Role of Game Programmers for Serious Games in Academia: Colleague, Collaborator AND Client

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Abstract *- This paper presents a unique collaboration among faculty and students from four distinct disciplines united to create a game-based simulation of a Materials Science laboratory experience for non-Mechanical Engineering students in a lecture-only course. The benefits to each of the development disciplines is unique, and has been sustained over a lengthy development cycle. Student feedback shows the value of the software tool to engineering students, in addition to the highly enriching experience gained by multi-disciplinary student engagement in its development.*

Keywords: Materials Science, Interactive, Simulated Laboratory

1 Introduction

A typical situation at institutions of higher learning is that faculty in different colleges (or departments) are unlikely to find common ground to collaborate. But the presumed **Colleague**-role will easily allow a faculty with a need (computer enhanced education in Mechanical Engineering) to reach out to another. In our present case a large portion of undergraduate students in the College of Engineering were each required to take a lecture course in Materials Science, however, only students in the Mechanical Engineering (ME) major received the hands-on experience of working with the impact testing and tensile testing machines in the Engineering Materials Lab. A team of investigators with multi-disciplinary backgrounds covering materials engineering, 3D Game Programming [1], digital arts & design and educational assessment assembled to provide a solution for students who are deprived of hands-on experiences in materials science. The present paper is a brief presentation of the activities behind the development of the Materials-ISLE (Materials Interactive Simulated Laboratory Experience) [2] software, with a focus on the role of programmers as colleague, collaborator and client.

2 Serving the different disciplines

The goal of this project was to create an interactive computer simulation of the Materials Science laboratory experience that students in the lecture-only course could use to gain some level of insight to the field. The software provides students with experimental experiences not achievable through textbooks or regular simulations. As such, within the developed simulations, experimental roadblocks were intentionally placed for students to overcome. In addition, a direct benefit was to provide students enrolled in the 3D Game programming course (CS 583) the experience of working outside their discipline with a Client from mechanical engineering as well as develop and produce a product with art and design students. In general most CS programmers do not have the training in art to allow them to effectively create the 3D objects that would be needed to simulate the actual engineering laboratory. Therefore a realistic virtual lab with furniture, machines and relevant objects was produced by digital arts experts and a systematic assessment plan implemented by learning assessment experts within the software game.

2.1 Computer Science game programming

The game-based simulation code was written in Microsoft XNA [3] based on the software ability to simulate the engineering lab in 3D, strong education support from the online community for developers, advantageous licensing fees (free) for non-commercial use and this was the software currently used in the CS 583 course.

The NSF OCI "EPIC - Engaging People in Cyberinfrastructure" [4], using the Torque Game Engine [5] led to establishing the SDSU course in 2006. Further studies showed how game programming can be used as service-learning for computer science students [6]. Channeling CS programming student interest towards the Serious

Games [7] field adds depth to the student programming experience. Over time much additional evidence tracks the growing use of game technology in a variety of applications [8]. There are applications in military training [9] and NASA (National Aeronautics and Space Administration) [10] as well as Science and Engineering Visualization [11].

2.2 Art Design

The artists' first choice of development tool was Maya [12] from Autodesk, due to its capability and availability in the Art Labs through cite-license with SDSU. This software is covered in various arts courses taught at SDSU which would allow the participation of arts students after taking their courses.

3 Evolution of the student team

Within the game programming side of development, Stewart was able to engage a sequence of students, after completing the upper-division CS elective class CS 583, to join our team. The first student was Mark Thompson, Jr., in January 2009. Mark worked closely with the students from ME who used Pro/Engineer [13] to create fine-grained prototypes of the devices in the Materials Science laboratory. Mark was key to the project in finding the way to smooth the process of taking prototypes from Pro/Engineer, which were refined by the art lab students using Maya and eventually recast using 3D Studio Max, software which is now also available from Autodesk [14]. The compromise between the realistic detail from the engineering CAD models, then made believable as 3D models on the screen by artists using Maya, then simplified to allow effective representation within the 3D world of the game environment without losing any needed detail for an efficient game was essential to the development and is a continual tradeoff.

Our second game programmer, Abhishek Sood, took on the task of providing much of the text-manipulation needed in the lab to explain the requirements of the lab and the materials science content being explored as well as capture the results of students using the lab. As a preliminary presentation on campus, both Thompson and Sood participated in the SDSU Student Research Symposium, 2010, with their poster [15] created by Claudia Faulk in the Art Lab. Abhishek Sood defended his Masters Thesis [16] at SDSU Spring 2012. A co-game-programmer with Sood, Sathyanarayan Chandrashekar, also successfully defended his CS Masters thesis in Fall 2011, on a topic distinct from Materials-ISLE, "3D Visualization of Conic Sections in XNA Game Programming Framework" [17]. Our current game programmer, Megha Shaseendran, has entered the Microsoft Imagine Cup with her programming of the interactive, virtual 3D Lattice Voyage [18].

4 Assessment

Continuous assessment of student learning outcomes (direct and indirect) was conducted over the period of the development of the software. We have shared the design of the assessment plan [19] for the learning outcomes of the students from engineering who have used the software game. Once students in this spring 2012 semester complete their coursework, and provide additional assessment data, we anticipate sharing further results.

5 Our programming outcome

Our game programming students and art students have worked side by side through the development process for several years now and though the individuals have changed, the project is now demonstrating believable detail and effective game-play. The development students have also had the opportunity, in our weekly team meetings, to observe some discipline-specific approaches expressed by the faculty. Talking with the game programmers afterwards, they have uniformly told Stewart that the experience was unique and useful. Programming to deadlines is always challenging. Being the Client for the artists who were charged with creating the 3D models was illuminating. The game programmers have been client, collaborator and colleague with an outcome of three separate Material Sciences Labs that allow 3D simulation of the three labs, pictured below in Figures 1-6. The engineering students have expressed they value the interactive labs and further formal assessment results are expected soon.

We have a first person point of view game that runs on Windows platforms that provides an interactive, non-linear and dynamic education experience, as recommended by Jackson [8]. Students take initial quizzes testing their understanding of lab safety before they enter the virtual materials science laboratory. There are additional quizzes, tailored for

the individual labs, that allow students to demonstrate their mastering the actual content of the materials science laboratory. The large class of engineering students, roughly 100 to 140 per semester (due to recent spike in student enrollment), have their results captured within the XNA game and automatically sent to a MySQL database running on another campus computer. The several quiz results are available to the engineering faculty to include in the scoring for students in the lecture-only class as well as the assessment faculty to monitor student learning outcomes. Anticipating a need to easily modify quiz questions from class to class, the NEEV engine [16] provides an interface to modify text and summarize results of actual game use, such as time to complete and number of attempts of quiz questions. The NEEV engine also ensures student logins and results are maintain through a secure registrations of students.

Figures 1-6 show images from Materials-ISLE game play. Detailed presentations and discussions of the individual labs will be the subject of separate publications. Online resources such as Multimedia Educational Resource for Learning and Online Teaching (MERLOT) [20] will also be targeted as dissemination routes for Materials-ISLE.

Tensile-Testing Lab:

Figure 1 The Samples on lab table with Task List for this lab

Figure 2 The Virtual Tensile Testing Machine

Impact Testing Lab:

Figure 3 Safety screen to protect users during impact testing

Figure 4 Actual high-speed video of Impact Test Machine, included in Materials-ISLE

Lattice Voyage:

Figure 5 Virtual image of teleporter in the virtual lab environment

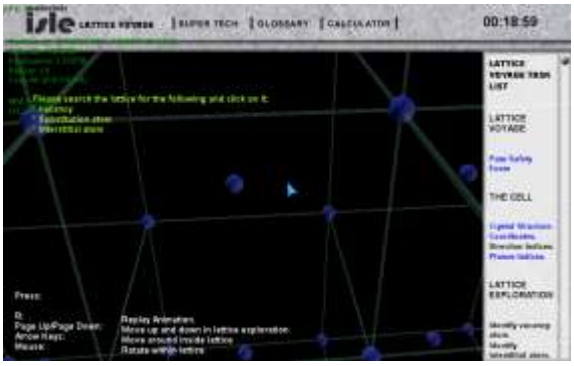

Figure 6 Student will search 3D space to identify a vacancy, a substiubstitution atom and an interstitial atom

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[20] http://www.merlot.org/merlot/index.htm MERLOT is a free and open online community of resources designed primarily for faculty, staff and students of higher education from around the world to share their learning materials and pedagogy.