Interactive Streaming Storyboard Platform

1. Research Team

Project Leader:	Prof. Wee Ling Wong, *IMSC and Biomedical Engineering*
Other Faculty:	Prof. Shrikanth Narayanan, *Electrical Engineering* Prof. Roger Zimmermann, *IMSC and Computer Science*
Graduate Students:	Kulin Parik
Research Staff:	Eduardo Carriazo, Jason Dziegielewski
Collaborating Partners:	Corporation for Education Network Initiatives in California (CENIC) Galaxy Institute for Education, Lord Foundation, Toyota USA Foundation, USC's Distance Education Network

2. Statement of Project Goals

The goal for the Interactive Streaming Storyboard (ISS) platform is to use visual thinking and learning to assist teachers in creating visually compelling interactive lessons as well as support users in telling stories with streaming media. Dynamic illustrations such as animations, can more explicitly illustrate the dynamic properties of systems and the functional or causal relationships among their entities. Video is a compelling medium to communicate real-world footage that captures simple concepts from everyday life to conveying more complex science, math, engineering, and technology concepts. Text or verbal narration can use language to identify, describe and explain entities and processes of a system that may not otherwise be perceivable, and correspondingly, this information is stored in memory in characteristic ways. Using streaming media resources may help students develop a range of simple systems to express their ideas, therefore providing a strong rationale for the use of multimedia to support visual thinking and learning for students of science, mathematics, engineering, and technology. Evaluation and design feedback from teachers in field test studies conducted by BioSIGHT effort suggested a need for tools to support customizing and authoring lessons with streaming media.

3. Project Role in Support of IMSC Strategic Plan

In support of the 2020Classroom project and the vision of IMSC, the Interactive Streaming Storyboard project is being used as an assessment tool for objective and subjective assessment and evaluation of the effectiveness of High Presence Environments for Complex Learning, a recently submitted ITR proposal in conjunction with Stanford University. The use of this tool is envisioned to complement the debriefing exercise for simulation participants or as a presentation mechanism to facilitate discussion by observers. During the debrief exercise, participants will be able to view their performance during the simulation and faculty mentors can assist and comment on how positive aspects of participants performance as well as areas where participants can improve. ISS users can tell stories by integrating from archived material, "cut and paste" URLs from distributed streaming media sources, as well as use preprocessed materials.

The Interactive Streaming Storyboard project from the BioSIGHT lab in the IMSC Research Program is an example of a custom educational application using commercially available technologies to support and enrich the teaching and learning processes. The BioSIGHT lab is developing and testing new paradigms for the application of advanced integrated media technologies to science and engineering learning for education. In this process, the two key components to this paradigm include an approach to the use of integrated media systems in science learning and education that BioSIGHT calls *interactive visualization*, and a transactional approach to user studies that advance our understanding of learning behavior and the engineering technology that can enable it.

In the course of our research on student learning, novel enabling technologies will be developed to 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. The key enabling technology required to support the BioSIGHT™ ISS platform is streaming media.

4. Discussion of Methodology Used

The ISS platform consists of the following three components: (*i*) Media Manager Tool; (*ii*) Authoring tool; and (*iii*) a Player tool. Each of these web application tools are Active Server Pages (ASP) using a combination of JavaScript and VBScript to interact with each other, as well as the Open Database Connection (ODBC) interface to support maximum interoperability and scalable tools development, accommodating access to data from a variety of database management systems as the project evolves with the Pacific Lighthouse and USC's Distance Education Network users.

As shown in Figure 1, the software architecture for the ISS components relies on a server-client model, where key advantages include simultaneous access by distributed users as well as spanning asynchronous access by either individual or multiple users.

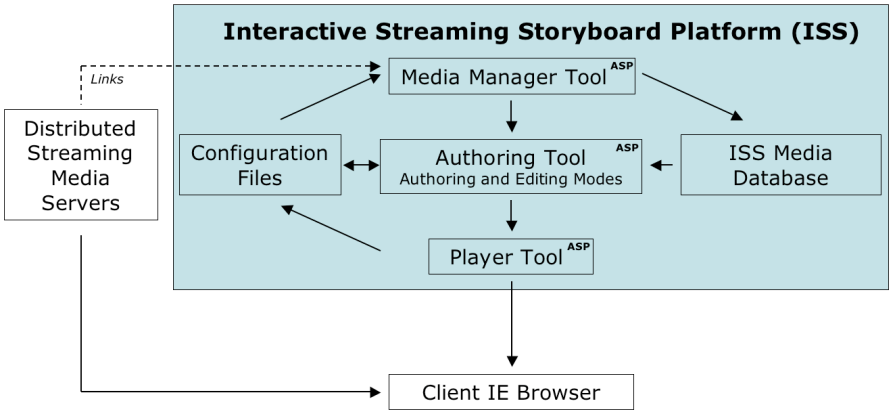

Figure 1: Software architecture for the ISS Platform

Storyboard presentation lessons requested by the client computer through the ISS Player tool are dependent on a set of configuration files dynamically generated by the ISS Authoring tool. In addition, access and queries to streaming media content from ISS lessons are coordinated through the ISS Media Manager tool and the configuration files. The current version of ISS

requires a computer running Windows 2000/ME/NT/9x with an Internet connection of at least 56K, version 5.0+ of the Internet Explorer web browser, and the RealPlayer plug-in [1,2]. ISS is a web based software platform that delivers streaming content by taking full advantage of the pedagogical power of interactive visualization. Because ISS is web-based and structured around a browser delivery and standard streaming video formats, the requirements for deploying BioSIGHT™ ISS are highly flexible, opening it up to a wide range of adoption on a variety of hardware configurations. Videos are remotely hosted in a streaming server such as the Real server and Microsoft's IIS components, and are streamed to schools and individual users, thereby eliminating the dependency on a large hard drive capacity.

The ISS framework is a modular hierarchical layout format, in which a storyboard presentation page is composed of *concepts,* and each concept has its unique *cast of characters.* This framework will facilitate users in *reading* streaming media pages by supporting a user's navigation that is analogous to thumbing through the pages of a book, such as skipping ahead to new topics, going back to revisit previous topics, or drilling down to uncover greater detail through subtopic exploration. The novelty of the ISS application is the ability to author streaming pages ***without*** programming knowledge, consequently focusing the collaboration around content and the storytelling process.

5. Short Description of Achievements in Previous Years

In February 2002, a focus group consisting primarily of biology teachers was conducted to evaluate the utility of ISS and to collect data around how ISS can impact the teaching and learning process from a teacher's perspective. Users reacted positively to the ease of use for the tool, but cited barriers to adoption such as content availability and corresponding alignments to standards as well as computer access on a regular basis.

In January 2002, Eduventures Inc, an independent research and advisory firm exclusive to the coverage and service of pre-K to 12 learning markets, conducted a product analysis and produced a case study for "The Market Opportunity for BioSIGHT: A Platform for Interactive Visualization" [8, 9].

In 2000, a formative field test study was conducted in select high schools from San Francisco, Los Angeles, and Boston using the *Immunology* module [2, 3]. Findings and recommendations influenced the design and features of the current version of the BioSIGHT™ Interactive Streaming Storyboard.

5a. Detail of Accomplishments During the Past Year

We have developed and implemented an Internet-version of an easy to use tool for users to create and customize streaming storyboard presentations. Specifically, the ISS platform consists of the ISS Media Manager tool, the ISS Authoring tool, and the ISS Player tool. Figure 2 shows a montage of the screens encountered during ISS authoring process of a lesson. Lessons content from ISS is conveyed in a hierarchical manner, where a lesson is made up of concepts, and concepts have their own cast of characters. The use of concepts and characters as the building blocks in the lesson lets teachers tell a story by integrating video and animation segments from a

reusable course assets from digital archive. Figure 3 is a screen shot example of lesson accessed with the ISS Player. Each lesson experience also contains a storyboard of key still image frames from the video material presented during the lesson, transcript text that corresponds to the narrations, and a collapsible text outline of concepts and corresponding characters.

The development of these tools in a web-enabled platform has allowed us to form several collaborative partnerships that examines how streaming resources are being used, documents the impact of novel technologies in the reality of today's classrooms, and identifies opportunities for modifications and new directions. In December 2002, we established a collaborative effort with the Pacific Lighthouse and CENIC to examine the utility of the ISS platform to address how users are accessing and using streaming media resources, with target users in the K-12 segment. In February 2003, we established collaborations with USC's Distance Education Network (DEN) and the Lord Foundation to address searchable video by keywords through time coded video transcripts as a first step toward the construction of reusable course assets for distance education in engineering.

Interface for Authoring Component

Figure 2: Interfaces for the ISS platform authoring process

Interface for Player Component

Figure 3: Screen shot example of lessons accessed by the ISS Player

Additional Features Developed for ISS

There are four new ISS features developed this year. The first is the ability to "cut and paste" URLs of streaming media such that individual users can add their own resource material, such as segments from a video or web camera, to a digital archive. Second, users can perform elementary video editing, such as trimming a video clip to reduce the duration of a video clip. Cueing to the appropriate video frame is an especially useful feature when a user only wants to show a shortened segment from a much longer video clip by. This feature is supported through a web browser interface and requires no prior knowledge of video editing software. Third, the "Editor Mode" to the ISS Authoring Component has been completed that allow users to modify previously made lessons by themselves, other users, and curriculum developers. Finally,

additional streaming formats such as Microsoft's ASX as well as Real's RPM and RM file formats are currently supported.

Pacific Lighthouse Collaboration with CENIC and the University of Washington
The Pacific Lighthouse project uses Internet-2 advanced networking to bring a range of integrated learning resources to the educational community in California and Washington State [10]. Pacific Lighthouse enables teachers and students to access primary source materials that would normally be unavailable to them for curriculum design and enhancements. Materials will be accessed through the Pacific Lighthouse specific interface, using a search engine accessing multiple databases simultaneously. The BioSIGHT collaboration with Pacific Lighthouse will provide the ISS platform to Pacific Lighthouse end-users (teachers and students) to complement their on-going effort in examining access and use of digitized streaming materials. Specifically, the ISS platform will support users in creating customized web pages with streaming materials returned from their searches, without any HTML programming knowledge. While numerous tools from efforts such as IBM's Webster for concept mapping as well as SURWeb and Stanford's SUMMIT Media Server Project that require no HTML programming knowledge exists to assemble static images into web pages, we are not aware of any browser-type software application targeting novice users that support the creation of web pages incorporating streaming media [6, 11, 13]. The CENIC partner -- the Corporation for Education Network Initiatives in California formed by the California state university system, CalTech, Stanford, the University of California system, and USC -- has provided Internet-2 access to their end-users. In addition, some of the participating content providers in this effort include the Burke Museum, Research Channel at the University of Washington, San Francisco's Exploratorium, and the Jason Project.

Animation Content Development in Physiology and Cell Biology for ISS Platform
Complementing the development of the ISS platform, we are concurrently developing original animation content to populate the streaming media database for the ISS. Since visual thinking and learning enhances what words alone cannot convey, dynamic illustrations such as animations can more explicitly convey the dynamic properties of systems as well as the functional and casual relationships among their entities. The content focus was in the area of cell biology and cardiovascular physiology, using the commercially available Studio Max 3D animation package to develop 3D models in conjunction with Adobe Premier and AfterEffects.

ISS Platform Integration for USC's Distance Education Network
Some of the key challenges that USC's Distance Education Network (DEN) faces are how to automatically index streaming video and correspondingly how to efficiently search and retrieve video content. Identifying solutions to these challenges will be a step towards reusable course assets for DEN. This collaboration was established in February 2003 and we are already examining the integration of commercially available technologies into the ISS platform.

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

Commercially available multimedia presentation software tools such as Microsoft *PowerPoint*, Tom Snyder Produtions *mPOWER*, or Hypercard and Hyperstudio are frequently used by teachers and students for the preparation of multimedia presentations. While these commercially available systems are very versatile, on-line presentations require a slightly more sophisticated

user. Furthermore, a local copy of the application is required to be installed, rather than accessing an Internet-based software application. The use of "Learning Segments" from SURWEB, a federally funded project aimed at providing resources to student and teachers, provides application technologies which allow students to manipulate Internet based multimedia that are primarily static images. Similarly, the Media Server Project at Stanford is a collection of still medical images and a web-enabled tool to assemble a series of images into a web- based photo album. While both the Media Server project and SURWEB are examples of technology application to support teachers and students, the software does not support streaming media and have a cumbersome interface for interaction [6, 11].

The past several years has witnessed the creation, development, and research on government-sponsored digital libraries initiatives to provide portals to a rich array of content as well as access to tools for analysis and visualization, hands-on virtual laboratories, and large databases of real-time or archived data. Furthermore, education product companies, such as LearnCity and Edmin, are rapidly emerging to provide lesson organization tools and state-aligned content to assist teachers with planning [7, 12]. The unique aspect of the ISS platform is that novice users are using a web-based platform to create dynamic web presentations, without any HTML programming knowledge, in a simple architecture consisting of multiple streaming media resources. The availability of appropriate streaming content material to complement a digital archive for software applications like the ISS platform and the ease of creating dynamic presentations for users can only have a positive affect on learning since participants will be actively involved in the story telling process and knowledge creation.

7. Plan for Next Year

We will examine the SDK for Virage VideoLogger application and the BBN Audio indexer plug-in as a prototype for automatic encoding, indexing, archiving, and additional manual annotation of streaming materials. This work will complement the integration and adoption of the ISS platform to DEN's users. We will concentrate first on the feature to support **searchable video** by keywords through time coded video transcripts. In conjunction, we are working with Prof. Narayanan for robust algorithms for real-time speech to text transcription to compare and contrast against the Virage application. Also we are working with Prof. Roger Zimmermann to prototype multi-user audio chat software to support DEN users. Dialogue can be captured, archived and transcribed with a speech to text transcription module for subsequent queries by DEN students.

Currently, the ISS platform only supports Internet Explorer users on Windows. In order to accommodate additional users, we must expand the ISS Platform capability to support users on Macintosh platforms as well as Netscape and Safari browsers.

Through the NSF RET program, we plan to invite teachers to participate in the structuring of content information through the ISS database as well as how the content can be implemented into the curriculum to include non-science disciplines like history, language arts, social studies and math to demonstrate a broader impact of the utility of this tool to non-science disciplines.

8. Expected Milestones and Deliverables

- **Integration of Searchable Video**: We plan to provide this capability to our Pacific Lighthouse collaborators, a few core DEN courses that we will identify, and to subsequently scale up to support all DEN users. We will extend the search capability to include "chat" searches for DEN users.
- **Support More Users and Browser Types by Expanding ISS Platform Capability**
- **Teacher Preparation Workshop:** Through this workshop, we will share the outcomes of curriculum ideas from teachers that participated in the RET program for wide scale implementation of ISS into classroom practices.

9. Member Company Benefits

CENIC and the Lord Foundation support education programs designed to enhance teaching of science, math, and engineering in California. The CENIC and the Lord Foundation collaborations will allow us to focus on education research issues and provide us with the means to develop prototype applications for the classrooms. CENIC is a collaborator on this effort and is not providing any financial support, while the Lord Foundation is currently supporting extensions of the ISS platform into a distance education setting. The benefit to CENIC will be a classroom tested prototype that can potentially impact K-12 schools with Internet-2 connection in California and Washington state, and similarly the benefit to the Lord Foundation is a classroom tested prototype that may span all of USC's DEN engineering course offerings.

The Galaxy Institute for Education is actively seeking commercial licensing partners for the BioSIGHT™ ISS platform and is not providing any financial support.

The Toyota USA Foundation supports education programs designed to enhance the teaching of K-12 science and math throughout the United States. The partnership that we have with the Toyota USA Foundation will allow us to focus on education research issues and provide us with the means to develop curriculum materials for the high school science classrooms. The Toyota USA Foundation is currently supporting the Cell Biology animation content development aspect for the ISS project. The benefit to the Foundation will be the ability to disseminate visually appealing, scientific accurate dynamic media to students and teachers.

10. References

[1] RealServer SDK: http//www.realserver.com
[2] http://www.real.com
[3] Prototype Immunology project:
http://biosight.usc.edu/research/projects/immunology_prototype/index.htm
[4] BioSIGHT Field Test 2000:
http://biosight.usc.edu/researh/progress/2000_field_test/index.htm
[5] Biology Teachers Focus Group Agenda: http://biosight.usc.edu/iss/focus_group
[6] SURWEB: http//www.suu.edu
[7] LearnCity: an educational product company providing K-12 curriculum on the web cross-indexed with state aligned standards. http://www.learncity.com

[8] Eduventures, Inc. http://www.eduventures.com
[9] http://www.usc.edu/dept/education/globaled/galaxy/BioSIGHT%20Case%20Study%20Final.pdf
[10] Pacific Lighthouse http://depts.washington.edu/paclight/about/description.shtml
[11] Stanford University SUMMIT's Media Server Project: http://mediaserver.stanford.edu
[12] Edmin.com: http://www.edmin.com
[13] IBM's Webster -- A web-based multimedia concept mapping tool: http://www.research.ibm.com/people/a/alpert/EDMEDIA2001/Edmedia.htm