How 3D Game Programming can Benefit the TeraGrid

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Kris' Faculty Background

(Kris Stewart, CS Professor, San Diego State University, California State University)

- **Numerical Analyst* led to**
- **Supercomputing and Undergraduate Education (SUE**) led to**
- **Supercomputing Teacher Enhancement Program (STEP***) led to**
- **Education Center on Computational Science & Engineering (ECCSE) part of NPACI/EOT-PACI (1997)**
- **ECCSE joins Engaging People in Cyberinfrastructure (EPIC) led to 3d Game Programming course at SDSU 2005**

* MS/CS SDSU 1979 (built IMSAI/Z80 kit computer), JPL 1981, PhD UNM 1987, SDSU 1984

** SDSC (1991); UCES (DoEnergy 1994)

*** Smithsonian Research Collection (1996)

Professional Rebirth of a Numerical Analyst as a Game Programming Enthusiast

- **Combining hobbies with professional activities**
- **Moore's Law still holding in gaming world**
  Now perform simulations and render them believably (on desktop – CPUs, GPUs). Our "stall" is their "lag"
  Gamers **feel** the performance hit on old processors

- **Collaboration – KUCSEK (I. Vakalis, Capital U.)**
  http://www.capital.edu/internet/default.aspx?pid=7111
  Computable Performance Metrics – Summer06
  Setup: Floating Point Precision;
  IEEE 754 standard and MACHAR (Cody);
  Goal: Computing Error and Work Estimators (grid-accuracy vs. problem condition#)

Computational Science indebted to the Game Industry, which now gives back

- **Power gamers' need to effectively run interactive games pushed the CPU envelope**
- **Resolution in graphics and run-time response has engaged this audience (market-driven, video games more $'s than movies)**

- **Higher Ed - need to engage this audience**
  - adapt the curriculum
- **Service-based learning is rewarding to the spirit (students may not know *they need this*)**

ECCSE collaboration with SDSC's Steve Cutchin using Torque http://vis.sdsc.edu/

- **http://visservices.sdsc.edu/projects/gamegrid/**

now hosts our Chemistry and Physics modules

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How the Ed Center on CSEng Lab used Torque as part of NSF EPIC (2005-06)

- **Hoover High School collaborators, Mr. Hal Cox (physics) and Mr. Robert North (chemistry)**
- **Both former STEP teachers**

  Supercomputer Teacher Enhancement Program (1993-1996)

  – Key STEP outcome, adoption of Web Browser in high school curriculum in 1994

  – Support from local infrastructure for network/computers in the classroom was justified by teachers' curriculum developments

1996 ComputerWorld/Smithsonian InfoTech Award for STEP

<Robert

<Hal

<Robert

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Web Page Development Adopted Quickly (wouldn't you prefer to have this young man on campus in the computer lab, than …)

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Computing Power a Decade Ago
(look familiar to you, or were you born digital?)

< Hal

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California State Standard Exam Topic

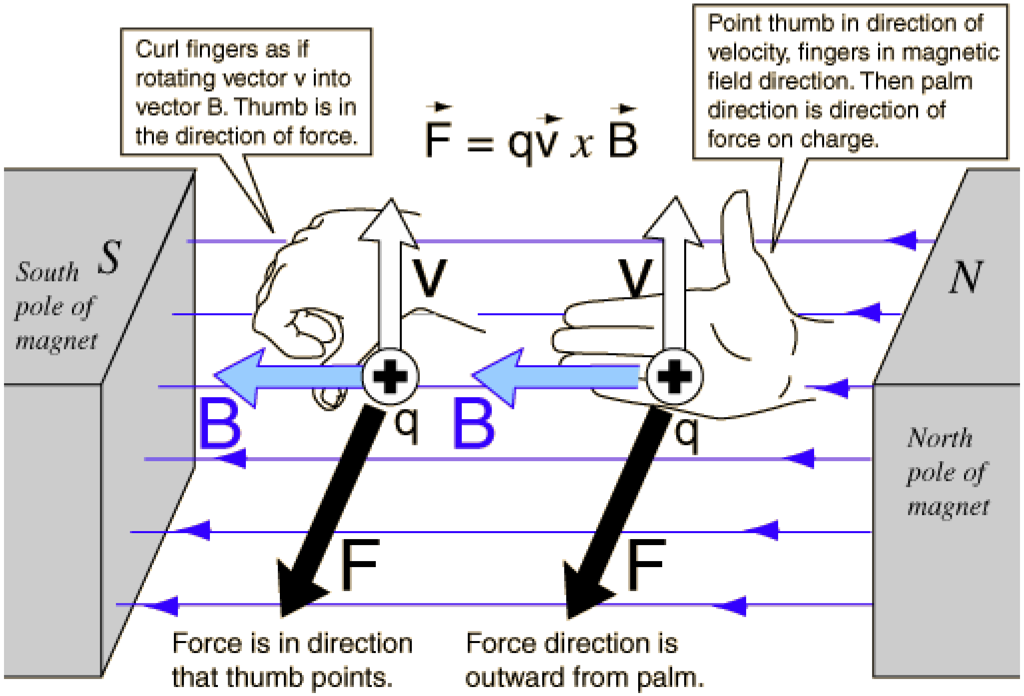
5n: Electric and Magnetic Phenomena

Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept:

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]

Directions – Right Hand Rule/Left Hand Rule



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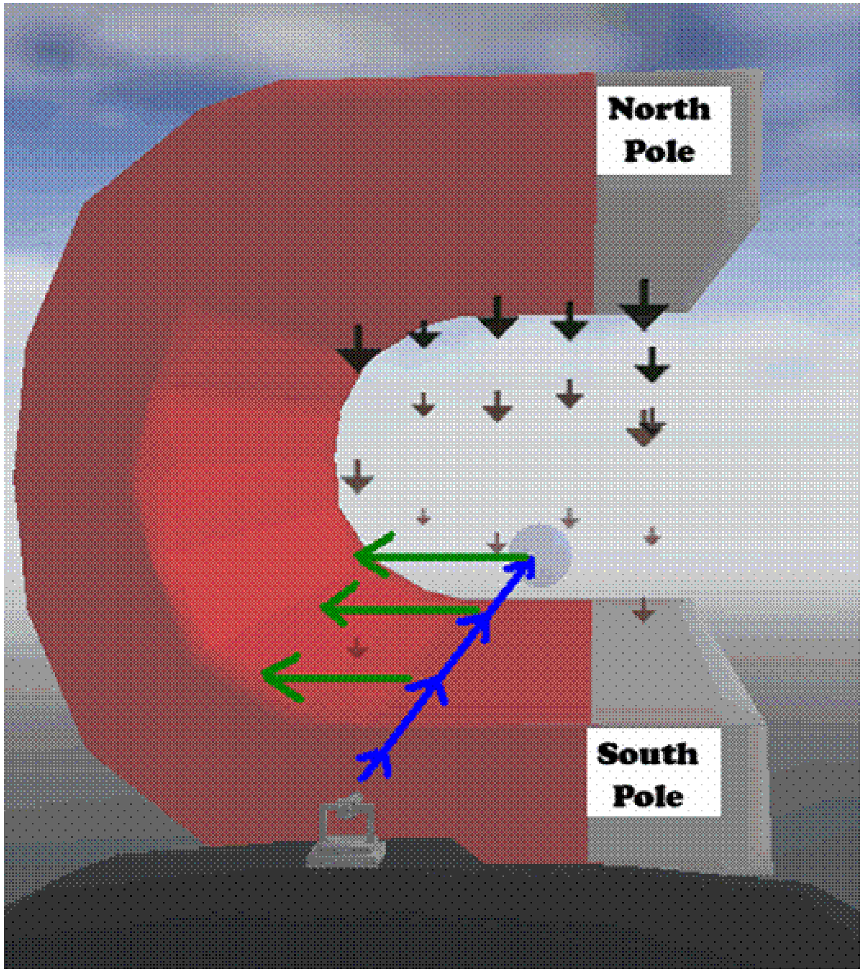
Magnetic Particle Emitter



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EPIC Grant: Visualize Education

as service learning

Students described their project to Mr. North:
"It's a First Person Shooter…"
Mr. North's face goes white
Afterwards discuss term FPS with students.
Though standard term in game industry,
have you heard of Columbine?
http://en.wikipedia.org/wiki/Columbine_High_School_massacre

Put yourself in shoes of clients – see from their point of view – First Person Point of View

My Students are Different from Me

Two sources of insight for me have been

- **John Seely Brown**
  “Growing up Digital”

- **Jean Twenge**
  “Generation ME”

Outside Wisdom on our Students

John Seely Brown – 17Jan05 @ SDSU

GROWING UP DIGITAL

How the Web Changes Work, Education, and the Ways People Learn

By John Seely Brown

In 1831 Michael Faraday built a small generator that produced electricity, but a generation passed before an industrial version was built, then another 25 years before all the necessary accoutrements for electrification came into place—power companies, neighborhood wiring, appliances (like light bulbs) that required electricity, and so on. But when that infrastructure finally took hold, everything changed—homes, work places, transportation, entertainment, architecture, what we ate, even when we went to bed. Worldwide, electricity became a transformative medium for social practices.

John Seely Brown is the chief scientist of Xerox and director of its Palo Alto Research Center.

10 Change • March/April 2000 Change • March/April 2000 11

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JSB
www.johnseelybrown.com

- **Having credentials that a computer scientists respects (Chief Scientist, Director Xerox PARC)**
- **Having publications that the education community validates (he joined the HBR debate on "IT matters to Higher Ed"* in letter to editor)**

***HBR May 2003 IT Doesn't Matter – Nicholas G. Carr**
***Does IT Matter to Higher Education?**
– Jack McCredie, Educause Review Nov02

Apply JSB Insights to CS Game Programming

- **Students grow up digital; faculty are analog. - becoming comfortable with "I am a digital immigrant".**
- **Capitalize on creativity by honoring the vernacular of today's students (multimedia-literate)**
- **Communicate complexity simply (a great skill)**
- **MIT's architecture studio – all work in public (development and critique) – in context**
- **Learning to learn "in situ" is key**

Apply JSB Insights in SDSU classroom

- **JSB highlights**

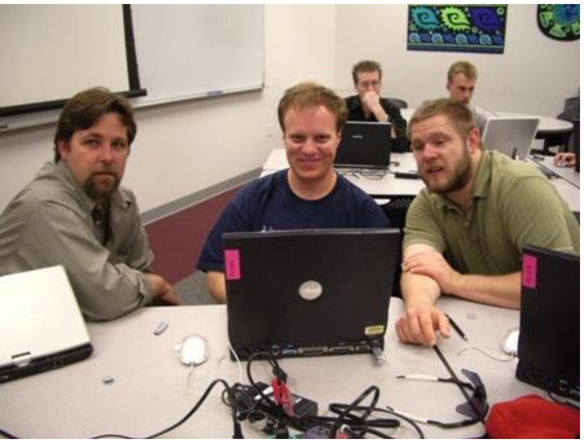
  multimedia literacy

- **Student Learning Outcomes**

  student group game development and presentations but classroom venue must support this activity

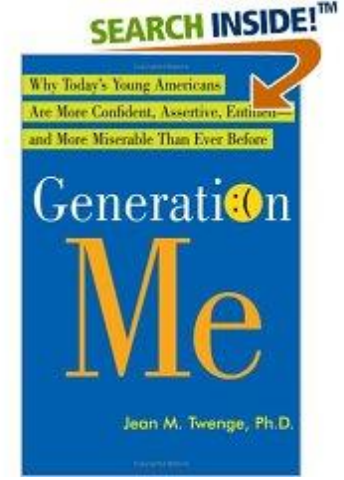
Gamer Groups Spr 2006-08

Great Classroom (AH1112) – Varying Engagement



/\ One girl

Generation ME



- **Why Today's Young Americans are more Confident, Assertive and more Miserable than ever before**

- **Jean M. Twenge, PhD, (Psychology Dept SDSU)**

  ¿ possible new collaborator ?

Gen Me -Twenge argues

- **Children of Baby Boomers (BB=post WW2/pre Vietnam "generation who discovered *self*")**
- **Gen Me raised to have high self-esteem [surveys show feel their lives controlled by outside forces, yielding apathy and cynicism]**
- **USA: Equality revolution in past 4 decades (1965 Selma marches) for minorities, women, gays and lesbians means Gen Me taught equality. Still more to do.**
- **GenMe feel entitled, no strong sense of duty**
- **GenMe less likely to believe in moral absolutes.**

Service Learning (SDSU)

- **“Combines community service with formal coursework in a way that both respond to community-identified needs and helps students meet academic, social, civic and moral learning goals” (http://servicelearning.sdsu.edu)**
- **Examples:**
  preventive dentistry (exams at clinics, etc.)
  video (script, production, direction, etc.)

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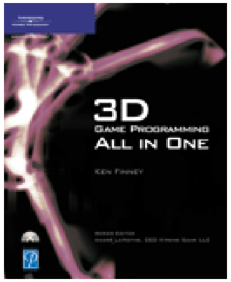
Service Learning for CS

- Working with community, we tend to find “jobs” rather than engaging projects
- Perhaps further discussions with community groups will reveal a need that goes beyond “programming”, but has not happened yet
- Most Computer Science students working on the Bachelor degree, already have employable skills as programmer / developer
- Difficult to find a match to benefit both sides

3d Game Programming
New Upper Division Course for Coders

- **Using the Torque Game Engine from www.garagegames.com**
- **Torque has object oriented scripting language with extensive game engine capabilities for the event-driven nonlinear programming. A large user community developed around this environment.**
- **06 Text: Ken Finney, Thomson Pub**
- **07-08 Text: Ed Maurina, GG Press**



Game Programmer's Guide to Torque Spr07 - 08

by Edward F. Maurina III

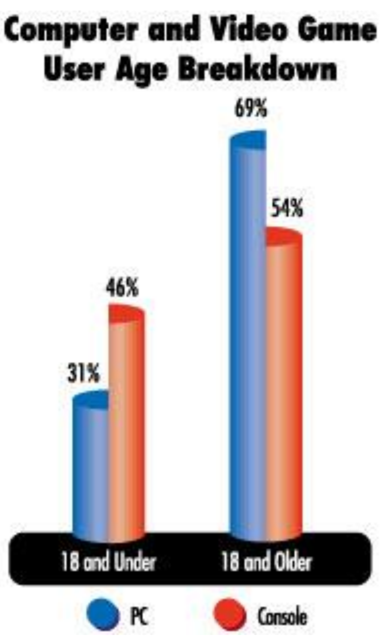
Windows, Macintosh, Linux

Changes from Spr06 course:

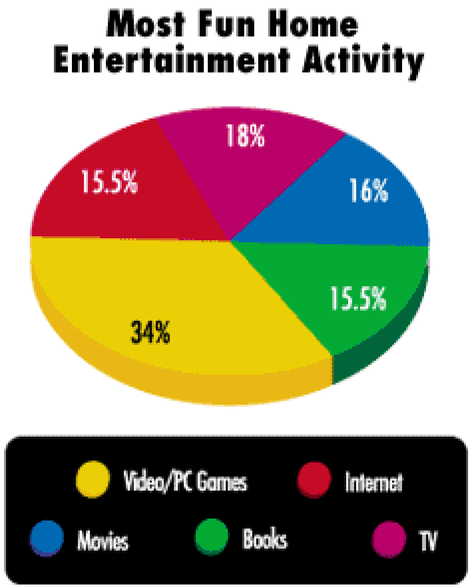
1. **Application server on-line for student course project development in a secure campus environment [firewall updates last year] – available on public internet to students**

2. **Student *cooperative learning groups***

Demographics of Gamers



43% women



http://games.advertising.com

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Ryuhei Kitamura @ Comic-Con *San Diego*

The story line is compelling.

Azumi – "I want to make samurai version of *Mad Max*"

http://en.wikipedia.org/wiki/Azumi#Azumi_feature_film

http://www.publicbroadcasting.net/kpbs/arts.artsmain?action=viewArticle&pid=31&sid=8&id=948591

•**KPBS interview with Azumi creator in 2007 by Beth Accomando**

http://visservices.sdsc.edu/projects/gamegrid/archive.php
Player.dts 3482 tris 10800kb file size
SDSC's Female Warrior

ShowTool examine details
http://www.stewart.cs.sdsu.edu/cs596-3dprog/SCRcaps/ShowTool/index-spr08.html

Ed Center on Computational Science & Engineering Engages People in CyberInfrastructure

Dr. Kris Stewart, Director

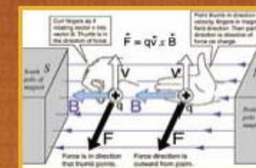
For over eight years, the Education Center on Computational Science & Engineering (ECCSE) promoted the use of high performance computing and its support systems at San Diego State University. The ECCSE originally formed in 1997 as a partnership activity with the San Diego Supercomputer Center's National Partnership for Advanced Computational Science Infrastructure (NPACI) grant from the National Science Foundation (NSF). When NPACI ended in 2004, we seized the opportunity for a new partner with Boston University and its efforts to support science education. We received NSF funding as part of the Engaging People in CyberInfrastructure (EPIC) grant, which is one of the first funded projects from the NSF Office of CyberInfrastructure (OCI).
http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0520146

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 collaborated with two science teachers from Hoover High School, a part of the SDSU Education Collaboratory. Mr. Robert North teaches chemistry and Mr. Hal Cox 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. We also had a partnership with the Visualization Team at the San Diego Supercomputer Center, who used the Torque Game Engine to develop modules to explore science.

Our development team at SDSU included a professor of computer science, Kris Stewart, staff resources specialist, Kirsten Barber, and two computer science majors as programmers, John Nguyen and Skylar Hayes. Our first project was to visualize a simple molecule to demonstrate the power of the nuclear force, a required topic from the California State Chemistry Standard. 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, students know protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.
http://www.cde.ca.gov/be/st/ss/scchemistry.asp

After establishing what would be beneficial for Mr. North's 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 during his presentation regarding our partnership at the August 2005 Chemistry Teacher In-Service workshop for San Diego City Schools.

Mr. North used this module in the computer labs at Hoover High School for his students to learn about nuclear force.



Next we worked Mr. Hal Cox to find an appropriate 3-D model to support concepts his students had difficulty with in physics. Electric and magnetic phenomena, the required topic Mr. Cox selected, are related and have many practical applications. As a basis for understanding this concept, 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

Our preliminary modules are available for download to an IBM PC computing platform as a zip-file from Virtual Field Trip to a Lithium Battery:
http://visservices.sdsc.edu/projects/explore/LitBattery.php

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

TORQUE GAME ENGINE

http://www.sci.sdsu.edu/cos/downloads/cos_fusion2006.pdf

Have a few copies – please take home with you.

What's Next?

- **CS 596 Game Programming brought into formal catalog – CS 583 3d Game Programming Spr09**

  Expect interesting feedback from students on their opinions on the *Digital Age*, given they were *born digital*

- **Expect interesting changes in the learning environment and its support on campus**

Assessment not just requirement

Rather, found to be

- **vital tool to assist in clarifying student and faculty needs**
- **improve prioritization skills**
- **validation of focus on human factors to integrate HPC (modeling & visualization) into undergrad curriculum**

U. Wisconsin LEAD for 1998/99 Ed Center evaluation

www.cae.wisc.edu/~lead/pages/products/eot-paci.pdf

Lessons Learned from SDSU Assessment 1999

- **Network brings resources to YOUR desktop (or lab or class)**
- **Computer network is community resource with individual opportunities & responsibilities**
- **Efforts within your local environment to raise awareness, but must credit the external source**
- **National partnerships, EPIC, EOT-PACI and this workshop. Voices that local colleagues listen to (more than you)**

Where did it begin?
1998/99 Assessment by LEAD

Background

- **Wisconsin Workshop April 1997 learn about assessment make it doable for EOT-PACI (NPACI & NCSA Education Teams)**
- **NPACI started 01 October 1997**
- **EC/CSE requested assessment for 1998 project**

NSF/EHR

National Science Foundation/Education and Human Resources Directorate

http://www.nsf.gov/pubs/2002/nsf02057/start.htm

LEAD

Assessment and Evaluation

1998 Formative for the ECCSE

http://homepages.cae.wisc.edu/~lead/pages/products/eot-paci.pdf

1. Introduction (46kb)
2. Section I - Evaluation and Types of Evaluation (55kb)
3. Section II - The Steps in Doing an Evaluation (154kb)
4. Section III - An Overview of Quantitative and Qualitative Data Collection Methods (66kb)
5. Section IV - Strategies That Address Culturally Responsive Evaluations (50kb)
6. Other Recommending Reading, Glossary, and Appendix A: Finding An Evaluator (56kb)

Entire PDF Document (379kb)

Updated NSF User-Friendly Handbook

Grand Challenges for HPC

Stewart & Zaslavsky, SC98, HPC=High Performance Computing

1. **Faculty system of rewards does not encourage teaching innovations**
2. **Lack of awareness of HPC technologies already used in research or teaching for different fields**
3. **Faculty & students unaware of benefits and accomplishments of HPC**
4. **HPC technologies considered too complex/inaccessible for undergraduate instruction**
5. **Sequential HPC-related curricula is absent**
6. **Curricula using very large data sets not widely available**
7. **Adjust to different learning styles when material is complex**
8. **Variety of platforms/software leads to fragmented curricula**
9. **School administration/support staff not ready for HPC**
10. **Specs of computers and networks below user expectations**

SC98 a decade ago

Have things changed on your campus?

Building the Community of Faculty

- **These 10 challenges are people-centric, not technology-centric and of interest to the broad academic community**

- **Systemic Change requires understanding the system and working within it**

- **Empower faculty (find the time), ensuring recognition (from chair/dean) and support (student assistants)**

Undergraduate Faculty: A Tough Target Group

- **Obstacles**: lack of time, tenure and review considerations, lack of awareness about available technologies
- **Undergraduate faculty (SSRL phone survey 1997 – thanks Doug Coe)**:
  - ¾ have used WWW often or sometimes (1997), but not in the classroom (only 18% - 1998)
  - The gap between those NEVER using computers in the classroom, and those using them OFTEN, is the largest for untenured faculty, increasing towards tenure review
  - Only 12% of surveyed faculty saw themselves as having a use for HPC applications in courses (higher for Sciences and Engineering)
  - 11% of faculty have students working with computer models OFTEN

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Next Step for me and you?

- **Participating this workshop to learn first-hand of the TG resources**
- **Assessment is important (for you, your peers, your students) to demonstrate value**
- **Talk with me about your ideas for wider dissemination of your TG project**
  Two grad students taken course & want thesis project implementing game module for TG

- **View the Physics Game now?**

References – TeraGrid 08

www.stewart.cs.sdsu.edu/PPT/
stewart-TG08-gamePlatform.ppt **(this talk)**

Stewart: curricula www.stewart.cs.sdsu.edu

John Seely Brown
http://www.johnseelybrown.com

San Diego Supercomputer Center
http://visservices.sdsc.edu/projects/gamegrid/

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More Information?

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www.nsf.gov/awardsearch/showAward.do?AwardNumber=0520146