IIT Office of Undergraduate Research
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"Prototyping a collaborative online undergraduate research forum"

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1.1 Summary

The IIT Student Research Web, or ResearchWeb, is currently active as a prototype online collaboration tool for research, with basic functionality and ability to add content. ResearchWeb has been developed under the auspices of the IIT Undergraduate Research Fellowship for the Fall 2008 award cycle. The proposed purpose of ResearchWeb was and remains to address the proliferation of non-traditional undergraduate coursework and summer programs, the surge in published undergraduate research, and the power of wiki-like online collaboration to produce high quality content with high impact.

ResearchWeb is meant to broaden IIT undergraduate participation beyond the existing mechanisms such as fellowships, research and reading courses, and departmental projects. There is also the possibility of broadening this program to other scholarly individuals outside of the IIT undergraduate community. These individuals include: IIT graduate students, students from other universities, and promising high school students.

ResearchWeb is also meant to improve the transition, and perhaps promote if need be, the transition from undergraduate education to graduate education. This would be fulfilled through practical research experience; getting people's feet wet per se. This environment strives to encourage active collaboration amongst students and faculty alike by providing resources that can link them together.

A waterfall model was decided upon to deploy the prototype. The waterfall came in 3 primary phases:

1. Background survey of existing tools and relevant literature;
2. Proposal of an integrated tool to provide the complete context for undergraduates to begin research projects and to present results in an informal or peer-reviewed format; and
3. Development of a prototype website, including pilot content, for IIT undergraduate researchers to test and use in Spring 2009.

As it stands now, ResearchWeb is currently implemented as a customizable MediaWiki. This is similar to other wiki-based sites, like Wikipedia. After a series of requirement

analyses, MediaWiki appeared to be the quickest and simplest path to fulfill the requirements that had been laid out. The following sections will dive into the details of the configuration and development of the MediaWiki based site. They will also delve into why MediaWiki may not be the correct approach anymore.

2.1 Prototype Deployment: Phase 1

Phase one began with exploring materials based around research practices and collaboration programs.

Why & Who:

The American Mathematical Society has been pushing to promote undergraduate research work to:

1. Give students practical experience
    a. Here lies a chance to become a part of a community and experience the feeling of being necessary to a group's success
2. Give students professional experience
    a. Another outlet for students to gain professional experience because not everyone can get an internship
3. Exposure to topics beyond the undergrad's major
    a. Research can be done in diverse teams

Since 2006, the American Mathematical Society has been bringing select undergraduate students together to perform research. Their intention is, and has been to promote undergraduates extending their education beyond normal coursework. They have been largely successful with their select students. ResearchWeb will take this another step further, by providing a tool that will assist in extending research opportunities beyond just a select number of undergraduate students. With this idea in mind, the ResearchWeb project stands as a cost effective solution to extending undergraduate research opportunities to the IIT's entire collegiate community and a step towards contributing to what is known as Research 2.0. These opportunities and contributions may extend beyond IIT depending on the results of the launch of this program.

> *"The term "Research 2.0" was coined to announce the research world's response to this new Web 2.0 world. Research 2.0 seeks a dialogue with consumers engaging with them continuously, connecting with them through the various platforms that Web 2.0 offers. This new paradigm challenges the static "top-down" research approach based on what international Research 2.0 authority Ray Poynter (2007) calls the "command and control" research mode. It is a bottom-up approach that often challenges the client – researcher - respondent hierarchy. Techniques like blog research, online research communities, online "coolhunting", social network research and "Netnography" have all evolved from the Web 2.0 collaboration imperative. This research paradigm is growing rapidly in Europe and the US. Various international conferences are being organized that center solely around this topic."*
> *~Research2zero.com*

This says to take emerging technologies and integrate them with current research standards and practices.

What & How:
Additional research on competing research websites pointed to certain, recurring characteristics. These recurring characteristics would help define what ResearchWeb will need to be able to fulfill.

- A file archive that is sorted by subject
- A search engine for finding specific materials quickly
- A self updating home page
- Contribution tutorials
- American Psychological Association links for stylizing and publishing research
- Some sort of administrative hierarchy for quality control
- Rendering published material for viewing
- Web based platform

When:
The goal was to have some sort of prototype up and running by the summer of 2009.

2.2 Prototype Deployment: Phase 2

Phase two composed of drawing up the requirements that would define ResearchWeb. These functional requirements are as follows:

- Vertically Integrated User Hierarchy
- Organized Page Linking
- Discussion Alerts
- Social Networking
- Page Search Ability
- Subversion
- Web-Based Text Editing
- Media hosting
- Simple Front-end Administration
- Streaming Media
- Rapid Communication Tools

Vertically Integrated User Hierarchy

The vertical integration hierarchy describes how users will interact with the site and each other. We expect vertical integration to lend to strong quality control over contributed materials. This sort of team structure is employed in many large publishing websites that have set the industry standard. Some examples include Wikipedia, ReadOz, and FreshMinds.

The hierarchy we have decided upon has five standard user groups and one specialized scripted, automated bot group. Each group has its own set of permissions that enable or disable site functions. Features available to users are as follows:

- Create – Allows a user to create a discussion page, pose a research question, or publish a research article.
- Update – Allows a user to edit the information on a page.

- View – Allows a user to see what is written on a page.
- Delete – Allows a user to remove a page from the view option and update option. The page will remain in the subversion repository.
- Reset Password – Allows privileged users to change a password to a user account.
- Private Message – Gives users the ability to send a private message that is similar to an email to another user in the case that discretionary communication is needed.
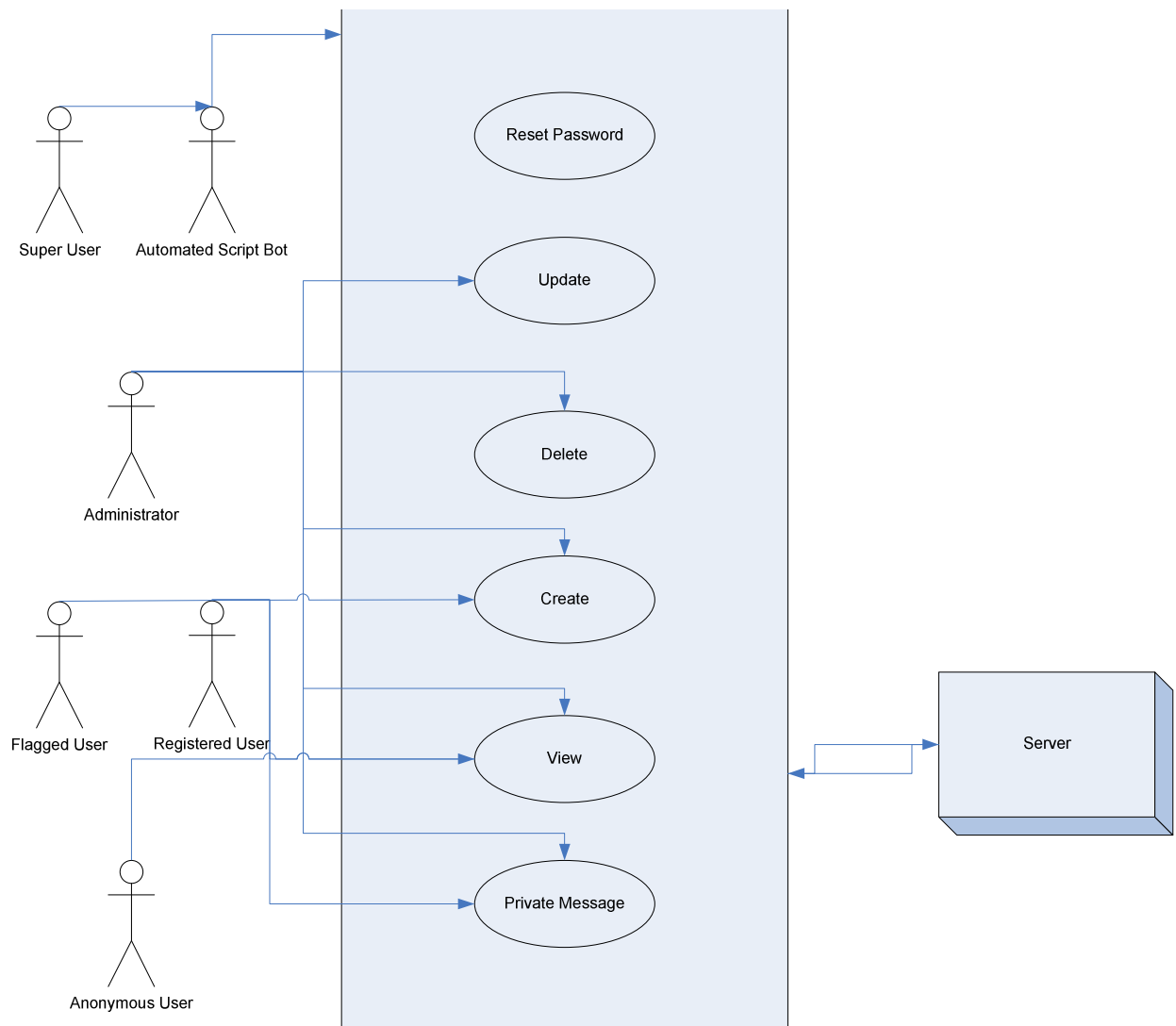

Figure 1: Vertically integrated user privilege hierarchy

Figure 1 illustrates the following user rights hierarchy.
- Super Users- Have access to all listed features.
- Administrators- Have access all features except the reset password feature.
- Registered User's – Can create and view pages. They also have limited update capabilities on pages they have created. This user may also set pages they created to private so only he or she may view the page.

- Flagged Registered User's – These users inherit the features given to registered users and have the limited ability to update specifically assigned registered users. These users can view pages others have flagged as private if given permission by the author of the work.
- Anonymous Users – These users can only view general research pages to spark their interests in registering. They will be barred from viewing articles flagged as private by other users.
- Automated Script Bot – Is a super user, but is listed for reference, as a predictable scripted actor.
- Server – Interacts with user requests to store persistent data. Any actions that manipulate the functionality of the site are saved into the repositories.

Organized Page Linking

Organized page linking is a native feature of MediaWiki. The software employs powerful techniques that allow users to create relational content. This allows users to rapidly explore the scope of any content posted and find where missing research content lies. Figure 2 is an example diagram of a page linking hierarchy. Each line represents a possible link to another content page. Note how all pages are related to one another in some sense due to the linked hierarchy. This model shows how one can be reading about mathematics or writing research about the field in general, then moving into narrower topics such as number sense (topic names are for demonstration purposes only). The writer or reader could go deeper all the way to the stems of applied math, or particular applications to computer science and physics. A site filled with content would go much deeper than this of course.

Discussion Alerts

Discussion alerts are another native feature available through MediaWiki. This allows users to be updated via email if their article has been discussed using the discussion function, allowing for rapid collaboration between multiple researchers.

Social Networking

Social networking websites have become an overnight phenomenon. Famous examples include MySpace, FaceBook, and Twitter. ResearchWeb will include social networking techniques to build community amongst its researchers and fall in line with Research 2.0. This is expected to be accomplished through a structured forum-style interaction because the objective of the website is to be professional, and not personal. A hopeful feature that can be derived from this is user ratings. Peers and editors may give other users ratings based off their submissions to the site. This will be an incentive to produce quality work. This is a very hard feature to implement because of the uncertainty of the climate of the community that will be produced by ResearchWeb. Things that still need to be addressed in order to implement this include:
- How personal is too personal?
- Personal attacks versus constructive critique
- Community cliques banding together to drive the direction of content

Page Search Ability and Link Hierarchy

Page search ability allows users to enter key words into a field and attempt to pull up a desired article. This iteration of MediaWiki will be powered by Google.
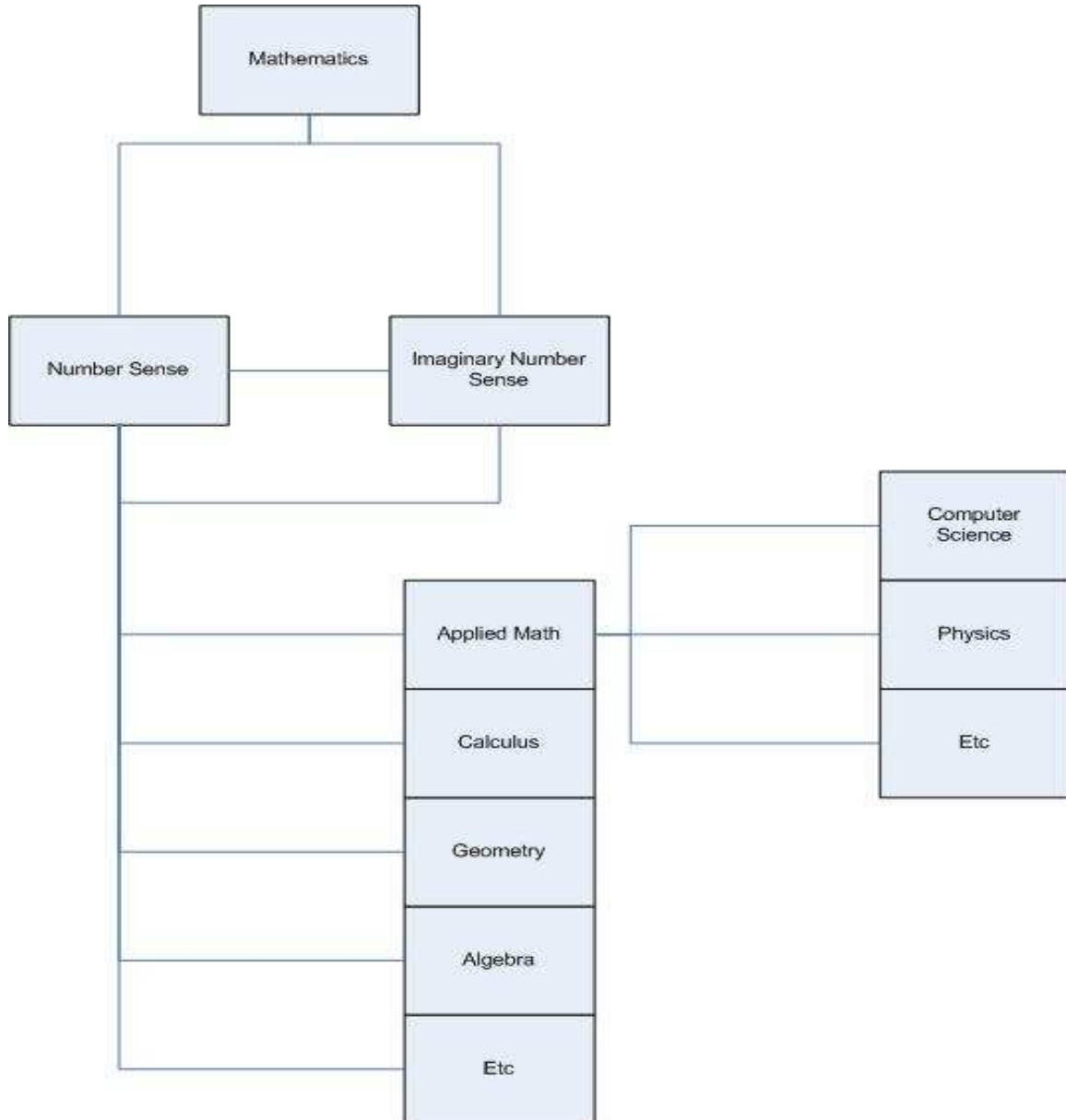
Figure 2: An abstracted example of organized page linking

Subversion

Subversion tools track and store historical versions of content. The particular implementation that comes native to MediaWiki keeps histories of each article uploaded onto the site server. This fits the needs of ResearchWeb very well. It allows users to

rollback content to a state that is satisfactory, and gives an easy method of dealing with vandalism and errors.

Web-Based Text Editing

Web-based text editing is critical to this project, as it allows users to collaborate in a single place, rather than losing track of items in emails or desktops. The text-editing in MediaWiki is highly modifiable. The ResearchWeb prototype includes an extremely simplified LaTeX engine integrated into the text-editing interface. This allows researchers of all skill levels to get experience with a technical writing language, albeit it a shallow one.

Image Upload Capabilities

This is a required feature so researchers may illustrate facts and conjectures

Simple Front-end Administration

This requirement is to allow site managers with less tech know-how but with experience in research to manage ResearchWeb after the programmers are done working on it.

Streaming Media

This is a required feature so researchers may illustrate thoughts via streaming video. The following link contains many resources on how to, and why to use streaming media: http://www.networkworld.com/research/streaming.html

Rapid Communication Abilities

Things that would fall under this category would be any sort of integrated instant messaging, or voice over IP.

2.3 Prototype Deployment: Phase 3

Phase 3 consisted of obtaining and configuring hardware, loading software, some coding, and configuring software.

Hardware acquired (Dell Dimension Desktop) and Server OS implementation

- 2.4GHz P4
- 512mb RAM
- 80Gig Hard disk
- ArchLinux
  - o Super light OS on a weaker server machine is a super plus.
  - o Highly customizable
- Set up of Linux, Apache, MySQL, PHP
  - o This is also known as LAMP.
  - o These technologies allow us to hosts the site.
  - o This is the standard for webhosting due to its flexibility and extensibility

Physical Server Space

- The server is currently located in Stuart Building 112b.

Network Integration

- IIT's Computer Network Services have assigned the server the domain name: researchweb.iit.edu

MediaWiki software loaded and configured

- Sample documents uploaded
- Plug-ins installed and tested

3.1 A New Direction

The site currently is launched as a prototype.   The focus of it currently is not the aesthetics but the functionality. This is where I came to believe that MediaWiki may actually fulfill the goals of the ResearchWeb project, but it does not do so elegantly. The goals in question are displaying content and generating content.

As it stands now, submitting any sort of content is exactly like submitting content on Wikipedia. Users may create or edit a page using a form embedded in the center of the page. This form will automatically generate HTML code to display the input content. The problem is that the pages that are automatically generated are not generated with APA standards in mind. They are generated to read vertically, along web standards; not in any sort of APA research standard format. This leaves two approaches: modify the current prototype to display in a research standard fashion, or develop a new platform. The following is a screen cap of an example research paper being displayed by MediaWiki's native html generator:

Navigation
- Main Page
- Community portal
- Current events
- Recent changes
- Random page
- Help

Search

Go   Search

Toolbox
- What links here
- Related changes
- Upload file
- Special pages
- Printable version
- Permanent link

page   discussion   view source   history

Hearing the shape of a graph via its spectrum

This page addresses an idea by Robert Ellis. It relates the significance of audio chords and their relationship to eigenvalues.

Contents [hide]
1 Hearing the shape of a graph via its spectrum
2 Can One Distinguish Graphs by Listening to Them?
  2.1 An Eigenvalue Chord Played with All Edges
  2.2 An Eigenvalue Chord Played with a Missing Edge
3 Gallery of Graphs

Can One Distinguish Graphs by Listening to Them?

This is a question which has intrigued me since I have been investigating an area of mathematics known as Spectral Graph Theory, wherein one of the central questions is whether a graph can be distinguished by certain characteristic values called eigenvalues which are associated with the graph. Here are several examples of "chords of eigenvalues" which are associated with various graphs. Be sure to listen carefully for which chords are harmonious and which are dissonant. There is a tie between symmetry in the graph and harmoniousness of its chord!

An Eigenvalue Chord Played with All Edges

Figure 1: A 2x2 Grid Graph

Figure 1: A 2x2 Grid Graph

Values between 0 and 2 are place on two octaves starting at A (440 Hz). Thus a value of 1 corresponds to A (880 Hz), a value of 2 corresponds to A (1760 Hz), a value of 1.5 corresponds to D# (660 Hz), and so forth. All the notes are played simultaneously in a chord. If a graph has a multiple eigenvalue, the corresponding note is played louder.

Figure 1 to the left depicts a graph which is a 2 by 2 grid. This graph is very symmetric - just by looking at it you can see the horizontal, vertical, and diagonal symmetries of the graph. As it happens, the eigenvalues of the graph, displayed in Figure 2, also have a lot of symmetry. The horizontal axis gives the values of the eigenvalues, and the vertical axis gives an idea of which eigenvalues appear more than once, by the height of the peak. The eigenvalues are 0, 1, 1, and 2.

Listen to a 2x2 grid graph chord(.wav)

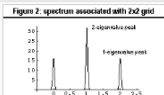Figure 2: spectrum associated with 2x2 grid

Figure 2: Spectrum associated with 2x2 grid

An Eigenvalue Chord Played with a Missing Edge

Figure 3: 2x2 Grid with edge missing

Figure 3: A 2x2 Grid with an edge missing

The second graph, depicted in Figure 3, is the first graph with one edge deleted. you might suspect that this disrupts the harmony of the graph's chord. Indeed, it does disrupt it to some extent, but there is still enough symmetry in the graph that the chord is reasonably harmonious. The result of deleting the edge is that the two eigenvalues that corresponded to A (880 Hz) are split into one at D# (660 Hz) and another an octave higher at D# (1320 Hz).
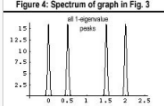
Listen to a 2nd graph chord(.wav)

Figure 4: Spectrum of graph in Fig. 3

Figure 4: Spectrum associated with 2x2 grid with an edge missing

Figure 3: A sample page generated using MediaWiki. Note that the content is built like a standard html document, built from the top down.

Biotechnology: Producing Nature

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Abstract – The United Nations Convention on Biological Diversity has defined biotechnology as such:

"Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use."

This document will discuss the implications and effects of biotechnology on the world in the present and future contexts.

Index Terms- History, Modern, Stem Cell, Genetic Indexing/classification, Issues, Consequences, Effects, Future

Historical Context

Biotechnology began to find its first, strong footholds around 10,000 BC during the Neolithic Revolution. This agricultural revolution transitioned humanity from hunting/gathering societies to communities centered about agriculture and settlement.

The early use of biotechnology was to selectively breed animals and grow crops. By being selective in the choice of animals and crops for development, farmers and herders were able to alter the natural genetic courses of their produce and livestock. The ability to create large surpluses of food allowed the human population to boom and take this technology further.

Along with this population boom, medical opportunities were found with the exploration of immunization. Civilization discovered how to prevent illness by allowing trace amounts of infectious bacteria or viruses into the body. This brought a huge surge in the discovery of medication; the means of curing disease that was not

famous antibiotic prescribed today by doctors because of its cheap cost and effectiveness. [6]

On June 16th, 1980 the United States Supreme Court would rule five to four in favor of Charkrabarty in the *Diamond v. Chakrabarty* case that:

"A live, human-made micro-organism is patentable subject matter under [Title 35 U.S.C.] 101. Respondent's micro-organism constitutes a "manufacture" or "composition of matter" within that statute."

This court ruling would make patents that related to biotechnologies have legal standing. Due to this, biotechnology would become accepted as a field of technology late in the 1980's, even though it found its roots at the dawn of the Neolithic Revolution.

Modern Context

In modern society, biotechnology has become an essential part of everyday life. There are also many different contexts in which biotechnology can be classified. Currently, their well known uses are categorized into four different colors.

- Red biotechnology deals with all parts of the medical industry. Synthesizing organisms to create Penicillin or to assist the body in its natural processes are solid examples. Also, controversial genetic manipulation also falls under this category.
- Green biotechnology is defined as biotechnology applied to agricultural processes and plant life. Some of the more infamous green biotechnologies include: Herbicide, selective breeding genetic plant engineering fertilizers

Figure 4: A sample research document that employs the APA style.

It should be especially noted that the item in figure four is built from the top down and then left to right, whereas the item in figure three was made purely top to bottom. Obviously, there is a distinct difference between the renderings of the content. I feel that the industry standard for research should be followed closely to give users the proper research experience.

Secondly, and most importantly, from a non-technical user's perspective, those unfamiliar with LaTeX or mark up languages will have a difficult time formatting and setting their content. As a user, working with the MediaWiki platform is not simple enough to be powerful in just anyone's hands.

However, other tools out there can be used to supplement, or replace this platform. That is where the future IPRO of this project comes in. Having many minds survey additional tools beyond what was found during the research fellowship will introduce new perspectives to the mix. This will help bring fresh ideas to solving the content generation/creation problem.

An example of displaying content can be found at http://www.readoz.com/. The following screen captures will illustrate the power of alternative software that can replace, or be integrated into the current system.
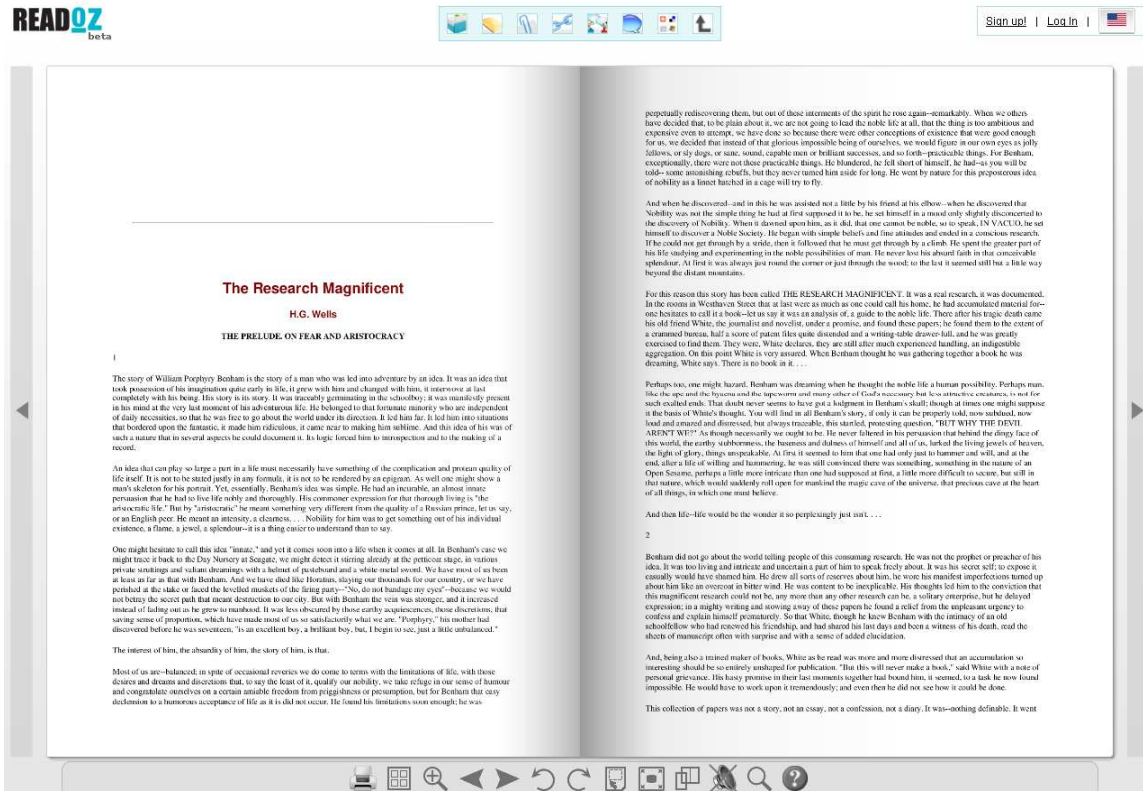

Figure 5: A zoomed out view of a ReadOz document

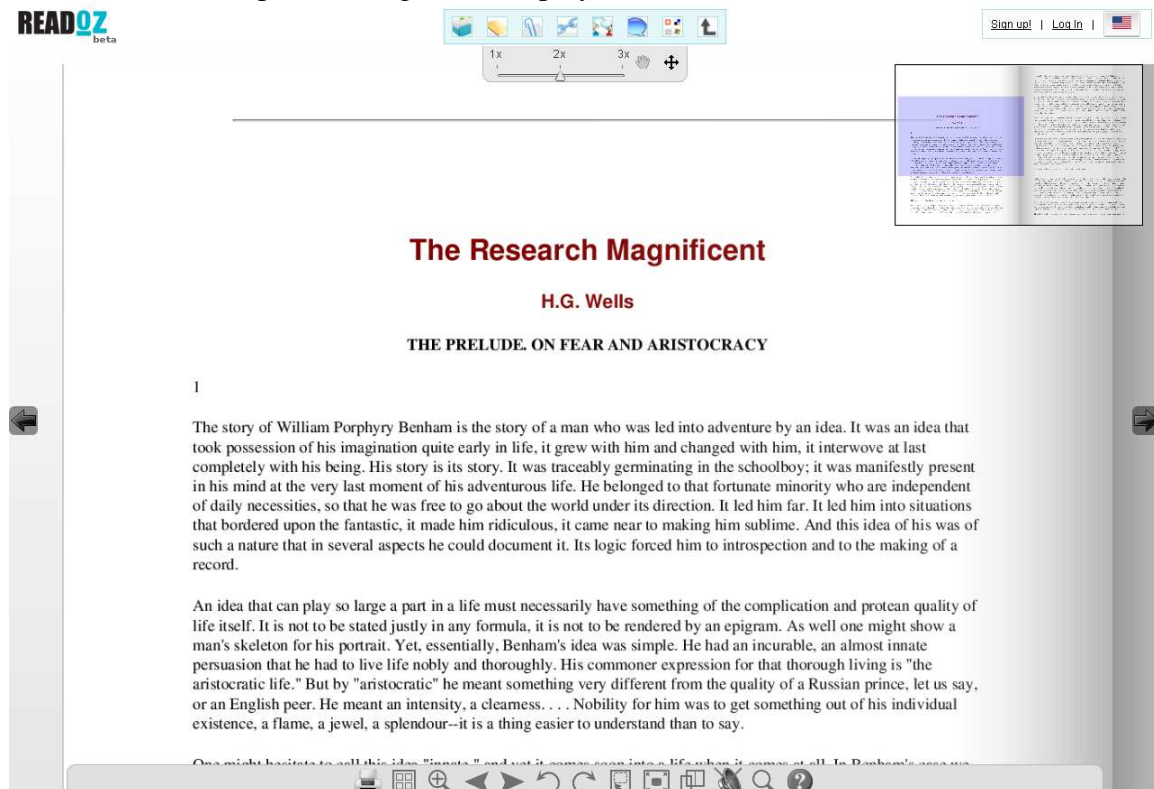These are screen captures using the flash player's zoom function:

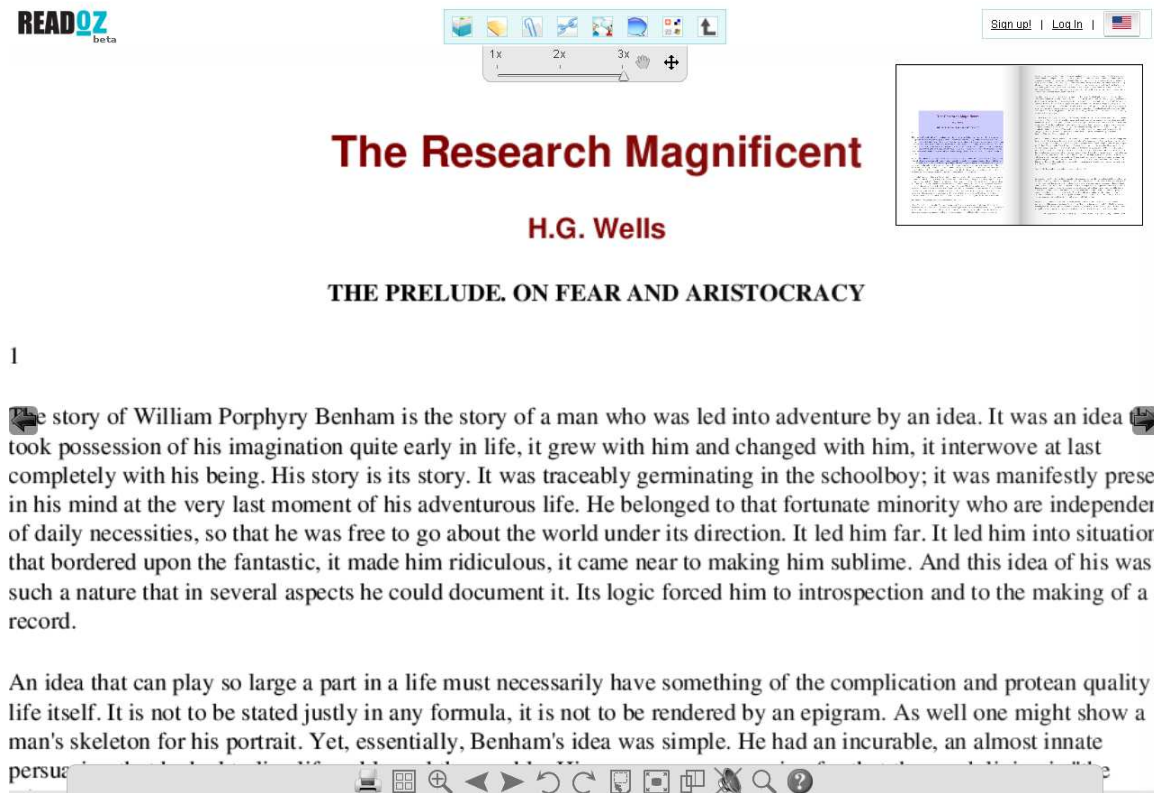**Figure 6: A 2x zoomed view of a ReadOz document**

Figure 7: A 3x zoomed view of a ReadOz document

Also note how the when the page is zoomed, navigation is possibly by dragging the page:
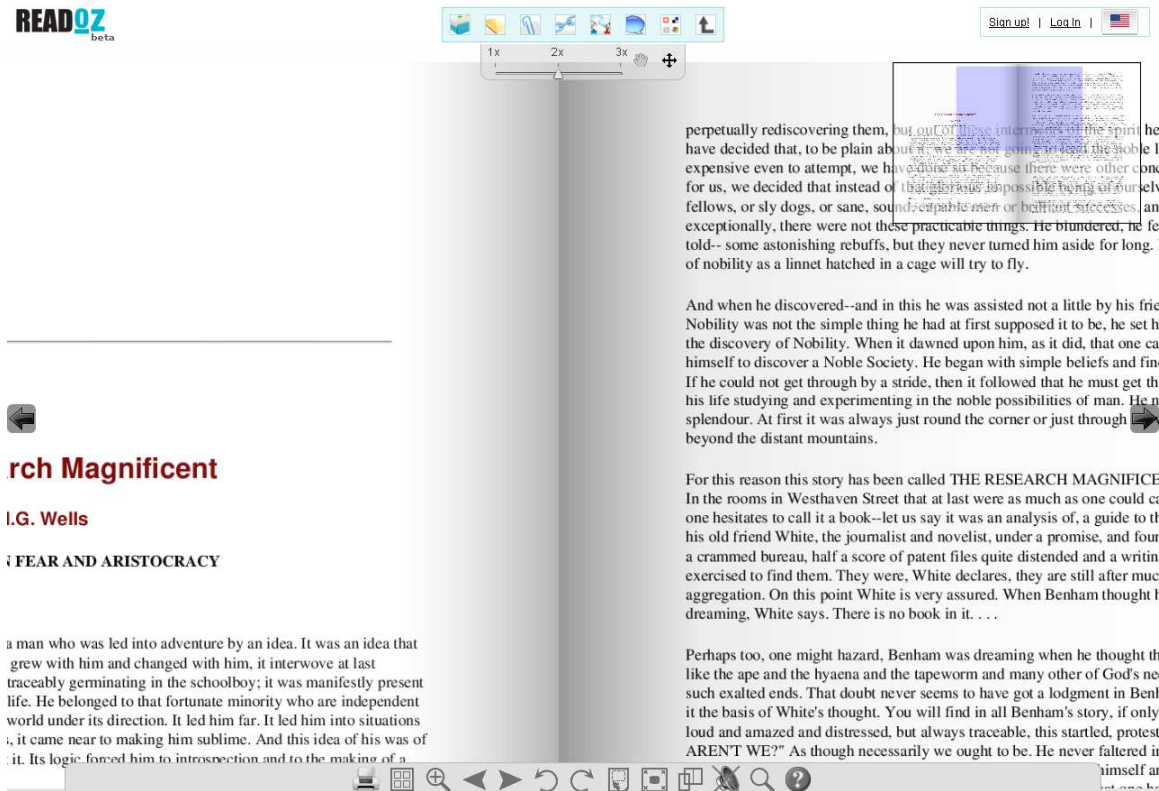

Figure 8: Navigating a zoomed in document on ReadOz

4.0 Summary

An idea and direction for the ResearchWeb project has been laid out. The idea is to provide a tool to publish quality research under the scrutiny of a vertically integrated user hierarchy to enforce quality control.

The direction is to contribute to the emerging Research 2.0 idea by bringing emerging web technologies together on one platform. These emerging technologies include social networking, integrated rapid communication, and automatic computing.

There are some issues in the theory behind it that still needs to be reworked; the role of social networking, content generation, content creation, and how strictly to follow APA standards. This is going to require some debate, and much additional research into industry standards and emerging web technologies.

The Fall 2009 IPRO will be addressing these issues, and continuing the development of the prototype platform.

A.1 Resources

Resource	Description
http://www.ams.org/employment/REUproceedings.html http://www.ams.org/ams/studentposters-sacnas06.html http://www.ams.org/government/DMSWorkshopOnMathMajors.html	American Mathematical Society – The need for

	undergraduate research
http://math.furman.edu/~mwoodard/fuejum/content/toc.html http://www.pme-math.org/journal/ http://www.cst.cmich.edu/org/kme_nat/pentagon.html http://www.rose-hulman.edu/mathjournal/ http://www.hcs.harvard.edu/~jus/home.html http://www.jyi.org/ http://www.morehead-st.edu/colleges/science/math/mejam/	Collaborative research websites
http://en.wikipedia.org/wiki/Vertical_integration	Vertical integration organizational scheme
http://www.ams.org/employment/reu.html	Applications to undergraduate research projects.
http://www.maths.abdn.ac.uk/services/lms/index.html	An indexing of mathematics research projects
http://wiki.cs.princeton.edu/index.php/UgradResearchTopics	Wiki used to dole out research assignments, and archive projects
http://www.apastyle.org/	Formatting standards by APA.