# 2020Classroom Content Development

## 1. Research Team

Project Leader: Prof. Wee Ling Wong, *IMSC and Biomedical Engineering*

Other Faculty: Prof. Chris Kyriakakis, *Electrical Engineering*

Research Staff: Eduardo Carriazo

Graduate Student: Sion Lee

## 2. Statement of Project Goals

The goal of the 2020Classroom Content Development for immersive learning environments is to fully explore the delivery of content within applications of immersive technologies to provide teachers and students with experiences that would not otherwise be available.

As educators increasingly look to technology to meet the challenges of teaching and learning in a rapidly changing educational environment, the field of *interactive visualization* – illustrating educational concepts through visual, interactive applications, and simulations – presents a promising and emerging paradigm for learning and content delivery. *Interactive visualization* puts students and their teacher into the picture of what they are studying, allowing them to share and manipulate the objects of study. It promises a rich learning experience that engages, excites, and motivates the learning in a dynamic environment. Current "technology-enhanced" learning programs are based on existing curricula that have been ported to the web or to televised lectures. In most cases students are not challenged to form their own models, nor asked to demonstrate their understanding through meaningful assessments. We view the lack of innovative curriculum that is optimized rather than adapted to a set of technologies, as an opportunity to design content material to be delivered, managed, and accessed in a novel way.

## 3. Project Role in Support of IMSC Strategic Plan

In the IMSC Strategic Plan, the basic premise behind the IMSC 2020Classroom Immersipresence Project is that immersive technology closely coupled with innovative curriculum design and meaningful assessment will not simply increase efficiency, but it will significantly improve the quality of the learning experience. Our vision is to pioneer a new learning paradigm for *collaborative learning* among learners in distributed geographic locations. One component to materialize this vision over the next five years is to implement a novel curriculum with content and tools that are specifically designed for this type of environment. The prototype 2020Classroom that we create can be used as a stepping stone for creating an immersive-technology-enabled educational paradigm that shifts the emphasis from a passive dependency on lectures to active learning through peer interaction. BioSIGHT is strategically positioned to develop and test a new paradigm for the application of advanced integrated media technologies to science learning and education. In the course of research on student learning with various representations of scientific phenomena, novel enabling technologies will be developed that will catalyze advances in scientific understanding. As the project evolves, the collection and analysis of human factors data on student learning will provide feedback for the technology research and development. We view this as two complementary processes: research in integrated media systems gives rise to new educational tools and the lessons learned from using these tools provide new directions for the development of more advanced systems.

As the BioSIGHT effort makes progress towards the education vision scenario described in Volume One, the use of a game engine platform as a model provides the flexibility to rapidly develop and pilot test prototype learning activities while concurrently presenting an opportunity to the IMSC Research program to identify integration issues that we can transfer to the IMSC software architecture for Immersipresence, as IMSC's components of the software modules matures. One such example is the integration of optimized algorithms for real time animation and rendering of deformable objects that are within the "IMSC Software Architecture for Immersipresence" being developed by Alex François [1-3], as well as real time head related transfer function audio algorithm for movable objects in 3D environments within *Immersive Learning Environments* [4].

## 4. Discussion of Methodology Used

The design methods for immersive learning environments include the activity scenarios (*e.g.*, task(s) that the user has to accomplish); the information scenarios (*e.g.*, background and detailed content to convey and metaphors to use); and the interaction scenarios (*e.g.*, the user interface as well as the way(s) that the user will encounter the task and avenues to resolution and information). This is an iterative process where the, analysis of usability claims and redesign complement HCI theory and guidelines into usability specifications of a prototype. Our approach to 2020Classroom Content Development in immersive learning environments addresses the pedagogy of how learning can be conveyed through games without diminishing content, specifically examining the notion of how students can *play* with ideas or concepts central to the curriculum. Specifically we will address:

- How immersive environments can be designed to convey scientific concepts to a novice target audience,
- What pedagogical issues impact corresponding classroom implementation, and
- How immersive environments influence the teaching and learning process

## 5. Short Description of Achievements in Previous Years

**April and November 2002:** Student usage pilot tests were conducted using tutorials and several learning activities developed in Conitec's A4 game engine framework. We informally observed users in the course of interacting with the learning activities and discovered that despite the familiarity of computer games, our user population was overwhelmed with information, and exhibited a fairly high frustration level of navigating in the context of the game environment, prompting a redesign that was re-evaluated by students.

The ***Exploratory Challenge*** from BioSIGHT's *Immunology* module is a computer game-like simulation developed in collaboration with our colleagues at TERC that introduces students to the visual and spatial concepts that must be understood before the learner can successfully visualize the topic [8]. Treated in purely abstract ways, key ideas are presented without explicit reference to the biological subject. We used what has been learned from the realm of educational computer games to present challenges that are self-motivating, and that can easily engage students without requiring lengthy preparations as well as from research literature that identifies certain features of computer games, such as mystery, fantasy, challenge, and reward to name a few, that motivate students.

## 5a. Detail of Accomplishments During the Past Year

In the activity scenario, consider a study group of students in a Biomedical Engineering course that wish to collaborate to work on class assignments. Their tasks will require that they work together as a team, capture information from their lectures so that they can go back to it at a later time, share high fidelity audio, video, and image content among them, and create content to demonstrate how well they have grasped certain principles. The content we have identified focuses on the electrophysiology of the heart. It involves dynamic phenomena in time and space that are particularly difficult to teach. It offers students an opportunity to discover and explore difficult concepts such as drug design and delivery as well as science and engineering principles as they apply to a complex living system. We have created 3D models, information scenarios, and preliminary interaction scenarios for content assets in cardiovascular physiology using 3D StudioMax. In addition, we have also designed an investigatory module for exploring kinetics and reaction rates in physiological systems. Students will be exploring concepts in basic chemistry, neurophysiology, zero and first order kinetics, integration by approximation, and physiology to prosecute a defendant driving under the influence of alcohol.

## 6. Other Relevant Work Being Conducted and How this Project is Different

The Electronic Games for Education in Math and Science (E-GEMS) project is one such example of an interdisciplinary team doing research and development on strategies and materials to integrate game-like activities with other forms of classroom learning, as well as the design and use of educational games [9]. Another example is the *Logical Journey of the Zoombinis* (Broderbund) game is an example of applying insights from informal learning to the application of technology in the class for leaning math [10]. In addition, there are many research groups exploring the use of technologies such as virtual reality as applied to the area of education to create novel educational experiences and environments. Examples of educational virtual reality projects include the Narrative-based Immersive Constructionist/Collaborative Environment (*N.I.C.E.*), which gives children an authentic activity in building an experimental learning environment; the *Round Earth* project, which teaches concepts that are counter-intuitive to young learners; the *Virtual Explorer*, which allow players in a virtual world to explore the human immune system and participate in an immune response on the cellular and molecular level; the Virtual Solar System project and the Virtual Gorilla Project to name a few [11 - 16]

## 7. Plan for the Next Year

Using focus group and survey methods, we will pilot test the stand-alone cardiovascular materials and investigatory module in the fall 2003 with sophomore Biomedical Engineering students to identify shortcomings to the activity and information scenarios. Findings and recommendations will feed back into our design process to be reflected in subsequent revisions that can be implemented into the 2020Classroom Immersipresence Project. In addition, we will continue to develop information scenarios for pharmacokinetics and the cardiovascular system.

In collaboration with Prof. Chris Kyriakakis, the challenge that we present to the IMSC Research Program is how to use auditory cues to augment a 3D immersive experience. The majority of the visual cues that we obtain assist in the determination of depth in a 3D environment. We explore the notion of sound associated with interactive and dynamic elements in a 3D environment to enhance the visual cues in the perception of depth. To provide true spatial auditory cues requires integrating optimized audio algorithms within the 3D simulation engine capable of synthesizing head-related transfer functions with respect to the dynamic objects in the 3D environment in real time in what we call "volumetric audio rendering". Novel ways to render HRTF-based sound over multiple loudspeakers will be investigated.

## 8. Expected Milestones and Deliverables

- User studies for content appropriateness
- Specifications for mapping content and interaction into functional software through a game engine for functional interface and navigation in immersive environments

## 9. Member Company Benefits

Not Applicable

## 10. References

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