Recent Advances in Science Learning Games

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Overview

- Game Culture and Technology
- Games in Science and Science Learning Games (SLG)
- Early SLGs
- Recent Game-like Environments
- Next-generation SLGs
- Future SLGs and Emerging Opportunities

Game Culture and Technology

- Games as immersive, experiential literary form -- *game play as emergent narrative*
- Gaming as rapidly growing global industry
- "Modding" and making games as practice-based *learning* and *career development*
- Games as *new media* and cultural form
- Game culture as *social movement*


t3h S00p4rFr34k!
‹Freakshow›
Level 30
Elite Boss
Actions
Options
All Pets
Call Genin
Keitaro
Seta
Taka
Call Jounin
Fujisawa
Chiba-san
Oni
Moshigosan
Destroy the SuperFreak
Defeat the Superfreak
Map Contact Mission Clues Badge
Chat Tray Target Nav Menu
Games as a new medium
Pets
Arachnie
Ms. Chievous
Kick Promote Find Quit
Team Friends Super Email Tab 1 2 3 4
Global Combat Rewards System
You gain 102 experience and 71 infamy.
t3h S00p4rFr34k!: d0 j0u d4r3 t0 ch4l13ng3 t3h p0w4r 0f t3h S00p4rFr34k!?
You have defeated Slag Heap
You gain 102 experience and 71 infamy.
t3h S00p4rFr34k! has defeated Battle Drone
Team:
Powers Inspirations Enhancements Salvage
Att
diss
Beat
SSR
SSF
Go
CSF
FSF

L.A. Renews Its Libraries as Modern Civic Centers

■ More than just housing books, the new and refurbished branches bring people together.

By Noam N. Levey, Times Staff Writer

On a dusty, hot summer afternoon in South Los Angeles, 13-year-old Joseph Robinson and 9-year-old Franklin Flores are in a favorite place — huddled in front of a computer terminal playing RuneScape together.

For the boys, one black and one Latino, the new Ascot branch library at Florence Avenue and Main Street is their daily meeting place, a refuge from a gritty neighborhood where interracial tensions recently sparked violence at a local high school.

In the Pico-Union neighborhood, older residents go to their new branch for a library-sponsored Coffee and Conversation, which brings together strangers to talk about Iraq, immigration or whatever topic may be in the news.

PHOTOS

'Neutral territory' (Christine Cotter / LAT) November 26, 2005

Success story (Christine Cotter / LAT) November 26, 2005

PRINT EDITION

Cunningham's Fall From Grace, Power

Real Estate Fraud Booms

Ebb and Flow on the Volga


Sports Festival
스타크래프트
STARCRAFT

Research objective

- Employ networked computer game technology in ways that integrate
  - social learning opportunities
  - scientific visualization methods
  - external scientific datasets
  - science work practices
  - open source software community dynamics
  - playful fun

  to develop, deploy, and evolve single/multi-player games for informal science education in different science disciplines.

Early SLGs

- Computer games for Operations Research
  - Game theory (1940-1950s)
- Games for Artificial Intelligence
  - Samuel's Chess and Checkers games (1950-1960s)
- Non-game science learning or scientific reasoning environments
  - Sophie (1970s)
  - Plato
- "Science inspired" games
  - Science as source for fantasy or make-believe (science fiction)
  - May be fun to play, but unclear if any science learning facilitated
    - Best outcome--inspiration to discover scientific knowledge
    - Worst outcome--fantasy treated as factual scientific knowledge

Disney Dino

Zoo Tycoon--Dinosaurs

Nanosaurs
(Dinosaurs with Jetpacks!)

LucasArts Droidworks


Reward:
Cybot Galactica AT-9 Tank Locomotion System
#1 The Slippery Slope
Mission Briefing:
Get your droid through the security exit door at the top of the cliff. In the area nearby, there are objects that can help your droid reach its goal. The speed and weight of your droid are important factors.
Droid Info
Mission Goals
#1 The Slippery Slope
pass through security exit door
Droid Requirements
treads and wheels
Ranking:
Apprentice
Designer
Master
Mos Eisley
Jundland Wastes
Tosche Station
1
2
3
4
5
6
7
8

Game-like educational environments with science/engineering content

- *River City* (Chris Dede et al., Harvard)
  - An interactive 3D computer simulation for middle science students in learning disease transmission and scientific method, while addressing national science education standards.
- *Quest Atlantis* (Sasha Barab, IndianaU)
  - A learning and teaching project that uses a 3D multi-user environment to immerse children, ages 9-12, in socially responsible educational tasks, consistent with local academic standards.
- *Whyville.net*
  - Corporate sponsored Web site with multiple games targeting 8-15 year old girls and boys (more than 2.2M users, more than 50% female)
- *SciCentr.org* at Cornell Theory Center
  - Online science museum that uses online multi-user virtual worlds for informal science and technology outreach.

The River City Project

A Multi-User Virtual Environment for Learning Scientific Inquiry and 21st Century Skills



Grant Info
Funded by the National Science Foundation

Introducing River City

Welcome to River City!

Welcome to the River City Project. With funding from the National Science Foundation, we have developed an interactive computer simulation for middle science students in learning disease transmission and scientific method. River City has the look and feel of a videogame but contains content developed from **National Science Education Standards**, **National Educational Technology Standards**, and **21st Century Skills**.

http://muve.gse.harvard.edu – River City: Screen...

Bird's Eye View of River City

Done

he National Science
ofessional development,
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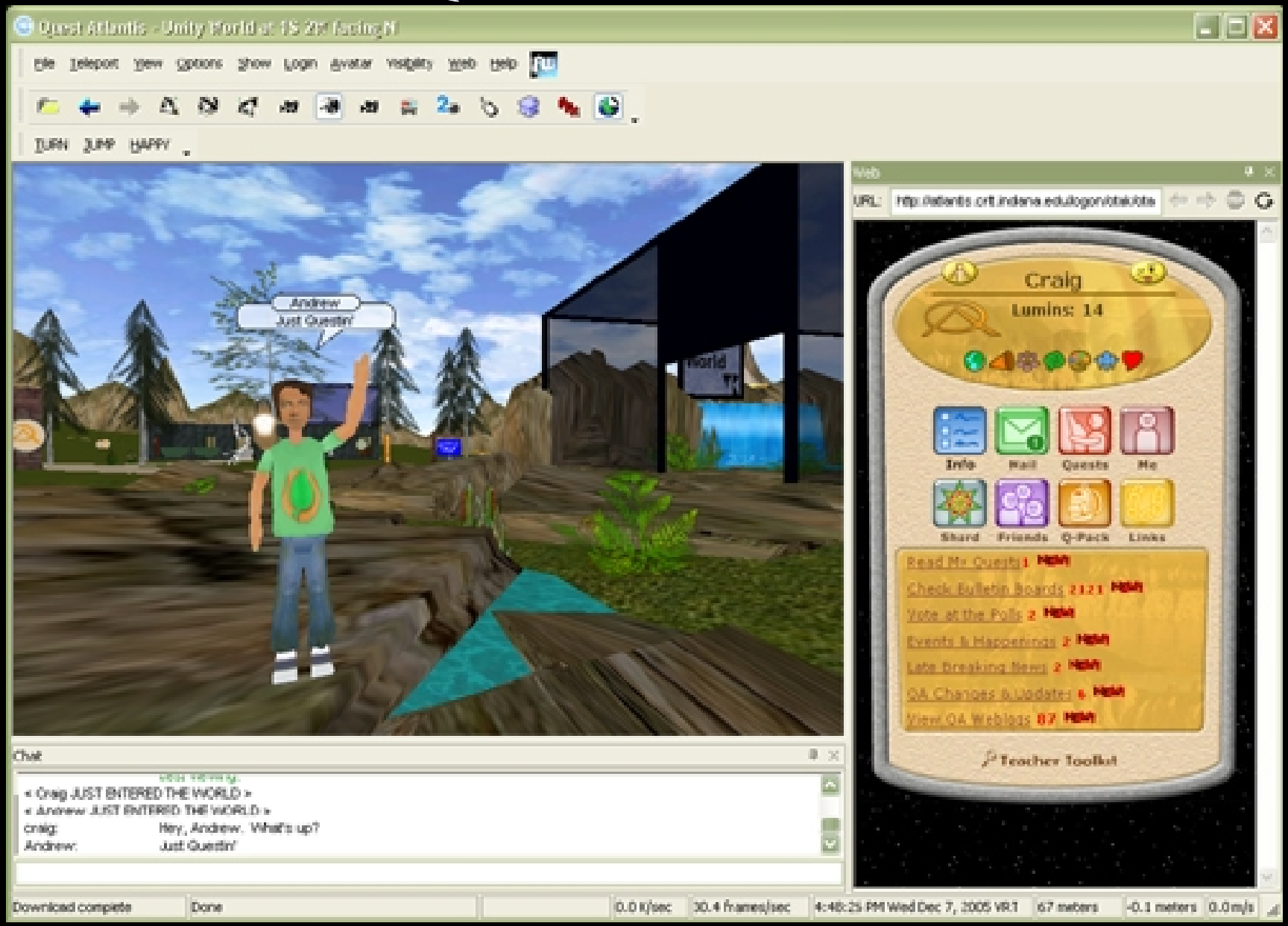
Quest Atlantis



Whyville's Educational Games

In Whyville, citizens earn a salary of "clams", our virtual currency, by participating in a wide range of educational games and activities. They include:

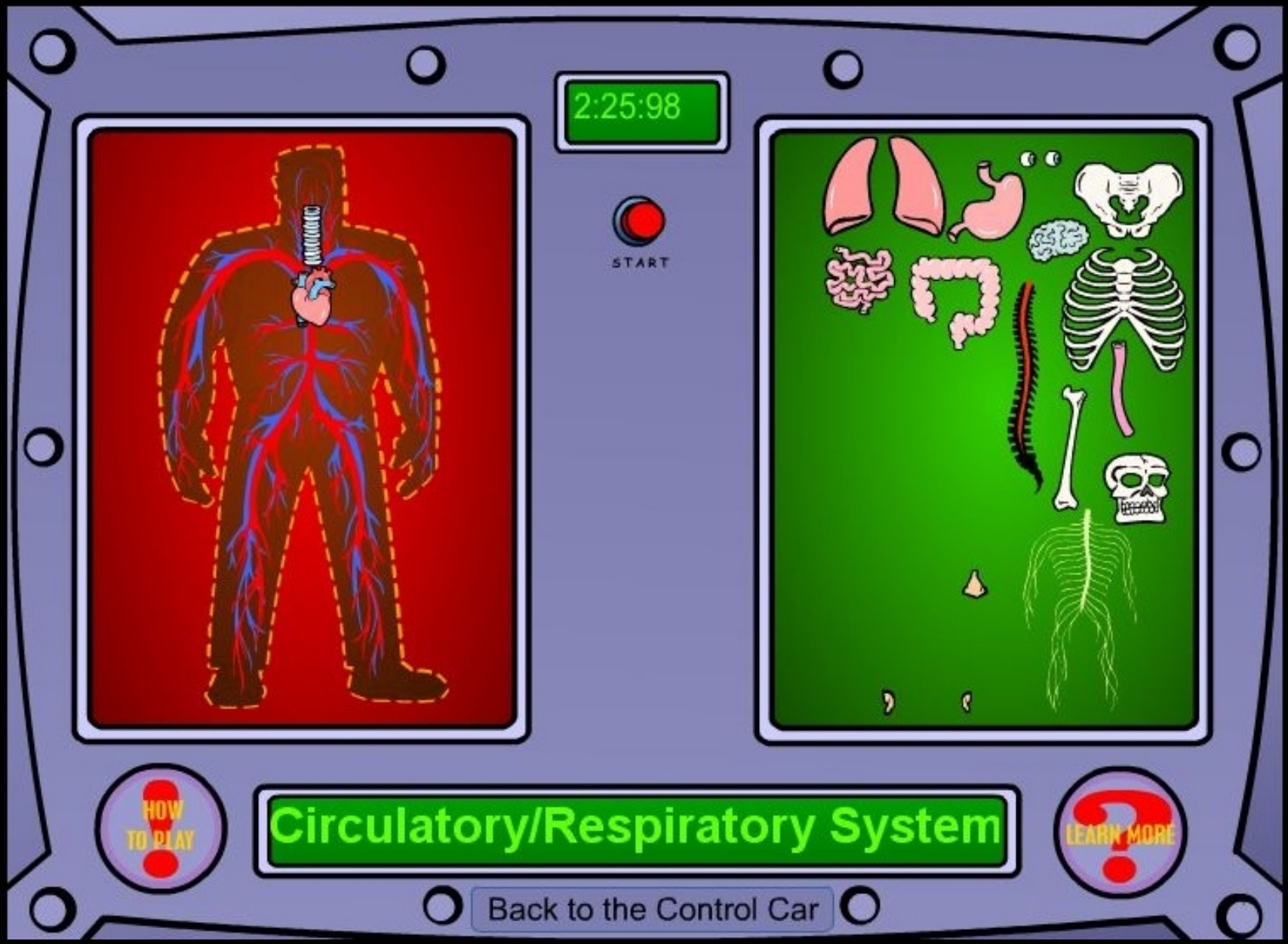
The Skater	is a simulation-based game on angular momentum. It challenges you to answer the question, "How do skaters get spinning so fast?"
The Spin Game	extends the Skater activity by addressing the issue of rotational axes and symmetries.
The House of Illusion	is an exhibit on visual illusions.
The Sun Spot Puzzle	introduces you to the concept that sun rise and sun set times vary according to your latitude.
The Alien Rescue Game	takes you around the world in search of lost aliens while honing your understanding of how the perceived path of the sun changes throughout the year.
The Solstice Safari	is an extended collaborative activity where citizens team up to collect data, plot graphs, and predict the solstices.

Recent SLGs and Science-based Games

- *KineticCity*.com
  - NSF-AAAS game for learning life science in line with National Science Education standards
- *Task Force Biology* (ecological restoration and economic development via role-playing game)
- *Industry Player*
  - Commodity-based, multi-industry market simulator
- *GTR* (car racing simulation)
  - Vehicle dynamics engineering (race car tuning)
- *NASCAR 2007* (racing simulation)
  - Systems engineering (performance-based system design via telemetry capture and analysis)


PLAY SCIENCE GAMES NOW!
KINETIC CITY
MISSION TO VEARTH
WHAT IS KINETIC CITY ?
THE MOST AMAZING SCIENCE SITE ON THE INTERNET !
LOGIN OR SIGN UP NOW!
NSF
Kinetic City: Mission To Vearth is produced by the American Association for the Advancement of Science, with major funding from the National Science Foundation. Copyright 2002 AAAS
Click here for Terms and Conditions
AAAS
FOR EDUCATORS

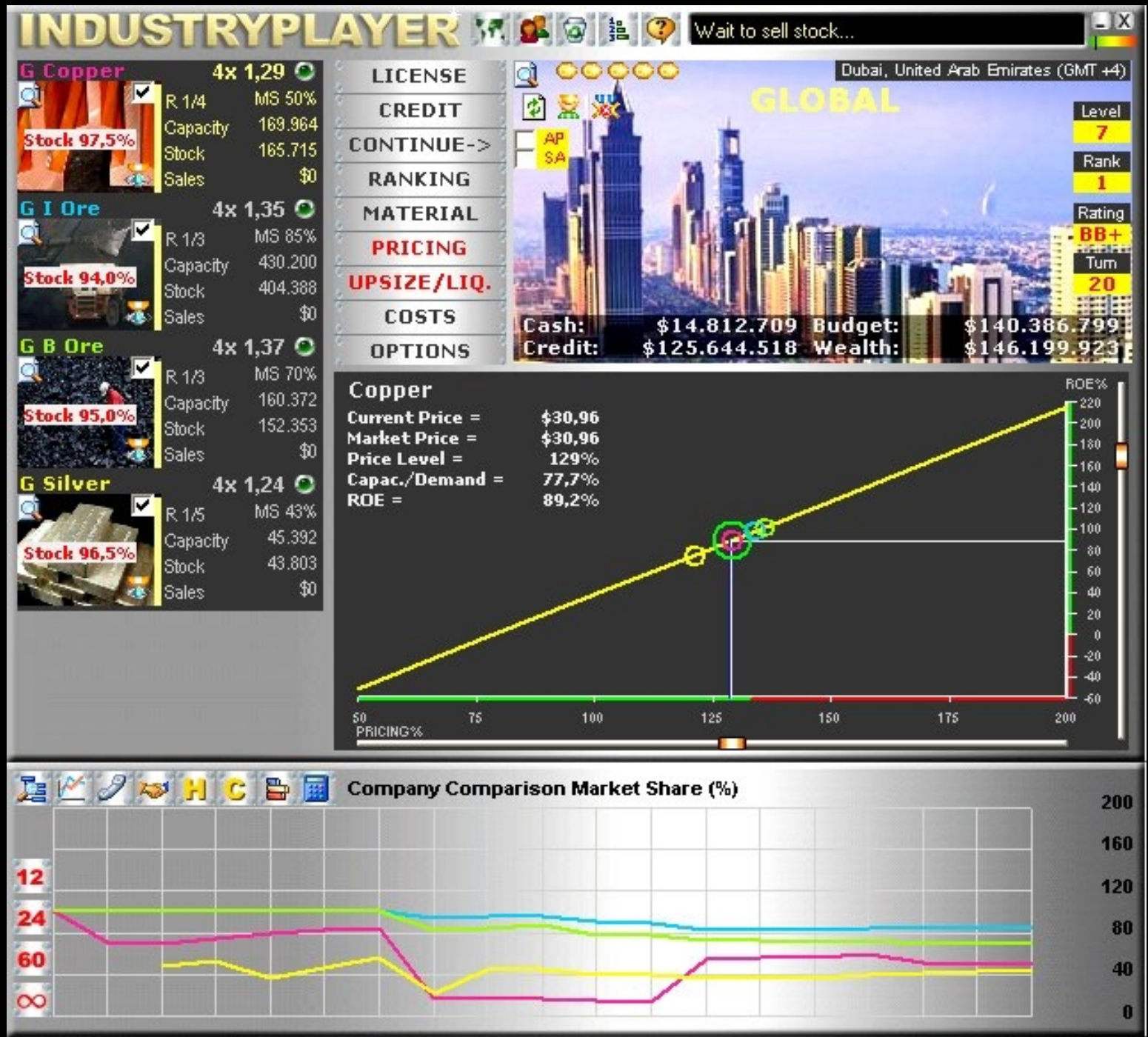
KineticCity MiniGame--Body System Identification



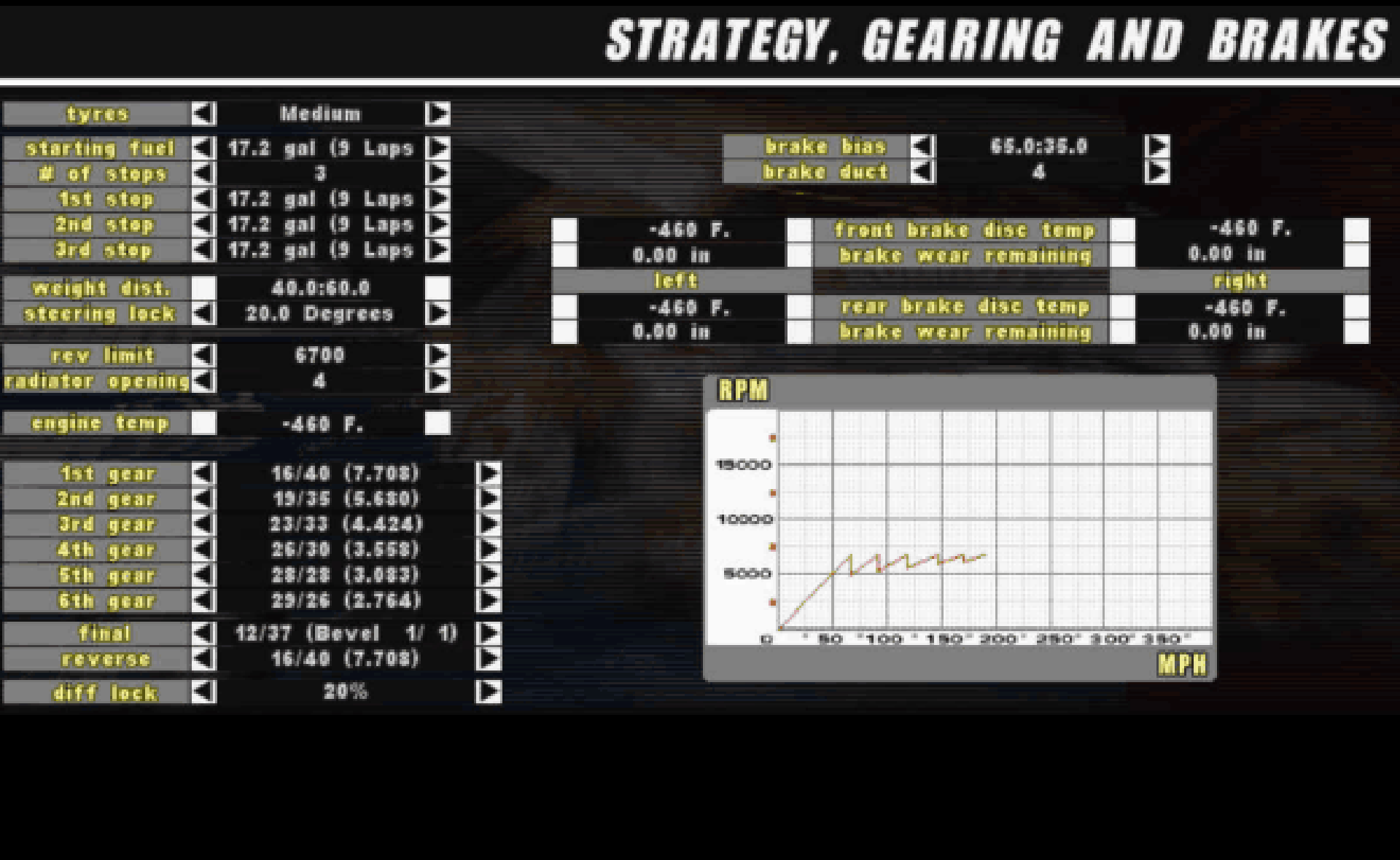
KineticCity Body System *Identification Game* Play-to-Learn techniques

- Given prompt (e.g., *Circulatory/Respiratory system*) select, drag, and place system components into correct locations
  - System component identification (e.g., heart, arteriole-venal network, esophagus, lungs) and location
    - By iconic form/shape (no names)
- Placing all correct system components allows advancement to next system; any mistake resets (removes) placed components requiring iterative play.
  - Failure-driven (trial+error iteration) and spatial-shape reasoning
  - Play-learning anomalies
    - Some components resize, others don't
      - Nerve and arteriole-venal networks resize on placement (automatically), but bones don't
    - Systems are partial--why some components, but not others?
    - Which system -- cardio-pulmonary system vs. "circulatory/respiratory" system?

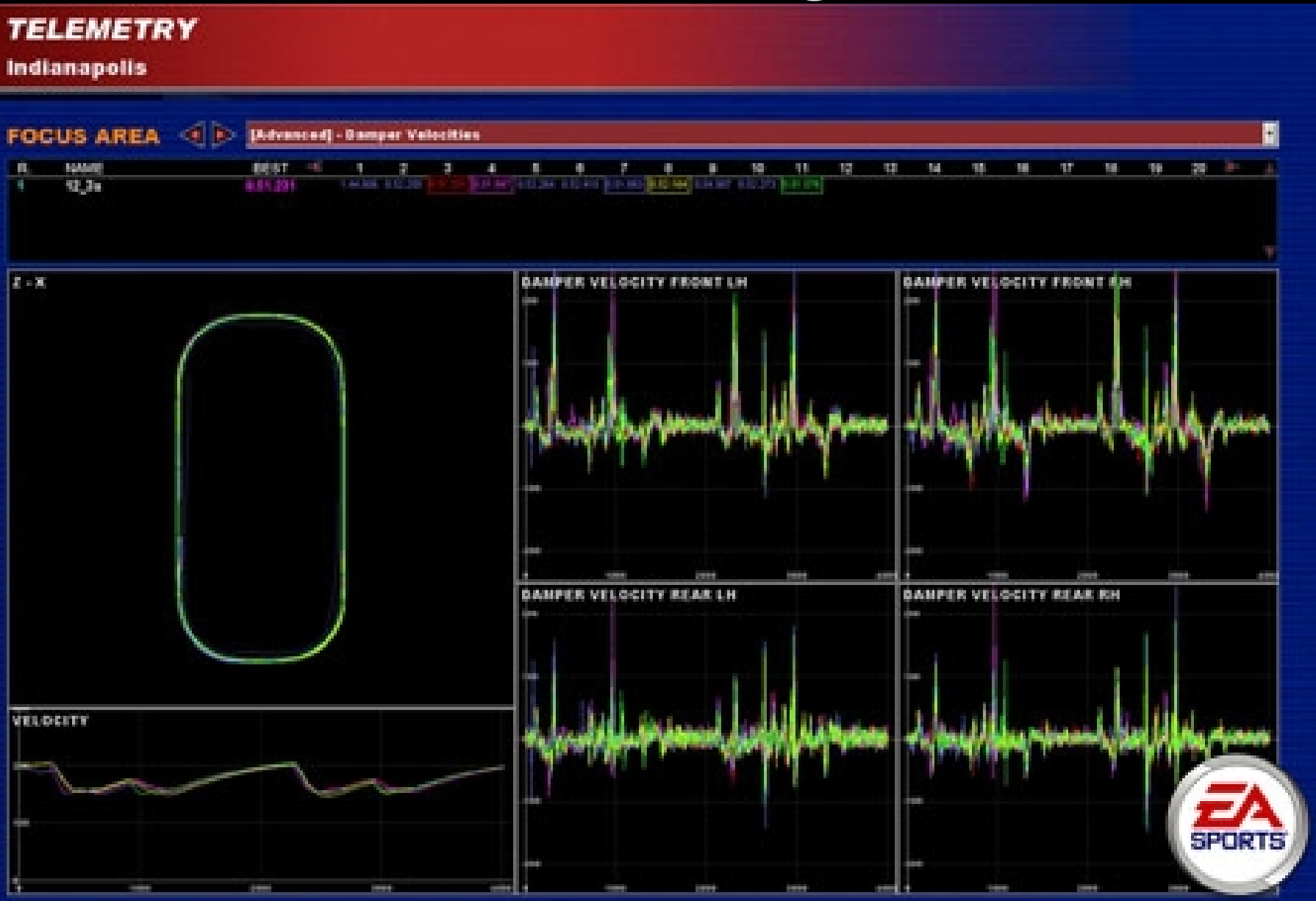
Radon Labs GmbH Game Development


INDUSTRYPLAYER
Wait to sell stock...
G Copper
4x 1,29
Stock 97,5%
R 1/4
MS 50%
Capacity 169.964
Stock 165.715
Sales $0
G I Ore
4x 1,35
Stock 94,0%
R 1/3
MS 85%
Capacity 430.200
Stock 404.388
Sales $0
G B Ore
4x 1,37
Stock 95,0%
R 1/3
MS 70%
Capacity 160.372
Stock 152.353
Sales $0
G Silver
4x 1,24
Stock 96,5%
R 1/5
MS 43%
Capacity 45.392
Stock 43.803
Sales $0
LICENSE
CREDIT
CONTINUE->
RANKING
MATERIAL
PRICING
UPSIZE/LIQ.
COSTS
OPTIONS
Dubai, United Arab Emirates (GMT +4)
GLOBAL
AP
SA
Level 7
Rank 1
Rating BB+
Turn 20
Cash: $14.812.709 Budget: $140.386.799
Credit: $125.644.518 Wealth: $146.199.923
Copper
Current Price = $30,96
Market Price = $30,96
Price Level = 129%
Capac./Demand = 77,7%
ROE = 89,2%
ROE%
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
50
75
100
125
150
175
200
PRICING%
Company Comparison Market Share (%)
12
24
60
∞
200
160
120
80
40
0

GTR racing simulation



NASCAR Racing 2007



Next-Generation SLG Environments

- *Eco-Raft* -- embodied ecological restoration game (Bill Tomlinson, UCI)
- *Fantastic Voyage through a Pig's Heart* -- Internal organ fly-through navigation quest, based on volumetric (CAT-scanned) data (Joerg Meyer, UCI)
- *DinoQuest* -- physical multi-mission game environment with embedded multi-media activated via sensor network (Discovery Science Center, Santa Ana, CA)
- *DinoQuest Online* -- Web-based multi-mission, multi-level, multi-genre games integrated with DinoQuest. (Robert Nideffer and Walt Scacchi, UCI, for DSC).

Merging Ecology. . .




Eco-Raft -- ecological restoration via physically embodied, interactive experience

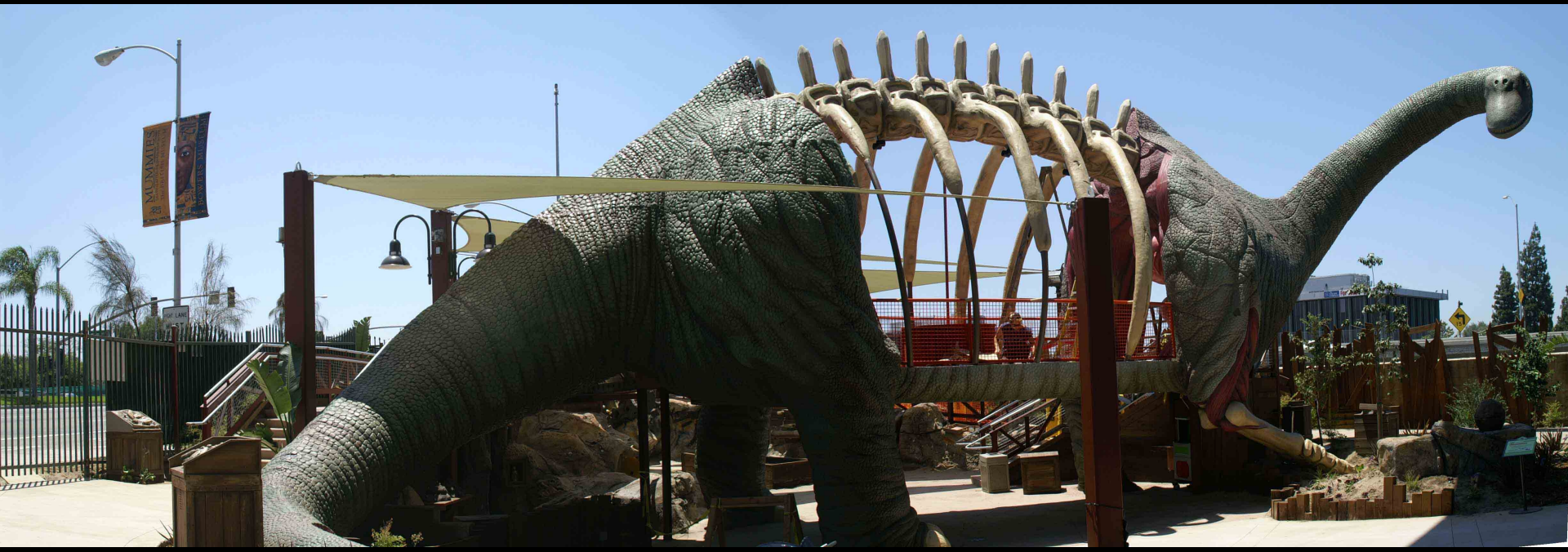
. . .with Technology




DinoQuest

- Physically embodied interactive museum installation
- Gesture-based, interactive exploration using keyed transmitters to designate objects with embedded sensors
- Narrative-based multiple scientific quest environment
  - Life sciences via paleontology
  - Addresses CA science education K-6 standards and beyond

DinoQuest



DINO QUEST
DISCOVERY SCIENCE CENTER

&

DINO QUEST
DISCOVERY SCIENCE CENTER
ONLINE

THE WORLD'S FIRST INTERACTIVE DINOSAUR ADVENTURE

DINO QUEST
DISCOVERY SCIENCE CENTER

TACO BELL DISCOVERY SCIENCE CENTER

1	Students enter into an area where they will select their Infrared Research Transmitter for the Dino Quest.
2	In the registration and training area they will login to the Quest computer system to create a unique, grade specific ID for themselves and learn more about the exhibit and how to use their research transmitter

3	Students will then enter the **Co-Laboratory** where they will select one of six Research Missions and continue their transmitter training.
4	**Quest Stations** are located throughout the exhibit and assist students in learning and successfully navigating through their research mission.

RESEARCH MISSIONS	These are educational challenges that align with the Life Sciences curriculum within the California Science Content Standards at a grade specific level. An example would be a 1st grade student learning about comparative anatomy.
ADVENTURES	Are student rewards after three successful research missions have been completed. They are a more complex challenge that requires the student to apply the science knowledge learned and engage them in thinking and problem solving—science literacy.

DinoQuest -- live action video (actors) with synthetic laboratory background


Field Site

BioMech Lab


Zoology Lab


Habitat Lab

DinoQuest Research Team and Collaboratories
Diverse Scientific Role Models (ethnicity, age, gender)

Go to Field Station and Select a Mission

8 Educational Missions:

- Each aimed at California Science Standards
- Mission topics: Predator / Prey, Trace Fossils, Anatomy, Habitats, Identification
- Each mission focuses on a different collaboratory and field of science
- Research Scientists request dig site to be searched & items electronically tagged

Video Game Mechanics

Uplink data collected to *collaboratories*.

- Earn Research Points for each item found.
- Obtain fossils with encoded DNA as reward for completing each mission.

Ability to save data and come back another day.

DINO QUEST
DISCOVERY SCIENCE CENTER
THE WORLD'S FIRST INTERACTIVE DINOSAUR ADVENTURE

- Picking up information throughout the physical site.
- Infra-red emitter and embedded sensor network for tracking visitor's progress on missions.

Technology:
Embedded Sensors and Transmitter Activation

Role play (see oneself as a scientist)

After selecting a mission, head out to the dig site!

Role play (see oneself as a scientist)

Search dig site and identify objects in the mission.

Computer and sensor network automatically tracks your success.

DinoQuest Online

- Web browser-based set of *casual games* that extend and deepen the DinoQuest experience base through game-based scientific workflows
  - Observational and collection building methods
  - Association development
  - Relationship articulations
    - *Example*: prey-predator or food-consumer with temporal decay functions

DSC *DinoQuest Online*

DINO QUEST
DISCOVERY SCIENCE CENTER
ONLINE

DinoQuest Online--Prof. Digwell

DinoQuest Online (released in late March)

- Four SLG collaboratories
- MyLab personal DQO-based collection site (associates FQ and DQO results like “Dino DNA” samples)
- Dinosphere -- Assemble virtual dinosaur via DNA-based body system components

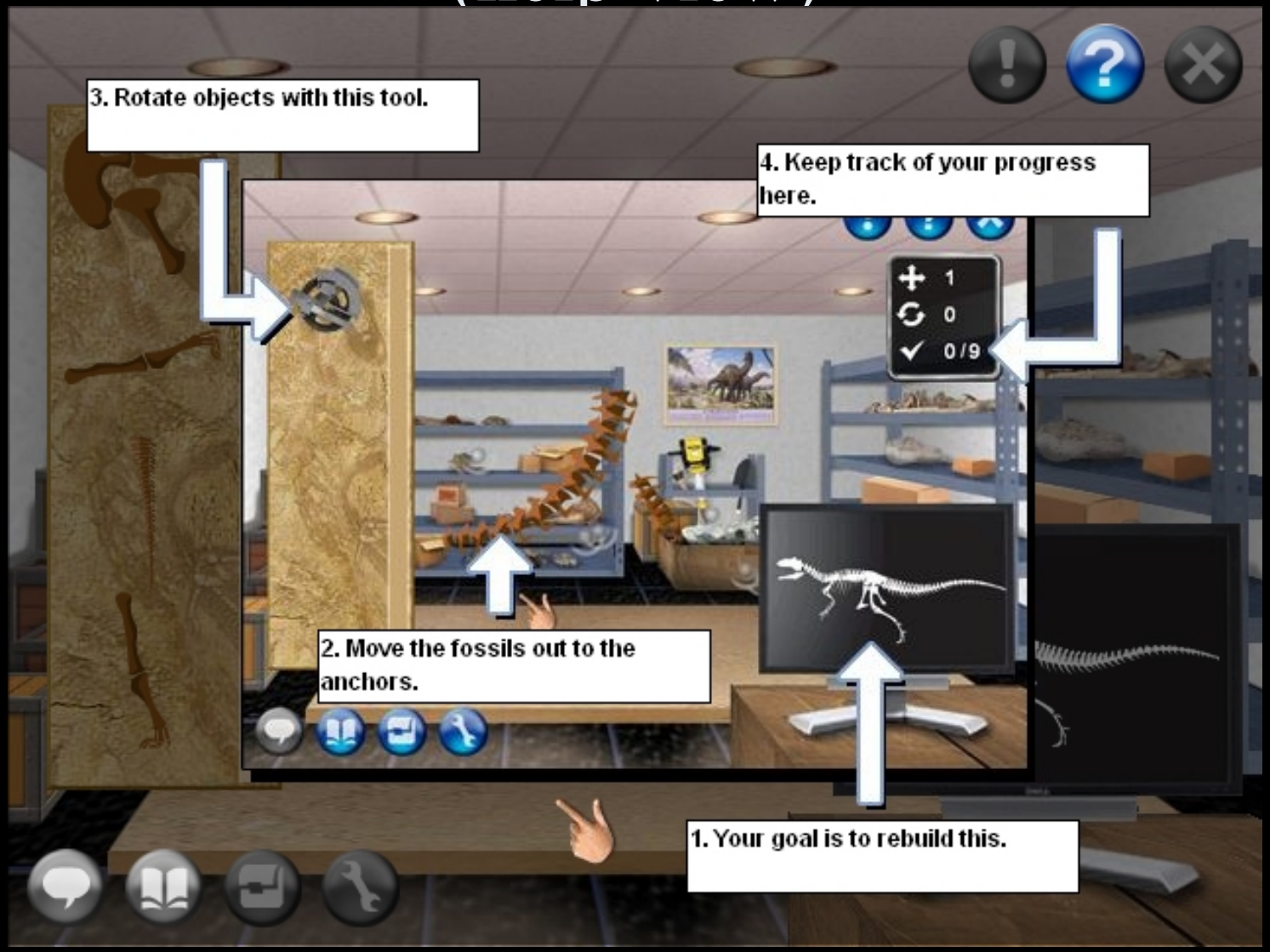
- Same scientists as DinoQuest at DSC
- Each collab game tied to CA science education standards, but experienced via discovery/exploration-oriented game genres

DinoQuest Online--Prof. Sanchez at DigPit

Uncovering Tailbones fossil at DigPit

DinoQuest Online Reconstruction Co-Lab

DinoQuest Reconstruction Laboratory (help view)



Biomechnical Lab -- Balance and Mass

DinoQuestOnline Ecolab

Addressing CA science education standards

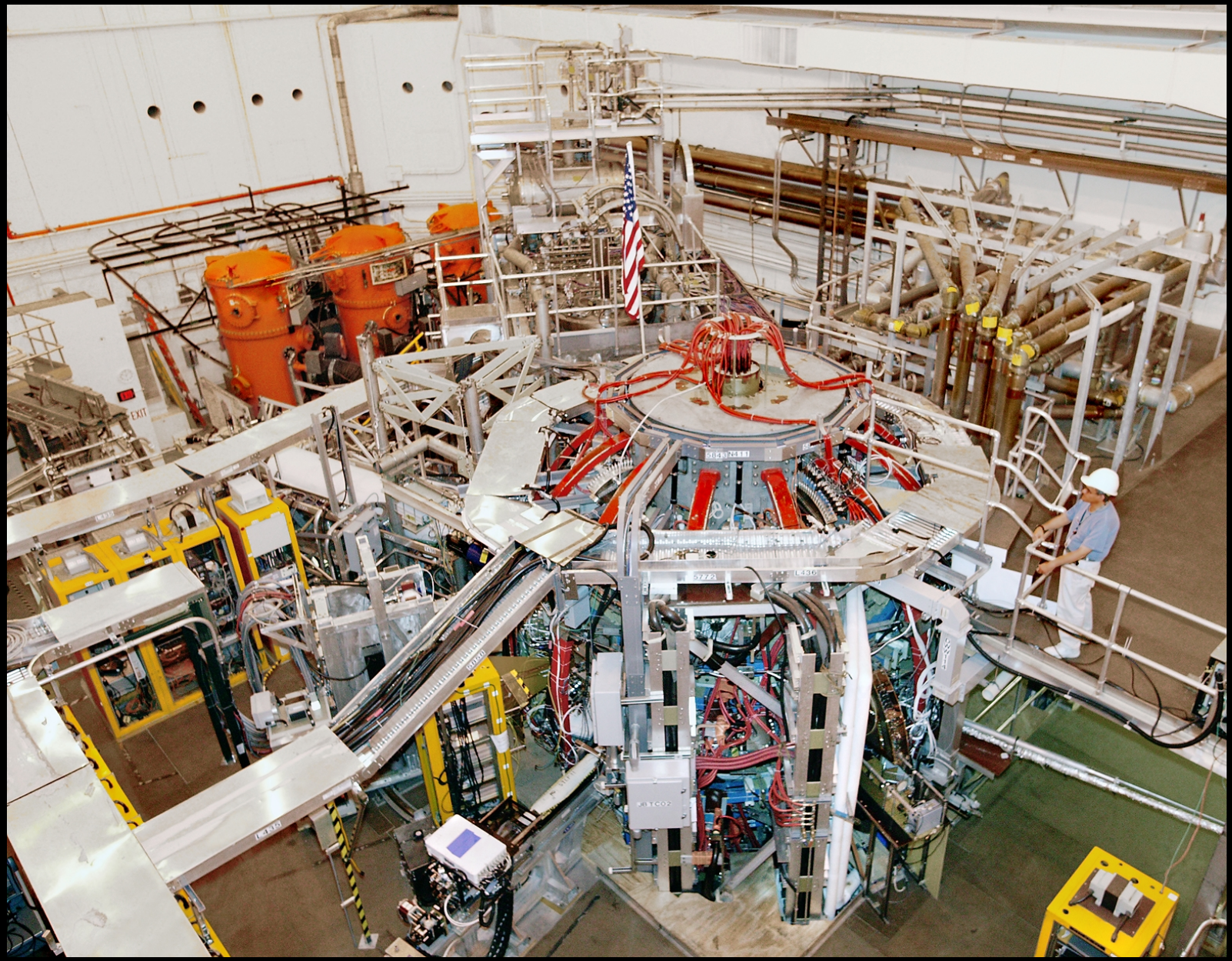
- Communicates about investigations
- Understands that learning can come from careful observations and simple experiments
- Recognizes how factors such as gravity can affect common objects
- Describes an observed change in terms of starting conditions, ending conditions, using words, simple diagrams, or graphs
- Identifies what does and does not change when matter experiences an external influence such as push, pull, tip.

Future SLGs

- Games employing advanced scientific models, simulations, and visualizations
  - Global Climate Systems Science Game Engine
    - *SimEarth*-like game with centuries of global weather data sets for scenario design, enactment, and evolution
  - Nanotechnology-based "incredible machines"
  - Plasma fusion exploratory simulation quest

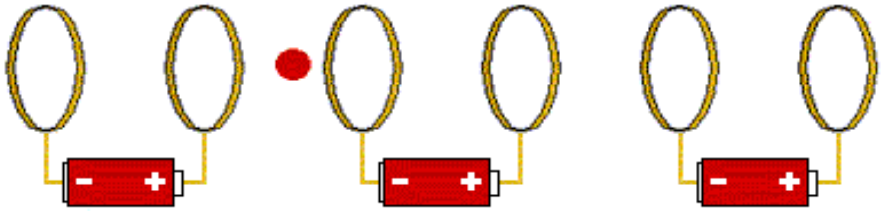
Incredible (nanotech) machines

Plasma fusion simulation exploration game



TOOLS

Accelerate the Particle



PLAY GAME

(may take a few moments to load)

game created by CERN

THE HEART OF THE MATTER

Research at CERN that garnered a Nobel Prize in 1984: Carlo Rubbia and Simon Van der Meer for the discovery of the "W and Z particles, communicators of the weak interaction."

Learning Scientific Domains through Game Development

- Focused on the development and articulation of concepts, techniques, and mechanisms from a scientific domain using game-play mechanisms
  - Interaction of the W and Z particles by C. Rubbia and S. van der Meer at the Exploratorium.org

Summary results

- Juxtapose physically embodied and online (symbolic reasoning) game-based learning environments
- Enables multi-mode learning situations
- Participation in scientific work roles, work practices, and (suggestive) work settings
- Extensible game content and meta-game environment (e.g., Dino science wiki, integrated information feeds (Web-based science mash-ups).

Emerging opportunities

- Regional science centers as legitimate, family-friendly venue for informal science education
  - Learning and evaluation challenges when engaging >100K students/year on site, and potentially >1M students/year over the Web
- Enabling cross-cultural language learning via extensible online game environment

Further information

- UCI GameLab: www.ucgamelab.net
- W. Scacchi, Free/Open Source Software Development Practices in the C , *IEEE Software*, 21(1), 59-67, January/February 2004.
- W. Scacchi, *When Worlds Collide: Emerging Patterns of Intersection and Segmentation when* , to appear in K.L. Kraemer and M. Elliott (eds.), *Computerization Movements and Technology Diffusion: From Mainframes to Ubiquitous Computing*, Information Today, Inc.

Acknowledgements

- Robert Nideffer (UCI GameLab), Joe Adams (DSC), Janet Yamaguchi (DSC), Alex Szeto (UCI GameLab), Celia Pearce (Georgia Tech), also others at the UCI Game Lab.
- Research grants from the National Science Foundation #0083075, #0205679, #0205724, #0350754, #0534771. (*No endorsement implied*).
- Discovery Science Center, Santa Ana, CA
- Digital Industry Promotion, Daegu, Korea
- UC Humanities Research Institute
- California Institute of Telecommunications and Information Technology (CalIT2)
- Creative Kingdoms Inc.