. bison and birds) (Fig. 4), weather, location-accurate bird sounds (Fig. 5), and prairie fire animation (Fig. 6). After much deliberation, students decided to create the game as a learning-first approach as opposed to an adventure-first approach.

Students developed these elements using their own studio computers, and then each element was combined onto a more powerful 3D gaming computer. Student computers consisted of Xeon 3Ghz desktop with 16-32GB RAM and at minimum an NVIDIA Quadro graphics card with 2-4GB memory. The gaming computer was in Intel i7-8700 4.6Ghz processor with 32GB RAM and an NVIDIA GeForce GTX 1080 graphics card having 8GB memory.

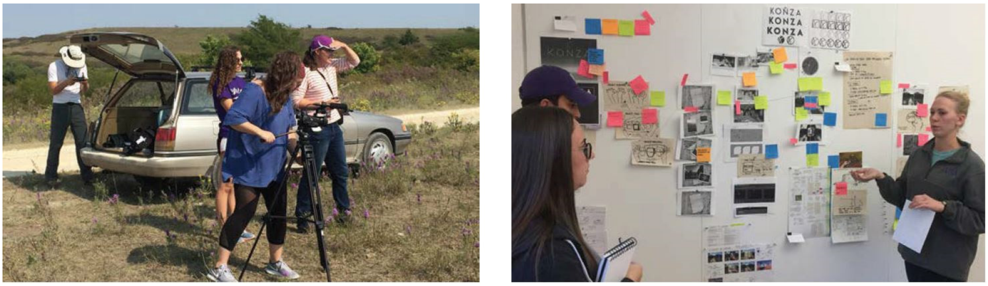

Fig. 1: Students collected ground-level and cinematic aerial videography via a drone, and spent considerable time storyboarding the game

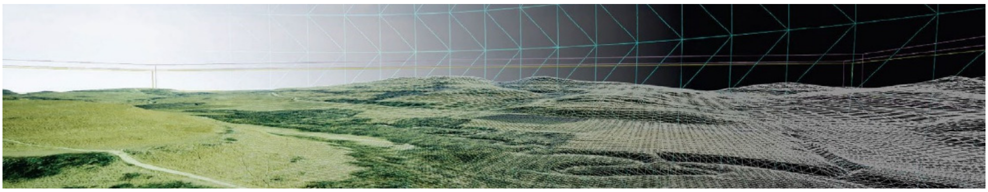

Fig. 2: *Terrain* – Auto-scaling terrain where tiles of different resolution dynamically swap from high resolution underfoot to lower resolution in the distance

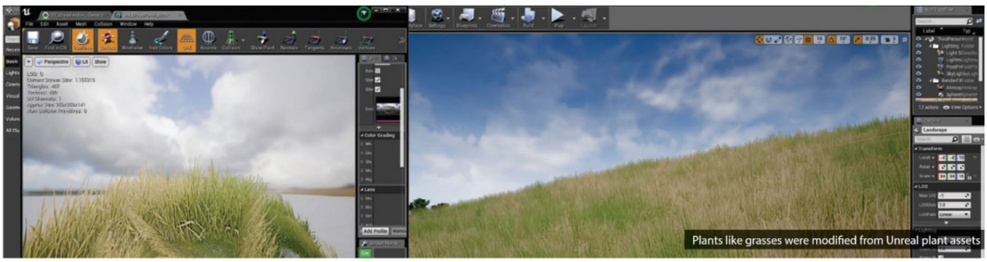

Fig. 3: *Flora* – Populating 3,500 hectares of grassland was a challenge and low plant diversity remained a shortcoming

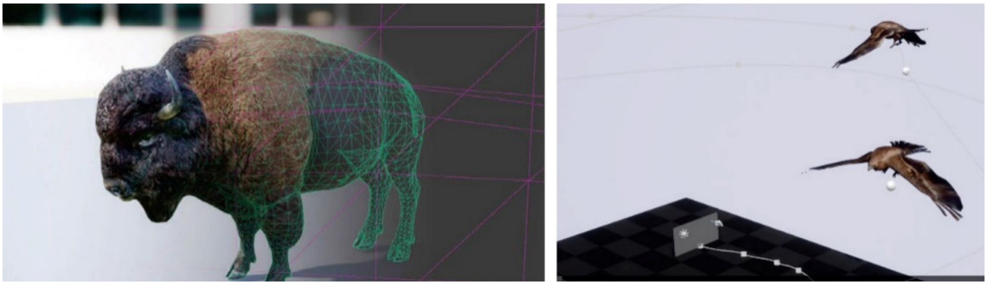

Fig. 4: *Fauna* – Assets like bison and hawks require animation pathing and controlling pre-rigged sequences. A sparrow tagging animation was part of a "research" activity

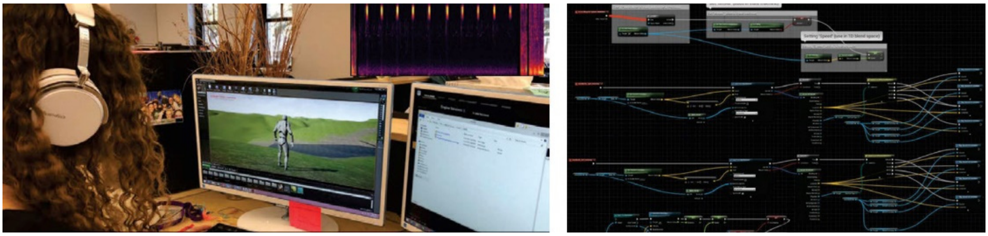

Fig. 5: *Sound* – Different surface texture sounds were location specific, and bird calls were spatially correlated to various habitat types like upland and riparian areas where they would most likely be statistically found. Image on right is the sound blueprint.

Fig. 6: *Fire*–Much Konza research is focused on comparing grass health and production relative to grazing and periodic controlled burns. Initiating a controlled burn (left) under the correct VR weather conditions (right) became a priority game activity.

2.4 Game Development Accomplishments

Goal 1: Creation of Virtual Prairie Environment

Game development Goal 1 was to allow players to hike through a VR landscape that realistically depicted expansive topography, diverse vegetation ranging from grassy rolling hills to riparian woodlands, moving prairie animals and birds, dynamic weather, fires, and spatially accurate sounds. The studio was successful in developing many of the game components, but limited time precluded combining the components into a real-time environment. Specific accomplishments included:

- Using World Machine software, prepared multi-scalar terrain from LIDAR data with varying level-of-detail (LOD) for 3,500 hectares;
- Built headquarters building (SketchUp) and floating orb (Unreal) for opening sequence (touching floating orbs is the way that many game events are activated);
- Applied several purchased assets (hawks, sparrow, bison, and fire);
- Customized vegetation by modifying texture maps on standard models;
- Procedurally covered terrain with grasses and trees based on aerial imagery;
- Sounds were keyed to underfoot surface types (gravel, wooden footbridge, etc.) and bird calls from the Cornell Macaulay Ornithology library were spatially correlated via GIS to bird surveys conducted by field researchers.

Goal 2: Simulation of Field Research Activities

Goal 2 was a major impetus for game development since the LTER Konza Prairie is foremost a biological research site and allowing game players to "conduct" VR research would allow a distant audience to better understand this internationally threatened landscape. Game ideas were developed for 15-20 research activities, and three were selected as priorities: grasshopper sparrow (Ammodramus savannarum) tagging, controlled burning, and interactive weather monitoring. Goal 2 proved challenging since it required developing a "heads-up" display to control game interaction and feedback, character animation/control, agent-based modelling, and dynamic linking of environmental variables. Only two activities were partially achieved: 1) getting a grasshopper sparrow to fly up out of the grass into a net for tagging, and 2) igniting fire that smokes and leaves charred residue but was not linked to weather conditions. Another, perhaps more efficient hybrid approach is presented in the Section 4 Discussion.

3 Pedagogy Results

3.1 Successful Milestones Reached

From a pedagogical perspective, we think the interdisciplinary studio and course bundle approach was a success. Overall, the technical threshold of developing plant intensive VR landscapes with some degree of interaction through gaming engines is being lowered by software requiring less deep coding and a burgeoning support community offering extensive tutorials and purchasable game assets to shorten development time. Nevertheless, the Studio Konza project was ambitious and required a multidisciplinary team of students and advising experts to connect ecological knowledge, landscape aesthetics, Next Generation Science Standards (education component), and computer science support. For the landscape architecture students, nine cumulative credit hours spread across three coordinated courses enabled substantial and focused progress beyond which we initially thought possible for students having zero game development experience.

3.2 Challenges Encountered

Implementing game activities that represented the range of research activities being conducted at the KPBS in an engaging virtual world proved challenging. As the process of creating a virtual Konza unfolded, we realized that the technological challenges and process bottlenecks would limit the amount of content we could develop. Unfortunately, when we undertook this teaching experience, our gaming engine of choice limited simultaneous multi-user interactions during the development phase. Students had to develop their own tasks anticipating that someone could pull all these different works together into a single product. This model is not conducive to the traditional semester-based pedagogical approach because it relies too heavily on a single person to deliver the final product. Most important to the timeframe, this was an ambitious project. The technological hurdles combined with the class' preference to ensure the gameplay experience aligned with ecological processes made it prohibitive to complete the Konza project in one semester.

4 Discussion

To counter challenges evolving in the virtual research activity efforts, we decided to create an education-focused group to explore simpler technologies to incorporate wide ranging documentation being collected by the studio: aerial drone imagery, 360-degree field video, video of research field activities, interviews, and hundreds of photographs. As a result, an interactive web map was developed to spatially locate the research activities and serve as a navigation hub for virtually touring research stations across the site. These contents were created in such a way that they could be later embedded into gameplay but could also stand alone as a website resource. We used the Next Generation Science Standards (NGSS) to support the development of online exercises that would appeal to elementary students and the general public. Applied to game development, it might be easier to hike to locations within the VR environment and activate a floating orb which triggers a pop-up video where actual researchers in the field explain and show the research being conducted, instead of trying to virtually replicate most research activities. Some activities like initiating the controlled prairie burn in VR could still be implemented. This would be considered a hybrid approach.

5 Conclusion and Future Development

The pedagogical risk we underwent to develop a studio of this complexity was no easy feat. It took a significant amount of student-led effort and a willingness to constantly revise priorities. While we did not achieve game development completion as envisioned, students learned what it takes to overcome some major technological hurdles and how to prioritize tasks. In summary, the outcomes of this studio deepened landscape architecture students' understanding of prairie ecology, taught them the foundational aspects of large area virtual landscapes, enabled interdisciplinary collaboration, and provided them the opportunity to develop greater problem solving and project management skills. By undertaking a project with little precedent, we believe the student learning was at its best and will prepare them to excel in their future careers.

Since it is doubtful that we will again be able to bundle three courses towards a singular focus within a dense curriculum, continued development will likely require funded research by a faculty member who can provide continuity over time. To that end, the students did a good job documenting tutorials and resources used and leaving an archival record.

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