Ed Center on CSE continues to Engage People In Cyberinfrastructure (EPIC)

The Education Center on Computational Science & Engineering (ECCSE) has promoted the use of high performance computing and its support systems for over eight years at San Diego State University. The ECCSE was originally formed in 1997 as a partnership activity with the San Diego Supercomputer Center's National Partnership for Advanced Computational Science Infrastructure (NPACI) grant from the National Science Foundation (NSF). When NPACI ended in 2004, we seized on the opportunity for a new partner with Boston University and its efforts in visualization to support science education and received NSF funding as part of the Engaging People in Cyberinfrastructure (EPIC) grant, one of the first funded projects from the NSF Office CyberInfrastructure(OCI)[1].

For our participation, we proposed researching how to use the current game engines as a platform to develop education modules to support high school science instruction. We established a collaboration with two sciences teachers from Hoover High School, a part of the SDSU Education Collaboratory. Mr. Robert North teaches chemistry and Mr. Hal Cox teachers physics. Both teachers were asked to identify a concept from their curriculum, along with its corresponding California State Standard, that they felt would be aided by a three dimensional, computer generated interaction module. We also explored the wide world of computer game engines and chose the Torque Game Engine (TGE) from GarageGames.com based on its broad user community, its effectiveness as a development platform on the personal computer and its attractive cost of $100 for an Independent Developer License. An additional assess was our partnership with the Visualization Team at the San Diego Supercomputer Center, who have used the Torque Game Engine to develop their own modules to explore science.

Our development team at SDSU included a professor of computer science, Kris Stewart, a staff resources specialist, Kirsten Barber, and two computer science majors as programmers, John Nguyen and Skylar Hayes. Our first project was to visualize a

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[1] http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0520146

simple molecule to demonstrate the power of the nuclear force. This is a required topic from the California State Chemistry Standard 11.a Nuclear Processes[2]

> 11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept:
>> a. *Students know* protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.

After preliminary meetings with Mr. North to come to understand what he felt would be useful for his students, our student programmers began developing a module for a "Virtual Field Trip to the Lithium Battery". After several iterations with Mr. North, the computer model was refined. The Ed Center team accompanied Mr. North when he presented information on the partnership we had formed in the August 2005 Chemistry Teacher In-Service workshop for San Diego City Schools.
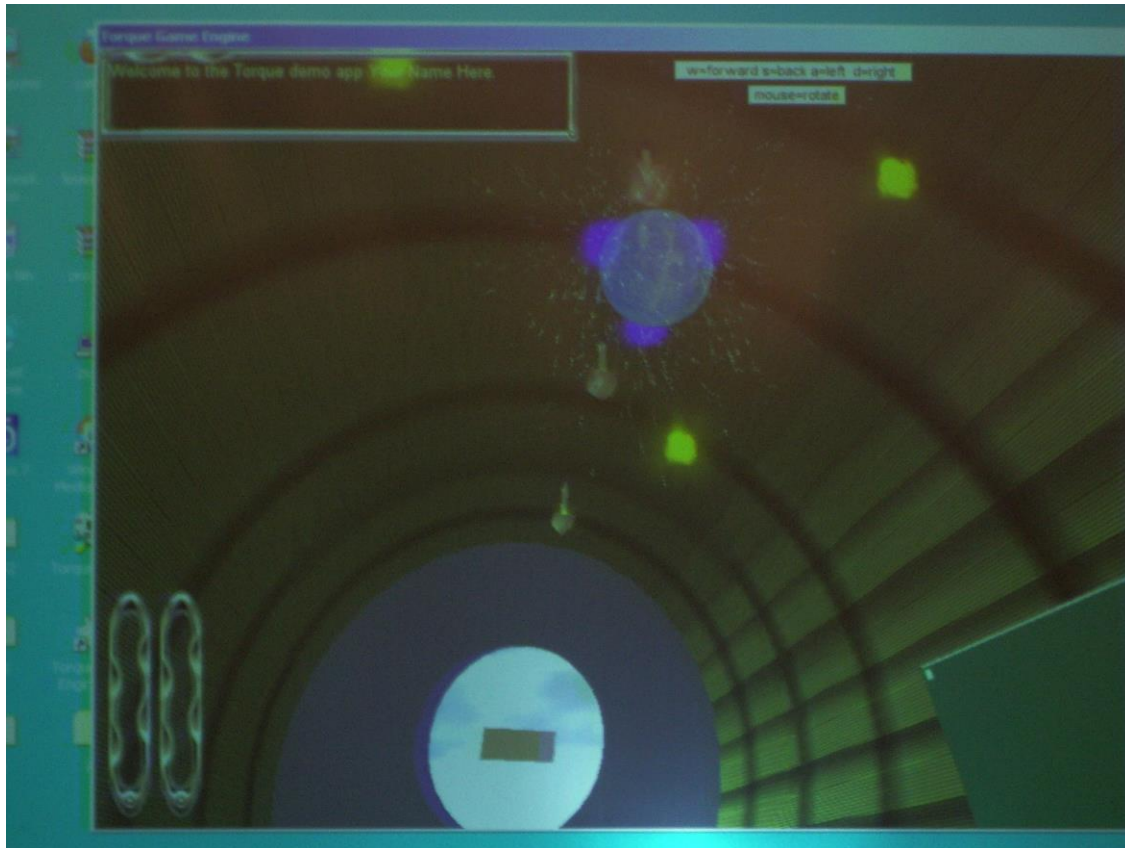

Figure 1 Mr. North shares Chemistry game modules with peers

Figure 2: Skylar Hayes and John Nguyen describe the Torque-based computer game for the Virtual Field Trip to the Lithium Battery (the *blue basketball*)

Screen picture inside the Lithium Battery itself

Later in the Fall Semester, Mr. North used this module in the computer labs at Hoover High school for his students to learn about the nuclear force.

Hoover High student interacting with the Virtual Field Trip to the Lithium
Battery in school lab session

We then began working with Mr. Hal Cox to find an appropriate 3d
model to support concepts his students had difficulty with in
their physics courses. The required topic that Mr. Cox selected
was 5n: Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a
basis for understanding this concept: *n Students know* the magnitude of the force on a
moving particle (with charge q) in a magnetic field is qvB sin(a), where a is the angle
between v and B (v and B are the magnitudes of vectors v and B, respectively), and
students use the right-hand rule to find the direction of this force.

[http://www.cde.ca.gov/be/st/ss/scphysics.asp]

Mr. Cox and Skylar Hayes comparing ideas for preliminary version of the Magnet module at the Ed Center on Computational Science & Engineering, SDSU

Skylar Hayes and John Nguyen meeting with Mr. Cox in his Physics classroom at Hoover High as the Torque game evolves.

Our preliminary modules are available for download to a IBM PC computing platform as a zip-file from

Virtual Field Trip to Lithium Battery

http://visservices.sdsc.edu/projects/explore/LitBattery.php

Hosted by the Visualization Services Group at the San Diego Supercomputer Center.

Our preliminary module on Exploring the effect of Magnetic Fields on Projectile Motion is available from

http://edcenter2.sdsu.edu/Torque.zip

The player, with crossbow, sets up to try to hit the target on the other side of the large C-magnet. Must make allowances for effective of magnetic force on the projectile.

Score increases. Also magnet rotates after each successful "hit", challenging the player to make the appropriate correction for the magnetic force effect.

To ensure continued development with the Game Engines, Dr. Stewart taught an upper division Computer Science Elective in Spring 2006 on 3d Game Programming for Simulation. This was well received by students from both computer science and from graphics arts at SDSU. It will be repeated in Spring 2007.

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Appendix – Rough Draft by Skylar Hayes on the Physics Game:

1.1 Proposal:

Hoover High School's Physics teacher, Hal Cox, stated a specific curriculum that students have a difficult time learning. This involves Electric and Magnetic phenomena. This problem is well suited to be explained in a 3-Dimensional medium, therefore Torque 3D Game Engine is used to create the environment.

1.2 The Problem:

What is the nature of a charged particle and a magnetic field? What is the nature of a charged particle moving through a magnetic field? How is the particle affected by the magnetic field and how is the magnetic field affected by the particle?

This Problem involves magnetic fields, charged particles, and movement in 3 dimensions.
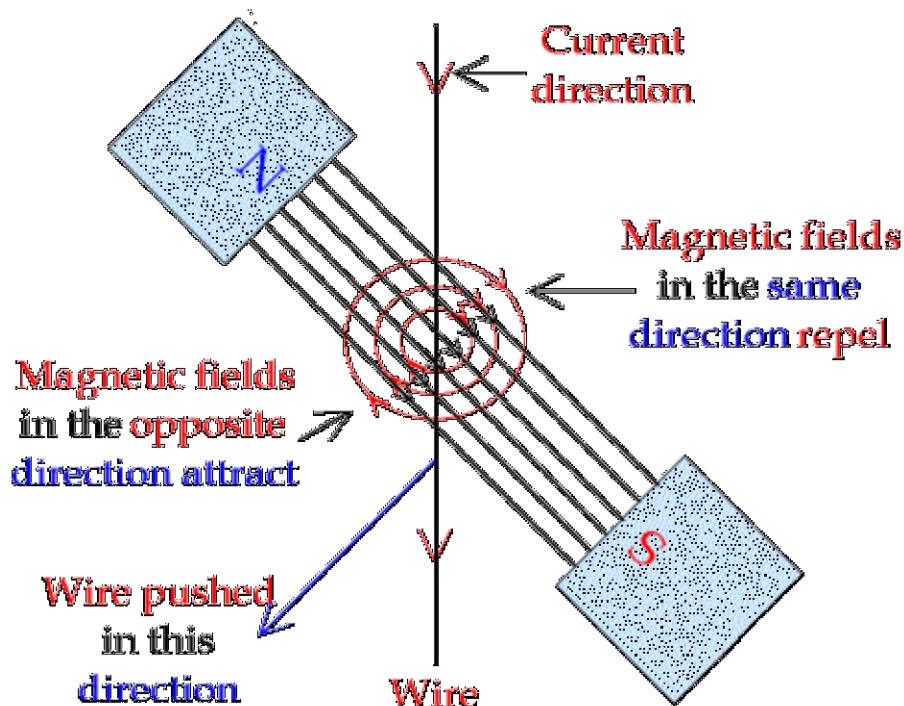
1.3 The Solution:

After figuring out what would be explained to the students, we as developers had to figure out a way to convey the information effectively. We decided that most students do not have knowledge of particles or magnetic fields, but that they had a small understanding of magnets. Therefore, students could relate to virtual magnets when shown in a 3D world so we used them as the base to our development. Most students have somewhat of an understanding that magnets attract and repel other magnetic objects. So the plan of this Physics module is to place magnets throughout the environment and allow the users to control the magnetic objects moving (or in

our case charged particles) through the magnetic fields. This can allow students to correlate what they already know with what they will be learning during the virtual lecture.
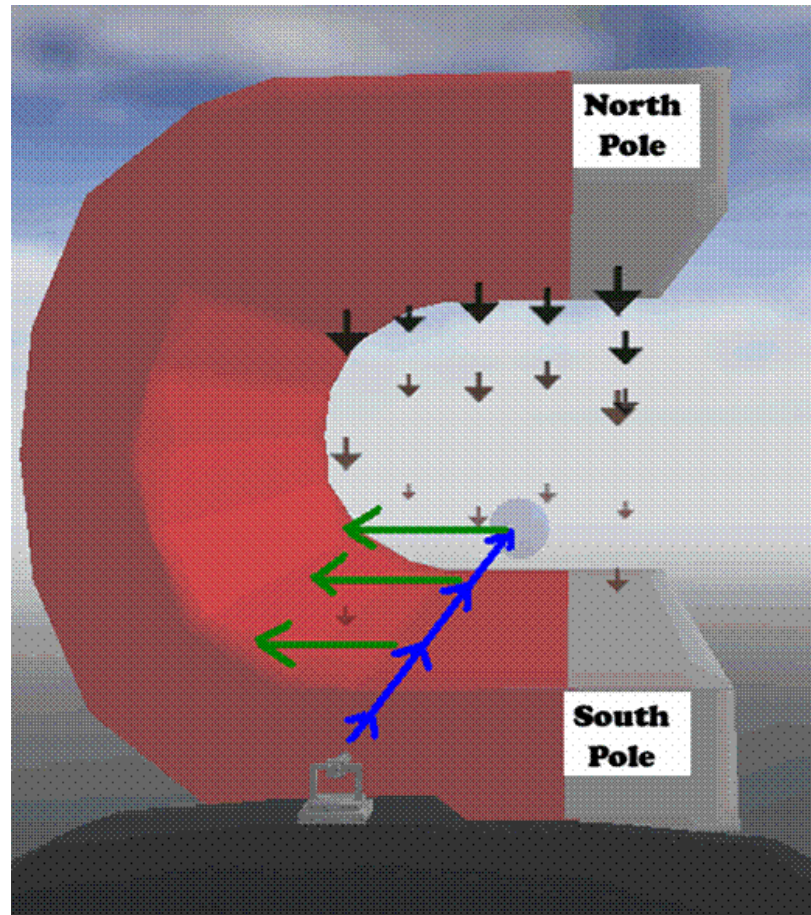
2.1 The Design:

The educational goal for the users, drove the design of the physics game. After contemplation, the design was created for a basic journey where the user would control an avatar and maneuver it throughout the 3d world. This style was made to mimic a field trip so that students could both learn and experience in one fell swoop. A basic map was designed such that the student walks through a series of prerequisite tutorials; these tutorials create the context of the 3D game and help the user prepare for the test period. The student who reaches the test period, will be involved in an interactive game. This interactive game quizzes the user on information just learned and also allows him/her to visualize this knowledge. The student can then understand this information in a way, such that testing in the future may seem more familiar.

2.2 Features of the Module:

Character: The avatar allows the user to move and free look just as an individual moving through a real life science exhibit would. This creates a sense of feel that is familiar for the user and easy to adapt to.

Virtual laboratory: Virtual Magnets and particles are created to allow the user to visualize what is normally outside of everyday life. All items have been increased in size so that the user becomes a part of what is going on in the environment.

Mission Completion: Upon final completion of the mission, students reach a final score with an end game scenario to let them know that they have won. This leaves the user with a feeling of accomplishment and lets them know that what they just practiced was correct.

3.3 Files and Installation :

PC Installation-

1. When the PhysicsGame folder opens there should be another folder titled SDK. Open SDK.
2. When the SDK folder opens there should be another folder titled Example. Open Example
3. Double-Click the file titled torqueDemo.exe to open the physics Module.
4. When the menu screen has loaded, click on Start Lesson to begin.