Bespace: Realism and the Design of Virtual Space

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ABSTRACT

Bespace is a synchronous web3D lecture hall and performance system that seeks to tap the educational and entertainment potential of virtual space. Its underlying interactive methodology is focused on the efficient delivery of information within the space. The entire virtual environment is treated as a one interface. Principles of human computer interaction are applied to the activities, avatars, and architecture. The outcome is an environment that utilizes the power of a digitally created reality and does not sacrifice usability in pursuit of realistic appearances. Bespace's interactive methodology seeks to implement the promises made by the early pioneers of virtual space.

ACM Classification: H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

General terms: Design, Human Factors, Documentation, Performance, Reliability, Experimentation, Standardization, Theory

Keywords: web3D, X3D, virtual reality, distance learning, education, avatar, multi-user, game, shared, simulation.

I. THEORY – FUTURE, PAST & PRESENT

The foundation for Bespace is the assertion that an avatar is, in the abstract, a four dimensional point for data exchange (x,y,z and time) and that it is bound to an individual user. The avatar is generally seen in the domain of realism, as a humanoid representation endowed with gestural expression, but this viewpoint limits its functionality to a narrow band of realistic activity. To address the limits of realism, a second broad assertion must be made. Realism is not a goal, but a means to achieve a goal. Realism is a method of generating behaviors or beliefs within a user. These assertions, on realism and the nature of avatars, allow for unique insights into questions of content development and user interaction.

One insight on realism and the nature of avatars, is the cognitive divide that arises between behaviors and beliefs that drive user interaction and the users ability to express those behaviors and beliefs. This divide can be addressed through the conflicting functionality of interfaces and environments. In a sense, this new divide replaces the form based construct of contrasting 2D against 3D with one based on functionality. As form now follows function, it becomes free of realistic constraints. Past failures are easy to perceive though this new lens of a divided virtual domain, though the divide of interfaces and environments.

A harder task is to refocus this abstraction forward into practical application. Creating content, building new native interactions and architecture, we can begin with film theory and use Noel Carroll's construct of real world invention vs. filmic convention. Unfortunately these ideas, individually straightforward, are also sweeping and hold radical implications. To appreciate them and Bespace requires an exploration of the past and present state of virtual design theory, through which Bespace can be fully understood. It also requires a long look at realism.

Bespace offers practical examples of a broad, abstract theory of virtual design, yet its full impact is difficult to express in current academic terms. Furthermore, the primary example in this paper, Bespace as education hall, is only one of several explorations of these underlying principles. Other works include musical performances, poetry readings, and experiments in human cognition and communication. As a whole, these works revive the ideas of previous generations of virtual design. In the early 1990's, abstract visions of virtual cyberspaces with isovists and liquid architectures, were plentiful. Authors such as Michael Benedikt, editor of Cyberspace: First Steps, would offer the following dream-like viewpoint:

Cyberspace: Through its myriad, unblinking video eyes, distant places and faces, real and unreal, actual or long gone can be summoned to presence. From vast databases that constitute the culture's deposited wealth, every document is available, every recording is playable, and every picture is viewable. Around every participant, this: a laboratory, an instrumented bridge; taking no space, a home presiding over a world. ... and a dog under the table.

In the 1990's, developers and educators embraced these idealistic views. Visions of virtual classrooms, immersive learning programs, and museums built to situate knowledge have been described in books, panels, and papers across the academic spectrum. Computer scientists, architects, education specialists, literary theorists, and HCI scholars agree that virtual space holds the potential to be a powerful educational tool. (Trindade, Fiohais & Almeidia 2002; Ware 2000; Winn, William & Jackson 1999; Murray 1997; Norman 1993; Benedikt 1992).

This potential remains untapped. The visionary viewpoints melted into the mundane and excessively obvious. Scholars have turned away from broad dreamscapes and applied their energies towards the narrow goal of creating faux physical realities. There has been economic and educational success in this direction. Simulations of activities in physical space have proven their value. Flight simulators, military and police training, drunk driving simulators, and educational role playing games support experiential learning and have many other practical benefits.

However, for the study of virtual space, the question of visionary potential remains. The first sections of this paper critically examines the existing virtual works in academic structures such as the ACM, the IEEE-VR, and various journals and conferences like SIGGRAPH, UIST and Presence. Part III. Bespace: Form follows Function discusses the Bespace project and its' offering of an alternative theory of virtual space - a direction in which "the rules of reality need not apply" (Sutherland, 1965).

II. REALISM ADDRESSED

Realism, Goals and Missing Research

It is not unusual for papers in the ACM library that cover virtual space to declare that there is little research concerning their targeted area of interest. While these papers typically acknowledge that a great deal of research has been done, they fail to explain why little research has been undertaken in their area of interest. Lev Manovich, in "The Language of New Media" creates a plausible explanation when he declares that there is no overall philosophy guiding the development of virtual space. Manovich states ACM library holds a collection of narrowly focused, unrelated papers that can only be loosely grouped by a shared goal of realism. These narrow explorations of virtual space in the ACM library fail to build any unified understanding of the medium. Despite a large body of work, designers lack a foundation on which to build.

Mavovich, citing Bordwell's work on the development of film, states that realism offers a tangible goal for hardware and software development. Fast rendering, rich textures and cast shadows are not unimportant; they are useful tools for developers. From Bordwell, realism is a competitive edge and plays a powerful role in the marketing of hardware and 3D engines. For content developers however, realism is not the end goal. Their end goal is typically one or more of the following: to educate, to entertain, or to accomplish a productive task. Realism is a only means to deliver that goal. When realism interferes with the achievement of these goals of entertainment, education, or achievement, the design discards or distorts the realistic elements accordingly.

Most developers recognize that realism holds a number of problems, yet their response is often more editorial than example based. None in the ACM, IEEE-VR, or the journal Presence have dealt with the matter in depth and with examples. At best we see respected developers, such as Ivan Poupyrev acknowledge myths – manipulation techniques should be 6DOF and that we should focus new devices and techniques. Poupyrev states that constraining the DOF and moving away from 6DOF is needed. He states that it is possible to design virtual environments that maximize the performance of existing techniques. Both these suggestions move us away from realism. Sadly he offered no examples of these newly designed virtual environments and no principles to guide their development. Other researchers have made similar remarks, and a few have offers somewhat more in the way of guiding principles. In a 2003 paper entitled "Why Not Make 3D interfaces Better Than 3D Reality", well known HCI author Ben Shneiderman places the obvious question in plain sight. It is worth noting that the very fact that in 2003, the question of making 3D interfaces better than reality is still just that - a question - highlights the failure of the entire academic domain to move beyond realism. In his paper, Shneiderman's advice is good, but still somewhat general. Borrowing from his HCI experience Shneiderman offers a number of guidelines for 3D development including:

- Minimize the number of navigation steps needed by users to accomplish their tasks.
- Avoid unnecessary visual clutter that distracts from or inhibits user tasks.
- Simplify object movement; use predictable paths and less than 6DOF
- Organize groups of items into aligned structures for easier access.

Unfortunately, how these guidelines could be implemented is unclear. Examples and applications of even these basic constructs is not offered. This is disappointing as Shneiderman himself suggests a look at novel interactive approaches but does not follow up on the matter. This problem extends out to academia as a whole. Web3D has over ten years worth of work that runs the gambit of design possibilities. New and novel ideas, readily available online and that have been displayed by major art institutions like the Whitney and the Guggenheim are untouched by academia. There are no critical, comparative papers discussing the interactive and structural design of online worlds in the ACM library. At best, we see lists of features, singular academic projects or narrow papers on interactive techniques – similar to those of Poupyrev. Given the issues of content and interactive development in virtual space, it is unforgivable that ten years worth of online work is undocumented, unreviewed, destined to disappear without a trace and also that comparative philosophy with a set of tangible design examples that could provide a means to link disparate virtual projects, as noted by Manovich, is unavailable.

Examples of new and novel ideas are exposed by Bespace, often to the extent that it addresses issues others may not have seen as problematic. Additionally, Bespace, with its avatar as a four dimensional point for data exchange and realism as method mechanism, far exceeds the boundaries of realistic behavior, and for those with a realistic mindset. may be difficult to comprehend. This is hinted at as other developers, armed with Poupyrev's and Shneiderman's advice, still fall prey to the allure of realistic interaction.

The Problematic Allure of the Real

The 2005 UIST conference offered a call to solve the problem of 3D interaction. A competition was proposed and new and novel ideas were specifically requested. The task that was proposed as the test however was problematic. The task involved the moving of virtual silverware from a virtual kitchen counter to a virtual dining room table. While the improvement of object selection, manipulation in 6DOF and navigation of space is important, the baggage of realism has closed off the structure of the environment and the objects themselves to Poupyrev's and Shneiderman's suggested improvements. Silverware, knives and spoons are objects that were invented to fit the human hand and assist the physical task of eating. In virtual space, neither the hand or the need to eat is present. Borrowing from pop-culture convention - there is no spoon. In designing interaction around a spoon one can only assume a realistic, simm-like function. The spoon would be carried by a fake avatar hand and used to lift faux food from a virtual plate. The placement of this non-existent spoon is dictated not by what is best for a user but by the imposed rules of the realism which states that items to be touched should be placed on a platform that allows easy access by a hand, which is attached to an arm on a physical body. Contrast this with the real reality, in which a user interacts in virtual space through mouse, keyboard and screen. Here a divide emerges for the developer, as they must choose to design for a faux hand, arm and body - that exist in the environment or see the space as interface and add elements and interactions optimal to mouse, keyboard and screen. While game designers generally resolve this by placing environments in interfacial frames, the trend seems to be one of losing the frame.

Just as realism forces a number of rules on the developer, a user embedded in a realistic scene seeks to respond accordingly. Interactions within most virtual spaces are screen based and driven through mouse and keyboard. There is then an immediate cognitive conflict. Users can see the book on a shelf and understand that it contains knowledge, but they have trouble in moving through the space and interacting with the book itself. Realistic space triggers a desire for realistic interaction (Guynup 2003).

Figure 1 – Library at Adriane - (Sonstein, 1996)

Seeing a book in the Library at Adriane and understanding its function may inspire the user's desire to thumb through it. Yet, the user has no thumbs! The scroll-wheeled, twin-buttoned mouse is no replacement for an adaptable, sensitive, and expressive human hand. A mouse offers only scrolling values along the x and y planes. A hand gives a full six degrees of freedom for both the object and its pivot point. This addition of a mobile pivot point gives the human hand 9DOF not 6. Putting this type of expectation on mouse and keyboard is at best clumsy and at worst frustrating and a failure. Simple interactions required by the physical world are often unwieldy in the simulated world embedded in the computer screen.

While some scholars may offer object manipulation strategies for interacting with the book, the computer in the Library at Adriane exposes an interactive truth: No reasonable person would attempt to use a mouse and keyboard to use the mouse and keyboard on the other side of computer screen. The goal is to tap the power of the computer not emulate it's interface for nonexistent hands. One need only look to high end 3D modeling software and note they are at least comfortable with mouse and keyboard. They lack the burden of realistic interplay and can focus on GOMS driven processes to achieve their goals.

Surprisingly, as realism is seen as a goal and not a problem (Manovich 2000), its unclear if any ACM scholars have formally addressed this basic issue, that realistic space triggers a desire for realistic interaction. It is certainly true that there is an awareness of it. Game developers adjust their spaces to train the player as to what realistic objects are interactive and what are not. Yet in games, these object manipulations are typically kept as simple as possible, chances for failure are limited, and realism is occasionally broken to highlight the proximity of an interactive object.

Academia seemingly has taken a completely opposite path. There are scholars who take the desire for realistic interaction in virtual space and it’s subsequent failure as justification for more realism. To them it fails because it is not realistic enough (Shaw 2002). Their approach has correctness about it and an appeal for those creating two-handed gloved input devices. Their approach also has a cyclical quality in that any failure in a realistic space can seemingly be fixed by more realism. In general, however more realism brings more failure, solvable again only the by the addition of more realism. The final solution is the worthy goal of perfect simulation. Perfect simulation is problematic as the real world is becoming increasingly virtual. RFID, Bluetooth, GPS, proximity sensors, video in real-time, and tricked-out cell phones all create new computer driven abilities for people. It seems odd then that inside the computer, the place in which the power of digital media can be most sweepingly expressed, it focused on creating the most mudune aspects of our world.

Interface – Environment & 2D – 3D

This conflict between interface and environment is rooted in the mixed desires and goals of the user. It is seen when the simplicity and clarity of task-oriented interfaces are contrasted with the richness and diversity of an enthralling environment. This conflict is manifested in the separation of input tools (mouse, keyboard and screen) and the behaviors users wish to accomplish in virtual space (getting a book from the shelf and reading). An overview of this division, this cognitive divide includes the following characteristics:

Environments:	**Interfaces:**
• Immersive	• Transparent
• Larger than the user	• Smaller than the user
• User responds to it	• Responds to the user
• Value created through Time (Experience)	• Values speed & measured by GOMS (Immediacy)

The key element is the issue of response. In a purified, theoretical sense environments move the user. They create user action and in contrast interfaces are tools through which these actions are taken. In reality this divide is not clear, there is overlap. It is however much more useful to designers than ascribing meaning based solely on a division between 2 and 3 dimensions.

The impact of the divide between interface and environment appears when scholars propose the use of agents in virtual space. Rarely do these scholars address the well documented failure of anthropomorphic design (Chittaro, Ranon & Ierorutti 2003). Projects that would immediately be rejected in a 2D space are lofted upwards by an additional third dimension. It should be stated clearly that anthropomorphic design suffers from complex AI issues and that an additional third dimension only complicates matters further. At best humanoid guides offer a means situating goals in a narrative content, in creating tasks. As an aid in task completion they are currently a well documented burden not a benefit.

To be fair AI is improving, the use of guides in the game and education environment is successful. game developers are also using the concept of pets aggressively. Its worth noting that players may treat pets as real, they use pets as tools, as weapons, as a bit of the interface separated by character properties. Buttons are pressed and it acts.

Realism & Immersion: Lessons from Film

Often conjectures on the uses of virtual space tack towards storytelling, and narrative driven spaces that allow authors to explore human behavior and activity. In this light, the Holodeck on Star Trek is in fact a plot device. The Holodeck functionality is in service to the storyline, generally as a conflict generator due to failed safety protocols.

Janet Murray's *Hamlet on the Holodeck* paints a picture of realistic-looking worlds that immerse the user in interactive game-play. From a design perceptive, she cautions against "celebrating the affordances of the media." Breaking away from realistic scenes and behaviors of physical space may break the sense of immersion, un-suspending the disbelief of the user. The result is a retreat from the abstract, user-centered visions of virtual space.

Murray's warning is predicated on the idea that the user exists in a story space. Narrative becomes the primary principle of design, as all objects must now work within the confines of a believable or realistic story. Behaviors within the virtual world must fit the cognitive definitions set by their historical and environmental settings. Within the virtual world, usability concerns are delegated to issues of object manipulation and avoiding objects while walking. Questions of usability regarding the world as a whole, its architecture, its objects, the activities of the users, and the abilities of their avatars are predefined by the story.

Stories and simulations situate the user in an alternate reality. High quality textures, millions of polygons, and accurate physics contribute to the believability of a virtual space. However, in simulations and stories the goal is not to be realistic; it is to be believable and/or place knowledge and experience in the minds of the user. Film theory offers several unique insights on the matter of realism.

Film is often most immersive when it breaks the rules of reality. In service to the narrative, film leaps through time and space; show hidden thoughts and desires; and offer impossible action, audio, and explosive sequences. Film uses narrative conventions, techniques such as jump cuts, pans, dissolves, flashbacks, split-screens, over the shoulder shots, and close-ups to meet the informational needs of the viewer Caught in the storyline, the audience suspends its disbelief. In film, reality is secondary to the story.

Convention, Invention, & Beyond Reality's Surface

Noel Carroll recognized that a farmer's plow on film functions differently than a physical plow in a farmer's field. The filmic plow's functionality lies solely in its narrative value. It is a symbol positioned in time and space which typically brings to the viewer a sense of human labor, a connection to the land and of rural values. Its' overall shape is guided by historical norms; its details are highlighted for dramatic effect. The filmic plow both a product of and a delivery mechanism for cultural conventions. In stark contrast, the physical plow is a cultural invention – *it was adopted because it worked, because it met a physical / cultural need and accommodated natural and biological factors.* It simply provided food. The clarity of this division, between the creation of an object (invention) vs. the use of its image (convention), is shattered with the introduction of a new example construct – the virtual plow. While the virtual plow is simply theory and difficult to explain, it's practical counterpart is Bespace.

Often new media projects touch on this grey space of invention and convention. It seems that the juxtaposition of a 3D world in a mouse driven 2D frame brings the matter in focus, if not resolution. Bespace spans issues of convention and invention. It is not to be judged by its adherence to realist norms, but by how it manages those realistic norms in support of the informational needs of the user and educational and or entertainment goals of the developer.

III. BESPACE: FORM FOLLOWS FUNCTION

An Environment – An Interface

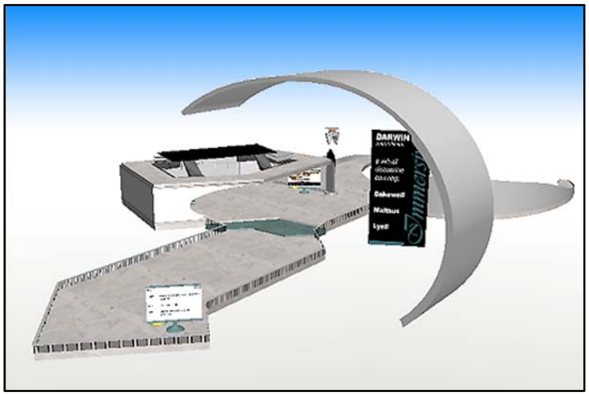

Figure 2- Bespace Lecture Hall 3/4 View

Figure 3 - A Student Walking to Class

Bespace is simple. In Figure 1 we see a 3/4 layout of an educational lecture hall. Like a real world classroom, it is designed to hold a variety educational material. Figure 2 shows the back of a student walking to class, in the distance a small floating figure, the teacher, awaits. That small figure, the teacher's avatar, morphs, moves and switches into a variety of 2D slides, 3D interactive objects and small 3D landscapes. In a sense, this simple delivery method is akin to standard PowerPoint presentations and current two-dimensional synchronous learning applications such as Horizon Live. Rather than view Bespace in terms of a conventional 3D environment, we can, for the moment, switch back to the domain of a 2D interface and simply see 3D as a value-added proposition.

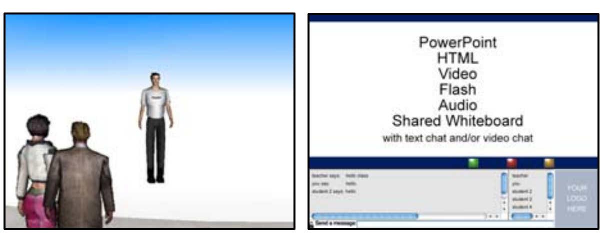

Figure 4 – Bespace & Horizon Live
Bespace shown without chat window

Figure 4 shows Bespace and the 2D synchronous learning application Horizon Live. In both spaces, educational materials are presented via text, images, bulleted lists, flash animations, audio, and movie clips. (While the shared white board option is not currently available in Bespace, there is no insurmountable technical reason why it could not be added). In terms of functionality, Bespace matches all the abilities found in current synchronous learning software.

Bespace addresses major concerns of distance learning and online synchronous interaction. Many scholars have asked "Where is the teacher – where is the community of learners?" (Shotberger, 1998). In the three-dimensional space, we can visually support the presence of multiple users. Simply put, other users can be seen in the 3D space, the learning community is visually present. Our testing, though still informal at present, has consistently confirmed that users feel also that a real teacher is present and guiding the learning process. This is in contrast to the unseen, controlling force that places content on the Horizon Live page. Educational materials are visually associated with the instructor. Interestingly, users react well to the morphing process. Magical, shape-shifting characters are common culture conventions used in games and stories. Their response to the initial morph is usually like that of Neo in the Matrix – Whoa… Still, to ease the user into this new convention we initially show the avatar morphing into the title graphic and then return to the humanoid avatar after a few slides to answer user questions.

By default, this shift back into humanoid form to address user questions sets a new user behavior mechanism in place. Often lectures, or segments of lectures, are not meant to be interrupted. The teacher can create open spaces to deal with user questions by returning to humanoid form. Visually we create a means to structurally smooth out communication issues in synchronous space, the chaotic conversational issues that dog instant message and synchronous chat usage. We empower the teacher to visually dominate the virtual space, while lecturing and then provide clear space for open discussion.

On the user side we have an issue; user questions typically arise during the delivery of the lecture. We again can draw from the real world solution – the raised hand. Not only does the hand raise give a quiet visual cue that a question exists – it reinforces polite behavior by providing a well-worn and cognitively embedded outlet for the user's questioning needs.

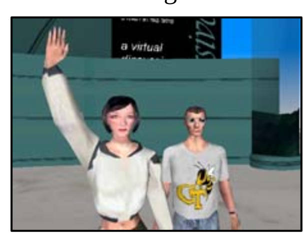

Figure 5 – Questions

At the onset, this paper declared that realism is not a goal; it is a method of achieving goals. This paper also declared that realism instills beliefs and behaviors in the user. Hopefully this discussion on community and conversation has shown these ideas in the context of practical application. The next section tackles the issue of usability and the limitations of realism.

Real Behavior vs. Real Usability

Figure 6 – Transition from Human to Title Graphic

Both Poupyrev and Shneiderman suggest altering the virtual space, limiting behaviors and navigation to achieve better functionality. Figure 6 demonstrates the most direct method of delivering educational content into a virtual lecture, the humanoid representation morphs into the educational content, in this case the title graphic. From a pure HCI perspective, having the humanoid representation walk on and off screen is unnecessary navigation. Sharing the screen is simple, yet it is not the most usable. Screen real estate is a precious commodity and giving maximum space and unfettered access to the educational material is a goal of any good design. A humanoid avatar standing in front of a slide is slightly distracting. A humanoid avatar, standing in front of an interactive 3D model is the definition of Shneiderman's unneeded clutter. It serves no function and does, sometimes critically, inhibit the users ability to manipulate the 3D model. While we could shrink the model to share the screen with the humanoid avatar, a smaller model offers less detail and smaller targets for users to hit – assuming the model has explorable features like buttons or sliders.

The humanoid avatar's role as generator of a teacher's presence, as seen in our small scale testing, is accomplished early on. With it's task complete, there is no functional or cognitive reason requiring it to be on screen at all times. In fact several academic testers familiar with PowerPoint presentations liked the undivided attention paid to the information centered on the screen. In real world situations, watchers of PowerPoint presentations look back and forth between the speaker and the presentation. This small issue of having two places to look, speaker and the presentation, and being unsure what to look at any given moment is resolved. In Bespace users see only what they need to see, when they need to see it. Whether it's a human form, an informational slide, an explorable 3D model or a small 3D environment, Bespace delivers.

The standard imagined practice of virtual environments is to be a large singular world with users roaming about exploring, playing and or learning. This approach has a great deal of value, provided that the whole of the experience is valuable. 3D Game developers often confront the issues of unneeded travel and unforeseen user behaviors. To be blunt singular spaces can be more difficult to manage. Users can get lost and confused. Users are often forced to walk distances that hold no educational or entertainment value. In a large space, users engage in long chains of behaviors that may build into false mental modeling of the space and end in unpredictable results. In the game world, if the players succeed and enjoy, the path they take is less important. In an educational setting, free thinking is highly valued, but so are the goals of the assignment. The common issue with 3D educational games is getting the desired knowledge into the minds of all the students and being able to measure that result. Often educational game papers cite a singular epiphany of an individual student. The trick is to focus that epiphany and to allow the mass of students to discover it.

Small focused environments, along with interactive objects, graphic slides and teacher guidance – in human form or through the ever present audio and text can be used to manageable immersive lectures. Student epiphanies do not require large complex virtual spaces. In the end, large complex worlds seem unneeded and unwieldy for much of what educators wish deliver.

Inside a Lecture

To recap the previous sections, a wealth of information is placed directly in front of the students. There is no needed navigation. By controlling the visual presentation and having it attached cognitively to their avatar, the teacher is empowered. Combined with the teacher's central location in the world, social constructs emerge to guide the behavior of the students.

Bespace's test lecture is on Charles Darwin. It uses the immersive quality of virtual space to show how Darwin came to his conclusions and how he was accepted in very conservative and Christian 1900^{th} century England. The lecture is designed for undergraduate students. Darwin and the issue of his acceptance was chosen because adaptation to the digital environment is at the heart of Bespace.

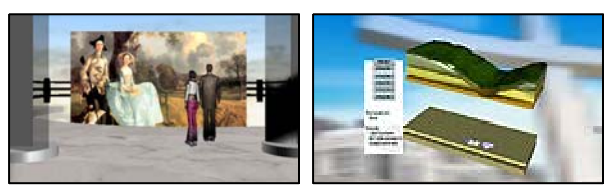

Figure 7 – Two images of the avatar. The agricultural context of Darwin's work and an interactive model discussing fossils found in rock strata, note the cross.

The image on the left highlights British farming and the Enclosure Movement. Students are asked about enclosing animals and the relationship to Darwin. The answer is the rise of selective breeding. Later, selective breeding's influence on England's economy and culture is discussed.

The image on right, the interactive model, has a menu attached to it. By pressing buttons on the menu, users can shift through layers of rock strata and discover fossils just like people in Darwin's time. A small bit of text on the lower part of the menu describes what they've found. The job of interpreting the fossil data as people in Darwin's time is based not on carbon14 dating but on the changes seen in their complexity and their resemblance to modern era animals. The cross in the background highlights the religious, great catastrophic flood viewpoint.

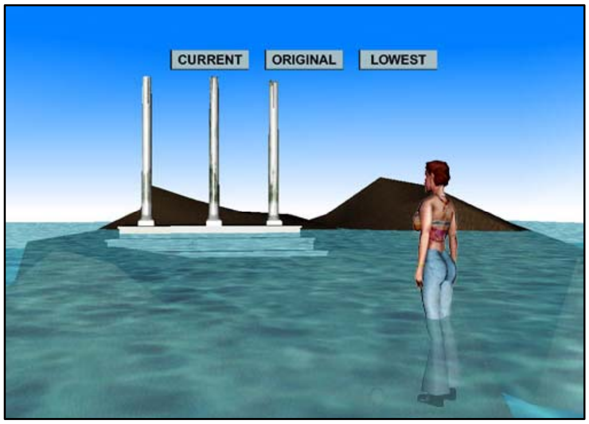

Figure 8 – A partially submerged student explores the Temple of Serapis, a small environment.

Students follow Darwin's path to the Temple of Serapis and discover an example of a counter argument to that of a catastrophic flood – gradual change. Buttons move the Temple up and down in the water. The Temple of Serapis has indications at the top of the columns showing that it was once deeply underwater. Certainly it was not build underwater. The earth changes gradually over millions of years – giving time for evolution and paralleling the evolutionary idea of slow constant change having great impact over millions of years.

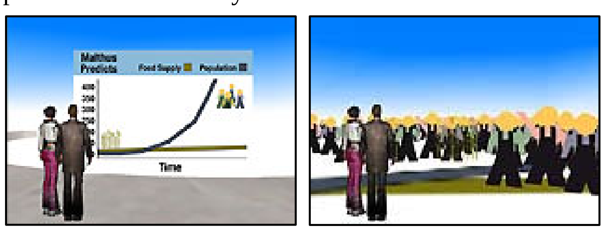

Figure 9 – A slide offers Malthus's Population Principle. Right, same slide – in an animated sequence it turned flat, grew large, and spawned dozens of hungry poor.

In the third part of the lecture, the idea of survival of the fittest is introduced as it was to Darwin, through the Reverend Malthus's Population Principle – that feeding the poor led only to more poor people so then society ought not to help them. For Malthus, the poor would only improve their lot in life through struggle and discipline.

The preceding examples only highlight the three sections of the Darwin lecture (Breeding, Geology & Survival). A good deal more is available online. Between each section and at the conclusion the teacher takes human form and has an open discussion.

A range of educational questions emerge as we ourselves learn about the methodology. Future research will be conducted on the amount of knowledge and interactivity students can reasonably handle in a model or environment also the overall scope and length of a lecture needs review. Learning to interact with various models and worlds is an issue, but our simplicity and standardization of the interactive processes appears to be inbounds of the learning curve of our users. Young researchers, ages 11-14 with the University of Baltimore's KidsTeam were awestruck by the single user version and without provocation pondered about the multi-user version. Multi-user is offline, and the full Darwin material above the KidsTeam age level.

Formal testing is set for spring of 2006. The major issue has been the lack of real-time audio, which is seen as critical to the teacher's ability to deliver the lecture and manage the space. With audio soon to be resolved, noted game and education scholar Stuart Moulthtop at the University of Baltimore, will have his Games and Education class not only test the usability of the Darwin lecture, but create their own virtual lectures as well. This raises the final issue of this paper, the ability to easily create content for Bespace.

Creating Content and Usability

Constructing a Bespace lecture is simply a matter of building individual slides, 3D objects and small 3D environments. To control the show, the teacher uses forward and back buttons. In terms of modeling, Bespace uses simpler objects than complex simulation spaces. In production, models and worlds produced by students or professionals are an affordable possibility. Additionally, free models are online. (See Figure 11, free cow) Lastly, Bespace's use of easily produced two-dimensional materials and texts brings content development within reach of a teacher.

Each educational object is in a sense a singular slide in a slideshow and so the ability to add, subtract and modify these small 3D objects is relatively easy. In a large simulation, objects and their behaviors are tied together – removing something may have dramatic, unforeseen consequences. The simulated world is large and complicated. In contrast, Bespace, designed as an interface, is three simple sections. Below is a top down view of Bespace. 3D content is delivered by the teacher's avatar into Section 3, the presentation ring.

Students arrive in Section 1, the landing pad. Section 2 contains kiosks with a few 2D graphics that foreground the coming lecture and assignments. Section 3, the presentation ring act like a frame, guiding the behavior of the user and maximizing the usability of the 3D content.

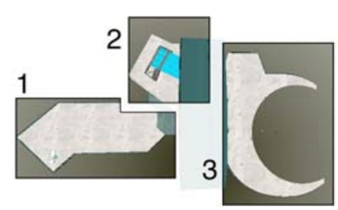

Figure 10 – Bespace, top-down

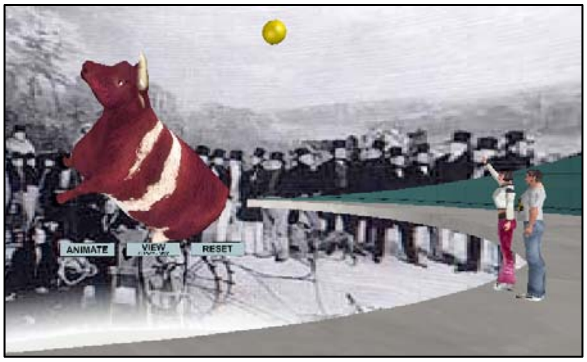

Figure 11 – Free Cow with interactive buttons

The presentation ring maximizes usability by creating a frame around the teacher. Confirmed by informal testing, students stop at the edge of the ring. With the students and teacher's position known, we can build objects that fill the students screen. The removal of the ground plane allows objects to be bigger. If not removed, the ground plane would take up half the screen real estate, the cow and the buttons in Figure 11 would be have to be made smaller.

Technology

The underlying technology of Bespace is a revamped version of Deep Matrix. Deep Matrix is a Java client applet/server system utilizing VRML to create a 3D shared environment. The client VRML is done with plug-in for the HTML browser and implements the first EAI (External Authoring Interface) specification classes (to communicate between the VRML plug-in and the client applet embedded in the HTML browser.

Admittedly, the EAI mechanism Deep Matrix relies upon has in recent years become unfriendly to the casual user, mainly because of JVM issues and to a lesser extent security issues of Windows. However the developers of Deep Matrix intend to give it -and EAI- a new lease on life for research in the fields of education and the arts where the technical issues can be addressed for users beforehand within a closed technical environment, because once the JVM and technical issues are out of the way, EAI can work magic.

Why contend with these technical issues at all? Deep Matrix is open source and free. It is supported at http://www.deepmatrix.org where JVM, Java classpath issues and Windows XP service pack 2 issues are addressed. Deep Matrix is power through flexibility. Its goal is to achieve total integration of the monitor screen. The 3D VRML scene can send chat strings to the network and visa-versa. HTML GUIs in the surrounding frames can also communicate back and forth with both the 3D VRML scene and the network chat. These GUIs can be made with basic HTML, JavaScript and VRML knowledge - or the ability to copy/paste and follow direction. No Java knowledge is required. Moreover, it is possible to incorporate other plug-in such as Flash into the mix. The Deep Matrix monitor screen can be a unified multiplicity of html, applets, network controls and plug-in. Deep Matrix is flexibility through cross-platform performance. The Deep Matrix applet works with the three main VRML plug-in for the Windows operating system: Bitmangement/blaxxun Contact, Parallel Graphics Cortona, and Cosmoplayer (created by Silicon Graphics, but now orphaned though still available). It will also work in the very antiquated WorldView VRML plug-in. On Macintosh it works with Cosmoplayer using a Mac G4 or greater. In the very near future, once the open-source VRML browser FreeWRL for Linux and Macintosh has EAI spec compliance, Deep Matrix will be developed for it.

The HTML browser and Java requirements for the Deep Matrix applet are as follows: HTML browser needs to be either Internet Explorer versions 4-6 using the Microsoft Java Virtual Machine or the Netscape 4* series with its own built-in JVM. The Netscape 4* series is freely available from the Netscape archives and offers the ability to run all three VRML plug-in with working EAI. The Deep Matrix applet will not work with the Sun JVM. On Macintosh, the HTML browser needs to be of the Netscape 4* series.

III. CONCLUSION: PAST PRESENT & FUTURE

The Works of Others

Despite the radical nature of its design, there can be little doubt that the principles behind Bespace present a practical methodology for developing virtual spaces. Reality as a goal is discarded as we move to meet the informational needs of the users. Virtual space as an information space forces a complete reassessment of the constructs of interface, environment, and avatar. Usability standards are applied to the entirety of the virtual domain, not subjugated to issues of object manipulation and navigational avoidances.

Issues of methodology and usability are critical. Bespace is only one of several projects that see the avatar as point for data exchange. Others too look beyond the narrowness of realism as a goal and reach deeply into visionary ideals of virtual space. Melinda Rackham's Softspace and Viral projects explore avatar as data carrier concepts. The chat dialogue box is removed, and users can only communicate through their abstract avatars. Adam Nash opens a new genre of online musical performance. His work Memory Plains Returning dramatically breaks from realism.

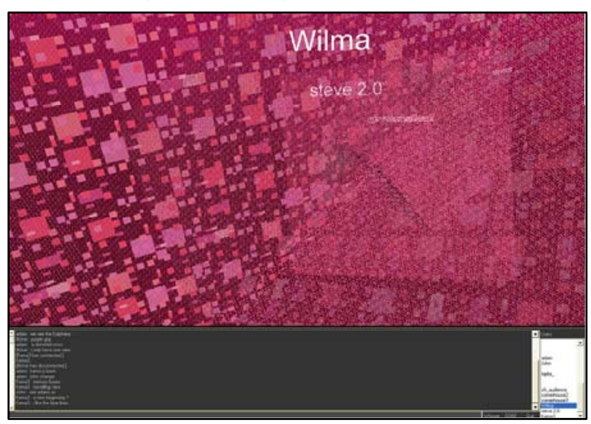

Figure 11 – Music in Memory Plains Returning

Figure 11 the users – the audience are dropped into a completely empty space, a black void. The user's avatars are semi-transparent grey balls. The musical concert begins when three huge abstract structures enter the scene. The three structures are in fact three musicians and the structures are both instruments and architecture. The three structures move and interact with one another with musically charged results. Early projects include lectures on other topics and a variety of poetic and theatrical works. Figure 12 – highlights two projects. On the left the teacher's avatar is a spinning galaxy in a lecture on comets. The right shows the first 3D project in this genre, a poem called Laundry Girl is being read to a group of visitors to Jeff Sonstein's Town Square.

Figure 12 – Early projects in education and art.

In Closing

Bespace is not a singular solution to issues of online learning, but could be a useful part of a larger program using both synchronous and asynchronous methods. Bespace's own methodology on the avatar and the concept that realism is not a goal but a method of achieving goals does not infer a lack of value in the work being done to further greater realism in rendering and interaction. By placing realism in the domain of a method, we follow the conceptual footsteps of filmmakers and game designers who both rely on realism to achieve their goals. Both filmmakers and game designers understand that realism alone does not make for a successful project, furthermore they know that breaking the rules of reality can actually lead to greater immersion.

Bespace offers a new flexible and practical conceptual position for understanding and developing virtual environments. It offers a series of real examples that demonstrate its position and its value. It is also just the beginning. Bespace begins to tap the visionary potential of virtual space and is one answer to the lost generation of virtual developers who saw within virtual worlds a limitless potential. We close with a link to the Bespace site and a quote from Michael Benedikt.

"Cyberspace: Its corridors form wherever electricity runs with intelligence. Its chambers bloom wherever data is gathered and is stored. Its depths increase with every image or word or number, with every addition, every contribution, of fact or thought. Its horizons recede in every direction; it breathes larger, it complexifies, it embraces and involves. Billowing, glittering, humming coursing, a Borgesian library, a city; intimate, immense, firm, liquid, recognizable and unrecognizable at once."

http://bespace.lcc.gatech.edu/single/

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Humanoid Avatars created by Josquin Bernard.

WEBSITES

1. Adam Nash, http://www.yamanakanash.net/3dmusic/
2. Melinda Reckingham, http://www.subtle.net
3. Jeff Sonstein, http://ariadne.iz.net/~jeffs/

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