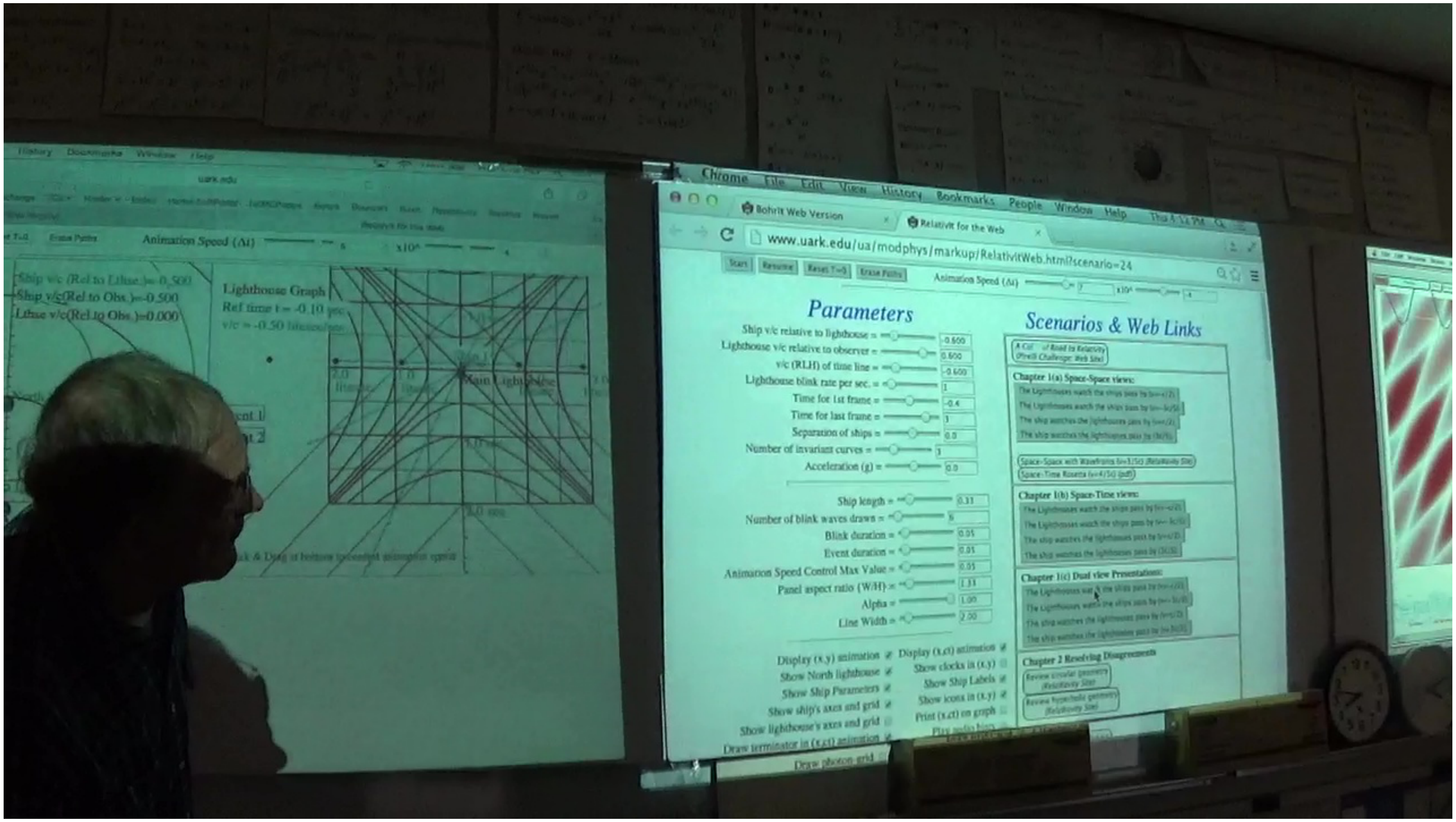
Leveraging Information Technologies for Physics Education



Audience: 2015 Fall Advanced Mechanics class at the University of Arkansas in Fayetteville (UAF)

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Leveraging Information Technologies for Physics Education

Objective and Motivation

To explore the core technologies used to teach Physics, at the University of Arkansas, Fayetteville (UAF). More specifically, how they were used in the 2015 offering of Advanced Mechanics, a graduate class exploring Classical Mechanics and how it interrelates with other fields in Science.

1. This presentation then came about from the student's voiced desire to see the inner working of the Web Apps used throughout the course of the semester. This is the main requirement for this, the Thursday presentation.
2. In putting this review together, we found that the content of this presentation might have the potential to be more formally included as part of the existing educational package. Rather this "presentation" could evolve, and become a part of the main site that it is talking about. And with its inclusion increase the *force multiplication* that we've already experienced.
3. Discuss further possibilities open to us through IT. It could prove helpful to envision ways in which this presentation itself might be modified to meet other differing needs, and how our designs could change to best meet those needs.<hide away bullets>
   - Primer to the LearnIt Suite of apps, *sans coding*
   - Portal for future LearnIt *contributions, to add* new applications to the suite already on Cavern (the U of A server).
   - V*iew* for other educational efforts: BMEC (Boston Mountain Educational Center), Upward Bound.
   - Portal for those with little knowledge of physics.
   - A look up page for desired features and the code necessary to bring them about. <hide>Similar to the way we use these three pages to select the LearnIt applications (1, 2, 3). Varying levels of sophistication and technologies brought to bear could be available to the viewer/instructor, on the fly. Change between them at will. Like switching from a student and teacher versions of a traditional textbook. </hide>
4. Observations and free form discussion. <hide>, and *If time allows,* compare and contrast the differences in sought after skill sets for academia and non-academic areas of endeavor.</hide>

Leveraging Information Technologies for Physics Education

Setting the Stage

More on Motivation

But what other factors aside from "they asked for it" are there? **What is the root motivation?**

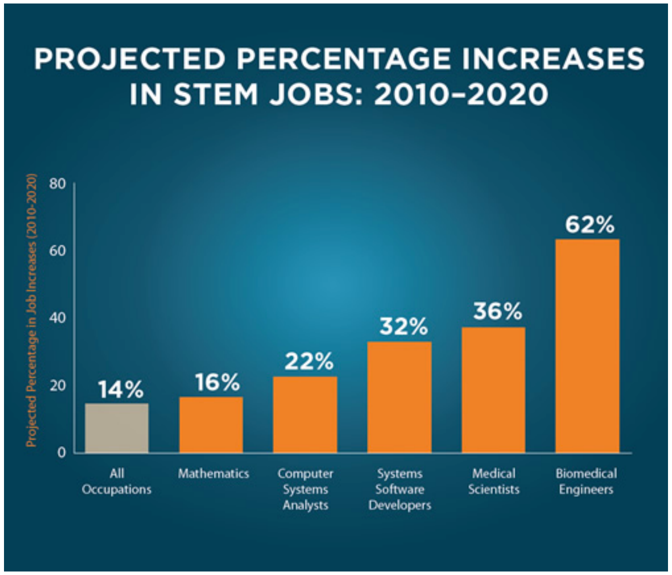
We are living in the information age! Why not be aware of and take advantage of the latest and greatest of our creations, especially those that have so much potential to enrich our lives. For example: Recall the days of going to the library, pouring over card catalogs, and/or hopefully using of a *nice* encyclopedia at home. At the time, they were our primary sources of intellectual enrichment (Short of consulting an expert, and that most likely came at a fee). Compared to that, the power inherent in a simple "*Google Search*" is truly astounding. The shear volume of information at our finger tips stagers the mind. And, a great deal of it, is publicly available, and can be identified in a heartbeat, and obtained in a just a few more. Given time , we might explore some of the new emerging technologies, and how the might apply to our efforts.

Now so, more than ever, there is a need to streamline and where possible **simplify the way that we teach physics**. <<Hide away bullets>>The breadth and magnitude of the subject of Physics continues to grow (some would say exponentially), and at times perforce spawning entire new fields (Cosmology, Physical Chemistry, Bio-Physics). What's more, some colleges have felt motivated to obsolete whole pieces of their classical physics program, in order to meet their traditional 4 year degree plans. This would be akin to the mathematicians doing away with arithmetic or geometry in their programs. Some question whether this choice is a sound solution, and others still believe it to be outright detrimental to progress in the field. Whichever the case may be, it does not seem to directly address the root cause. Namely, the shear volume of what Physics has grown to encompass. As educators, If we want to keep all of the important bits, then we need to condense the material, as well as improve our means of transferring that knowledge to the next investigative generation.

Leveraging Information Technologies for Physics Education

Setting the Stage

More on Motivation



Also, surprising to many, the **USA has an admitted problem with meeting its own demand for scientists**. One of the world leaders and foremost champions of the benefits of science, the United States, seem to be trending towards apathy towards STEM (Science, Technology, Engineering, and Mathematics, *U.S. Department of Education*, *Wiki*) related study. We apparently are (all at the same time): the envy of the world for our educational opportunities, champions of science, and see a real need to continue science (for real reasons, aside from inertia), yet feel the demand to hire experts from abroad in lieu of training up domestic talent.

Perhaps, there is some sort of "third generation phenomena" coming into play here. Whatever the reason, whether intrinsic or not; it is reversible. It is the need to correct this trend. That is what I personally identify with most as to be our root motivator. <May omit or hide />

The **educational goal** then could be summarized: to cover a maximal content, in as concise a way possible, without the omission of fundamental content, yet still promote or increase retention. And ideally the delivery vehicle/system for doing this should be:

- Be universal available
- Be faithfully rendered, regardless of computer platform
- Have a development workflow simple enough that making additions to the work is not difficult, and is that easy enough to pass on to future developers

It towards achieving this goal, for the field of Physics, that we turn to take advantage of some of mankind's most fearsome new tools - To the Information Systems.

Terminology

For the purpose of this talk we will consider these terms to be synonymous:

- IT (Information Technologies)
- IS (Information Systems)
- ISM (Information Systems Management)

The creation of electronic content, that operates on our computational devices, or actually drives them, is called *Computer Programming.* This is frequently shortened to *Programming*. More recent still, the term "*Coding*", has come into use. *The typical suffices apply.*

You will encounter frequent use of *acronyms* in this presentation. This is common it the IT field. To help alleviate the confusion, I usually expand the first occurance on each page; as well as include links out to various sites that have the definitons posted. Acronyms are so common in the computer specialties (computer programmers, analyst, engineers), that people in the field work with over such a long period of time, that meaning of the *abbreviation* has been forgotten. Acronyms seem to be common in fields that experience a degree of exclusivity - The military comes to mind. Many came about through the simple frustration of having to repeatedly the same windy phrases, over and over.

Leveraging Information Technologies for Physics Education

Primary areas of IT Exploitation

1. Exploration, experimentation, and discovery of new concepts
   a) Gives us sensory feedback on the processes and phenomena being studied. Verify complete Modeling.
   b) Practice aligning one's preconception of physics to better align with actual observations. Internalize or reinforce Scientific Methodology.
   c) Investigate/Explore physical behavior near critical values and discontinuities
2. Communication of physical concepts and phenomena
   a) Traditional: Publications and Presentations
   b) Multimedia: Audio, Video, advanced presentation apps, Multi Monitor
   c) Interactive - To encourage peoples explorative nature. Then, to better respond to the questions that these explorations take.
   d) Provide a force multiplier for the instructor to focus (or drill down) on certain concepts.
   e) To better expose the thinking that already took place, behind the scenes, in the original learning, distillation, and the actual class preparation and presentation creation.

Primary areas of IT Exploitation

3. Enable self guided, independent exploration by students

   a) Empower students and encourage them to be active participants in the educational process

   b) In this "*Code Review*" we will be disseminating the means of creating other like products, that exploit new information technologies. I think there is an elegant symmetry in this using code/apps, to create yet more code/apps … Similar to how a lathe can be used to create the pieces needed for another lathe. With the students in this review, we take a step further with the empowerment of actual agencies that might continue the chain. It is gratifying to consider this possibility.

4. Provide the framework to carry out group activities: Demonstrations, labs, projects, and homework

   a) With the recent rapidly shifting trends in education, one reoccurring theme places emphasis on the peer to peer dynamics, and the effects that it has on learning.

   b) We basically wish to leverage off of the students natural desire to team up when faced with a difficult situation. It seems to be human nature and there is no reason to fight it. Think of it as an extension of the buddy system, which is so strongly encouraged in deep sea diving.

   c) One of the major griping points in the work place is that new graduates are being hired on that lack many of the skills that were assumed to be taught at college. Communication and Interpersonal skills are those most often pointed out as being severely lacking. These small group, paired projects, and the more traditional study and problem solving groups are even more important for more remedial classes, where the students don't yet have a feel for how to go about learning or to actively apply the scientific process. For those, that have not yet learned how to learn, they are often best served by seeing and experiencing these discoveries, in a group of their peers. It can take on more aspects of an adventure.

   d) Go a long ways to reversing the *Cult of Not*, where it is cooler to find any means (and expel major effort) to NOT do the recommended study. Perhaps, rely on shame before peers to steer them into actually performing. Question: Is this issue solely limited to Elementary and Secondary Education?

   e) There is an element of dynamic human interaction, a sense of teaming up to overcome an obstacle greater than any of them individually (akin to a Team of Superheroes) component of thriving, that is far from trivial, but will hold for later time.

Core Technologies

1) W3C (World Wide Web Consortium) is an international community where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C's mission is to lead the Web to its full potential.<<Popup>>W3C standards define an Open Web Platform for application development that has the unprecedented potential to enable developers to build rich interactive experiences, powered by vast data stores, that are available on any device. Although the boundaries of the platform continue to evolve, industry leaders speak nearly in unison about how HTML5 (HyperText Markup Language Version 5) will be the cornerstone for this platform. But the full strength of the platform relies on many more technologies that W3C and its partners are creating, including CSS (Cascading Styles Sheet), SVG (Scalable Vector Graphics), XML (Extensible Markup Language), and a variety of APIs (Application Program Interface).<<>>W3C develops these technical specifications and guidelines through a process designed to maximize consensus about the content of a technical report, to ensure high technical and editorial quality, and to earn endorsement by W3C and the broader community.

2) Mozilla - Standards for Web, to promote **openness**, innovation, and opportunity on the Web.

- Mozilla Manifesto
- <<Popup>>The Mozilla Foundation - The nonprofit Mozilla Foundation is the organizational home of the Mozilla Project, a global community and **public interest** initiative that believes the **Web should be open and accessible to all**. To protect the Web as a public resource and empower its users, we create open source products, teach 21st-century skills and spur grassroots advocacy campaigns. All this is made possible by full-time staff and thousands of volunteers around the world.
- Makers of Firefox a long standing, widely used web browser

3) Internet - Global system of interconnected computer networks

- Physical hardware - Your own *computer*, local access point, hot spot, modem linking you to your ISP (Internet Service Provider) *Webopedia*, *Wiki*. All the computers networked together in this way form the physical component of the internet.
- WWW (World Wide Web) - An open source information space where documents and other web resources are identified by URLs (Uniform Resource Locator), this URL is usually displayed in the browser's address bar
- I2P (Invisible Internet Project) - A network within a network. It is intended to protect communication from dragnet surveillance and monitoring by third parties such as ISPs.

- TOR and Onion Routing. The latest Onion Routing system is freely available and runs on most common operating systems. Onion routers are used create and maintain a *TOR* network, which provides a means to avoid network surveillance and traffic analysis.

4) Decentralized computing - The distribution of needed processing, file transfer and storage over collection of decentralized computers systems are components of a larger computer network. Ex: BitCoin, SIRI, P2P, torrent (File transfer like ftp on steroids), and the basil SETI Screensaver

   - Our applications are decentralized.

5) Server/Client(s) architectures

   - Server - UAF's (University of Arkansas, Fayetteville) web host is named Cavern; Software available on Cavern; Where one Hosts their information, so that it can be served to interested web enabled parties. Synonyms: Back-end, Server-side
   - Client (Typically gets served information by making a request of the Server) - Workstations (Microsoft, Apple, various implementations of UNIX/LINUX OSs (Operating System), many mobile devices (iOS, Android), and "Smart" and Streaming television systems (Samsung, webOS, Android, Apple).<<Note>>Will link these up for the main site

6) Web Browser - the application one runs on their web enabled device that as a client communicates with the Server via the internet. The major web browsers available have integrated facilities to develop web pages or sites.

7) Page Access - The Device (Ex: Computer, Phone, Tablet, TV, or Game Platform) was first started with a specific OS (Operating System): Microsoft's Windows, UNIX/LINUX, Apple's OS X that launches a Browser Application (Apple's Safari, Mozilla's Firefox, Google's Chrome, Opera) that opens windows into which we can open web pages. The pages may be resident in browser's *cache* (Holds temporary working copies of all accessed), on the client's *hard drive*, or on the server (if it is there and you have permission to access it).

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Primary Languages and Models

1) HTML5 (HyperText Markup Language Version 5) - Markup Language that specify the layout of a web page
    a) 5th version of the standard HTML for the World Wide Web
    b) Widely available, has been adopted across all of the major web browsers
    c) The *new* <Canvas> element provides a fully featured bitmap drawing context, and in 3 dimensions with use of WebGL (Web Graphics Library *or* Layer) technology derived from the popular (i.e. - Gaming), OpenGL, an open-source standard for device independent 3D rendering.
    d) Numerous HTML input elements to aid in User data entry or input: Color picker, Date picker
    e) Persistent data - Smooths restart; Allows each browser to store and retrieve their own information locally (on the client) on a site by site basis
    f) Permits embedding other technologies - SVG (Scalable Vector Graphics); PDF (Portable Document Format), with enhanced functionality and native pdf level control through third party script *pdf.js*; MathML (Math Markup Language), Optionally enhanced through linking to MathJax); TeX *User Group*, Requires MathJax), {Example in RelaWavityWeb.html lines 53-55}
    g) Note - Some browsers are slow implementing (all of) the Version 5 standards. Ex: Safari color picker. See the '*Observations and Free Form Discussion' section*
2) DOM (Document Object Model) - Programming interface for HTML, XML (Extensible Markup Language), and SVG documents. *See* DOM *Drill-down (Next Section)*
3) CSS (Cascading Styles Sheet) a simple mechanism for adding style (e.g., fonts, colors, spacing) to Web documents
4) JS (JavaScript), a high-level, dynamic, untyped, interpreted programming (Scripted) language
    1) Used in client side web applications. Client-Side scripting. Others: VBScript (Microsoft), and PerlScript
    2) Syntax derived from the C programming language, and the semantics and design from the Self and Scheme(or Lisp) languages
    3) JavaScript can now be run on VMs (Virtual Machines) like the industry standard Java with an embedded runtime engine. Like Oracle's Java programming language, which when a VM is installed allows device independent (cross platform) programming.

Primary Languages and Models

DOM - (Document Object Model)

1. DOM (Document Object Model) - Programming interface for HTML (HyperText Markup Language Version 5), XML (Extensible Markup Language), and SVG (Scalable Vector Graphics) documents. It provides a structured representation of the document (a tree) and it defines a way that the structure can be accessed from programs so that they can change the document structure, style and content.
   - Provides a representation of the document as a structured group of nodes and objects that have properties and methods. Nodes can also have event handlers attached to them, and once that event is triggered the event handlers get executed. Essentially, it connects web pages to scripts or programming languages.
   - Though often accessed using JavaScript, the DOM itself is not a part of the JavaScript language, and it can be accessed by other languages, though this is much less common.
   - Accessing DOM elements
     1. Unique Id
        1. HTML: DummyElement = <tag id = “DummyId”> … </tag>
        2. CSS (Cascading Styles Sheet): #DummyId
        3. JS (JavaScript): DummyElement = document.getElementById(“DummyId”);
     2. Class identifier
        1. HTML: DummyElement = <tag class = “DummyClass”> … </tag>
        2. CSS: .DummyClass
        3. JS: DummyElementArray = document.getElementsByClassName(“DummyClass”)

Primary Languages and Models

MVC Design - (Model, View, Controller)

MVC (Model, View, Controller) represents a software architectural design pattern, mostly used (but not exclusively) for implementing user interfaces.

4. Model - Captures the behavior of the application in terms of its problem domain, independent of the user interface. It directly manages the logic, rules, and data of the application.
    1. May be stored locally in the client's memory (javascript vars)
    2. May be resident on the server warehoused in a relational database management system (RDBMS). Applications that need to store vast amounts of persistent data on the back-end often use these to facilitate the storage and retrieval of information. Retailers rely on them heavily.
    3. For our applications this is where we demand that physics reality holds sway
5. View - Any output representation of information based on changes in the model. Examples: chart, diagram.
    1. Differing views into the same information
    2. For us, the elements of HTML (HyperText Markup Language Version 5) page currently loaded web browser's window
6. Controller - Mediates between the Model, View components for us it also handles User Input (UI) and system, application and peripherals level events (DateTime, programmatically from the Model, Keyboard, Gesture, Peripherals)

Development Environment and Applications

1) Development can take place on either the Client or Server. For us it's on a Mac, so the following will most likely be Mac centric applications. Prefs are underlined
   1) Files are *coded* with proper/valid formatting and syntax
   2) Uploaded to the server
   3) Client browsers can then access the recently updated copies. Truly a godsend when it comes to the forced versioning that so many mainstream programmers need to deal with. (Note: We still have issues in needing the User to manually empty the browser's memory cache.)
2) Text editor for programming - Need to edit across our multiple files of our primary types: HTML (HyperText Markup Language Version 5), CSS (Cascading Styles Sheet), and Javascript.
   1) Bare Bones' Software - TextWrangler, BBEdit
   2) MacroMates' TextMate - This is my preferred text editor app for web development.
   3) Sublime Text
3) IDE (Integrated development environment)
   1) Web Apps: Adobe's DreamWeaver, Realmac Software's RapidWeaver;
   2) Applications beyond WWW: Eclipse for Java, Microsoft's Visual Studio, Apple's xCode

4) Development and Debugging

- Browsers with Integrated debugging
  - Apple's Safari Web Inspector
  - Firefox's Firebug (older versions as a plugin)
  - Google's Chrome Developer Tools
  - Opera
  - Web based TryIt Editor - Test *in page* CSS (Cascading Styles Sheet), JS (JavaScript) and HTML5 (HyperText Markup Language Version 5). Examples: Button event, Try-Catch Statement

5. Miscellaneous Applications

- Server access and file transfer - UNIX/SSH: Apple's Terminal; FTP (File Transfer Protocol): Fugu (Dated Cavern access), CyberDuck, FileZilla,
- BoKaMa TeX - suite of editors for TeX/LaTeX creation. One of the very few realtime, WYSIWYG (what you see is what you get) editors for TeX creation
- MathType is an equation editor for Windows and Macintosh that lets you create mathematical notation for word processing, web pages, desktop publishing, presentations documents
- Spreadsheet *with scripting*: Microsoft Excel, Apple Numbers, Apache Open Office. Handle batch-like preparation of HTML statements for repetitious text edits

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Ancillary and Supporting Technologies

1) PHP (Personal Home Page) - Server side scripting; Occurs before the page gets served to the client browser.
    - PHP, which stands for *Personal Home Page* or *PHP Hypertext Preprocessor*, is a widely used Open Source general-purpose scripting language that is especially suited for web development and can be embedded into HTML (HyperText Markup Language Version 5).
    - Its syntax draws upon C, Java, and Perl, and is easy to learn. The main goal of the language is to allow web developers to write dynamically generated web pages quickly
2) MathJax - One of the few ways to faithfully render complex mathematical statements cross-platform. A JavaScript display engine for mathematics that also works across all of the major browsers.
3) MathML (Math Markup Language) - A low-level markup language specification for mathematical and scientific content on the Web.
4) WebGL - Context type that extends OpenGL 3D rendering to enabled browsers; Slow browser implementation of standards
5) SVG (Scalable Vector Graphics) - Mark up language for describing two-dimensional graphics, applications, and images.
    - Avoids the pixelation inherent in bitmap based graphics
    - Makes resizing vector based graphics device/view/resolution independent.
    - Preferred format of many graphical design and layout professional.
6) SQL (Structured Query Language) - Structured language used to assess and maintain information warehoused in a relational database management system (RDBMS).
    - Traditional present mainly on the server.
    - The most common RDBMSs: Microsoft SQL Server, Oracle Database, mySQL

Leveraging Information Technologies for Physics Education

Application Archetypes and Requirements

We have a large palette of presentation options, all of which have the same near universal accessibility. Our applications usually fit an extension of one of the following archetypes<<Omit-Application ArchTypes and Requirements>>

1. Books - Visual, independently navigated; Traditional form of media; Ex:
    1. Viewer-centric: Easy to obtain and assimilate (↓$, ↓effort, and ↓time), physiological fatigue
    2. Author-centric: Easy to produce (↓$, ↓time, ↓"hand motions" or steps); High return (↑$, ↑#Viewers ↑#Repeat viewers)
    3. <u>Layout</u> (Viewer-centric) - Properly positioned and rendered
    4. <u>Content</u> (Author-centric) - Aesthetic, correct, and complete
    5. Well indexed - Perhaps the most important part of independently navigated media
    6. Noteworthy Requirements beyond those of the traditional books
    7. Our apps as example:
2. Presentation - Visual, and Auditory, typically with guided navigation; Extension of the traditional media
    1. Same as book's Viewer-centric, except the physiological fatigue can much more of an issue.
    2. Same as book's Author-centric
    3. Same as book's
    4. <u>Layout</u> (Viewer-centric) - Properly positioned and rendered. But, Components that evolve in time.
    5. Indexing almost nonexistent in traditional forms - Ask to go back to a page
    6. Noteworthy Requirements beyond those of the traditional Presentations
        1. Temporal components - Videos (Controls possible, but are often remedial at best); Full user control and conductible

2. Persistence - Restart where you left off
3. Context specific, Deep manifold navigation options
4. Ease of supplementing material

3. Group lead activity (Class, Subject, Field, Demonstration, Experiment) - Note: The latter two have not yet been fully considered and were not available to the students.

   Visual, Auditory, and a very important Time components; Guided navigation, traditionally not thought of as media. Blackboard Learn (Exercise - Challenge you to find support on this site.)

   1. Massive opportunity to use Information Technology.
   2. Real-time "*Spot*" Assessment with automatic scoring and posting
   3. Clicker system used in remedial classes
   4. System dynamical values could be *parsed* from streamed video source, via *Deep Learning* component.
   5. Options grow with group size and length of time taking data.

4. Class, Subject, and Field - Visual, Auditory, and a very important Time components; Guided navigation, traditionally not thought of as media. Blackboard Learn (Challenge you to find support on this site.)

   1. Self guided and paced, User specifiable depth of presented content

Leveraging Information Technologies for Physics Education

Computation Approach

Resource Intensive calculations

Discuss the parts of our applications that place the greatest load upon system resources. Calculations that are the most computationally intensive.

Numerical Methods - Field in Computer Science called (or Numerical Analysis) *Google*. Considers representing a real function in terms of a complete set of basis functions over a specified domain.

Highly efficient and accurate *algorithms* and *code (C, Pascal programming languages)* to carry out our calculations: Numerical Recipes, NetLib, NumericJS, jQuery, other libraries (*blog*)

Resource Intensive calculations and approach:

1. Rendering large Canvas contexts/bitmaps has been an issue in many applications over the years. Canvas contexts are relatively easy to work with, but can still a fairly large burden on resources. I often think of the mobile devices for my '*litmus test',* when testing and gauging performance.
2. Time evolution of complex coupled physical systems. Iterate step by step through the time domain
   - From Euler-Lagrange Equations which supply us with system of linked partial differential Equations. 2*N*D dimensional phase space for N discrete mass bearing objects residing in D-dimensions, the 2 accounts for both the position and velocity. Introduced in class lectures: 9 and 10.
     - Advantage of having explicit form
     - Preferred algorithm is a 4th order Runga-Kutta method. *Area of Opportunity*: Determine more efficient methods. Concept of an orthonormal basis, from linear algebra, can be generalized to Hilbert spaces. Ex: set of Cosine and Sin functions forms the basis in a Fourier expansion.
3. Calculate eigenvalues and solutions of large systems by diagonalizing matrix representations of the Hamiltonian
   - Advanced linear algebra
   - tred2() reduces matrix to tridiagonal form
   - tqli() to diagonalize of a tridiagonal matrix

Desired Features

1. View elements that are easy to create and work with. Ex: <canvas></canvas> would be interpreted by the browser as recognizable drawing window when located in a HTML5 (HyperText Markup Language Version 5) web page. These are Markup and scripting languages.
2. Ease in creation/passing/linking of variables to data supplied:
   - Data store
   - Programmatically
   - UI (User Interface) - Next Step, OS X (Operating System 10) with xCode Interface Builder
3. 3D rendering via WebGL (Web Graphics Library *or* Layer) a JavaScript programming interface for rendering interactive 3D and 2D computer graphics
4. Context Menus
5. Persistent memory

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Examples of our own archetypical Types

1. Simple web page listing the Harter-Soft Suit - Harter-Soft Web Resources for Physics
2. Scanned as a bitmap as a Acrobat PDF (Portable Document Format) file type - Principles of Symmetry, Dynamics, and Spectroscopy
3. Single page that allow the book to be indexed and linked to chapters of a textbook - Quantum Theory for the Computer Age
4. An entire class worth of content: text (PDF), lecture presentations (keynote, PDF), assignment, and their clearly legible, detailed solutions, lecture videos (MP4s on YouTube), fully functional cross platform cross browser applications modeling the physics and illustrating the physical relations - Classical Mechanics with a Bang!
6. RelaWavity
7. Harter-Soft LearnIt Portal Page
8. Support for poster session at the 2015 DAMOP Annual Meeting of the American Physical Society (APS). The site now acts as one of the main portals to our *Relativity* content.

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Emergent Technologies and Resources

1) Deep Learning (Alt: Neural Networks, *Wiki*, *Google*, deeplearning.net) - New branch of machine learning and data mining, designed to make better representations and create models to learn these representations from large-scale unlabeled data. <hide>Machine learning based on a set of algorithms that attempt to model high-level abstractions in data by using multiple processing layers with complex structures, or otherwise composed of multiple non-linear transformations.</hide>

2) Wolfram's MathWorld - Web's most extensive mathematical resource, provided as a free service to the world's mathematics and internet communities as part of a commitment to education and educational outreach by Wolfram Research, makers of Mathematica.

3) Online Access Research Journals

- PLOS - Gives researchers a faster path to publishing in a high-quality peer-reviewed journal. All work that reaches rigorous technical and ethical standards is published and freely and immediately available to *everyone*.

- ResearchGate - To connect researchers and make it easy for them to share and access scientific output, knowledge, and expertise

4) Assorted Sites: Grommet - Market your own merchandise

5) Kickstarter - Tools for inventors and patent process

6) Extension of the Holographic Principle to information systems - Volume of space can be thought of as encoded on a boundary to the region. Encoding being the operational word that links to IT. Note: Beyond the scope of this talk, included because it fits with the talk and mainly to pass it along, FYI (For Your Information).

Leveraging Information Technologies for Physics Education

Observations and free form discussion

A Heyoka TC point of view

1) Scripted, Markup and Compiled languages. - Already mentioned the appeal of the Markup and script style languages . They also help simplify the development cycle, reduce effort, allow rapid updates to client apps

2) Make note of the relatively new trend in IT, to rely more heavily on the high clock rates of our modern CPUs (Central Processing Units). Many modern languages and their applications, it unnecessary to compile (or pretreat) computer code. Scripting languages are now used for many applications and fields as far ranging as retail systems. The UNIX kernel that the Macintosh OS X runs on top was programmed using UNIX script. A script may call a program precompiled in C, or other goto work horse programming language when needed.

3) Start your employment searches, as early as possible. It is an extremely competitive field to be seeking and/or holding a job.

4) Products designed for specific archetypes, in this list above, may not (as is), be suitable for use as a different target type.

5) Knowing your audience, and selectively catering to them in your presentation pays dividends for the traditional forms of media; so too does knowing your true target audience when designing an application or other deliverable. Mis matching the two can lead to undesired results. In retail, the adage “the customer is always right”, holds sway up to in IT and Web design, most especially concerning content.

6) Intimate feel for overriding constraints such as: equipment, processing load (for Servers), and those that are time related. A given target audience may be equipment challenged. If so, content might be best served up in small pieces. Or perhaps encourage the user to return, when system resources become available. We did things, such as this, when needed, while working at Wal*Mart’s Information Systems Division.Hell, I had some apps that could spawn themselves when resources were rich, and quiesced during peak store hours.

Leveraging Information Technologies for Physics Education

Observations and free form discussion

A Heyoka TC point of view

7) Operating System Comparison - *Battle of Behemoths* - Microsoft Windows, Oracle Solutions, Apple OS X, IBM (International Business Machines) - "Mainframe" computer running one of the 300 series operating systems and controlled via JCL (Job Control Language). <Note need to expand for the site>

8) On Web Browsers - Safari, Firefox, Chrome, Opera

    1) Presentation mode - Very important for class presentations, as projectors (and even monitors) can be limited in working area. Missing or poorly implemented, in many versions of Safari.

    2) WebGL (Web Graphics Library *or* Layer) - Some Chrome issues. Very weak mobile support to date.

    3. URL can cause browser to navigate to specific page in an pdf: http://www.uark.edu/ua/modphys/pdfs/Talk_Pdfs/Leveraging_IT-2016.pdf#page=10

9. Compare and contrast the IT and Physics fields, both in and outside academia.

    1. Speed *vs.* Accuracy; Extensive project planning for the complement, though this scrutiny is more than matched, later in development/discovery cycle in academia

    2. Brevity *vs.* Verbosity - Perennial struggle with finite resources. 80% - 20% Rule in Software Development.

    3. Change Control.

    4. Production and testing hierarchy

    5. Consequences

    6. Hours, On call, Entry position usually has 1 week vacation until many years w/Employer ~

    7. Sometime takes One whole calendar year before HiEd employer matches retirement contributions. Visiting positions are usually less than that.

Leveraging Information Technologies for Physics Education

Observations and free form discussion

A Heyoka TC point of view