

ResearchWeb Final Presentation

IPRO 321

December 4, 2009

Presenters:

Matt Abhay

Adam Eberlin

Bethany Nicholson

Zach Cornelius

Max de Courten-Myers

Tom Corsus

James Kapaldo

Yuriy Sizyuk

Stephen Sundberg

Professor Robert Ellis

Undergraduate Research

- **Exposes students to research process**
- **Gives students a valuable experience**
- **Brings together the IIT Community**

Problems

- **Lack of understanding of research process**
- **Lack of promotion of research opportunities**
- **No place for student-initiated research**
- **No central, online place for undergraduates to display research**

Prior Work

- Undergraduate (UG) research project
- Software specifications
- Rapidly developed prototype

Mathematics:Graph Hearing

LOG IN / CREATE ACCOUNT

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

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

Values between 0 and 2 are placed 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: A 2x2 Grid Graph

Figure 1. A 2x2 Grid Graph

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



Figure 2: Spectrum associated with 2x2 grid

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.

An Eigenvalue Chord Played with a Missing Edge

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).



Figure 3: 2x2 Grid with edge missing

Figure 3. A 2x2 Grid with an edge missing

Listen to a 2nd graph chord.(wav)



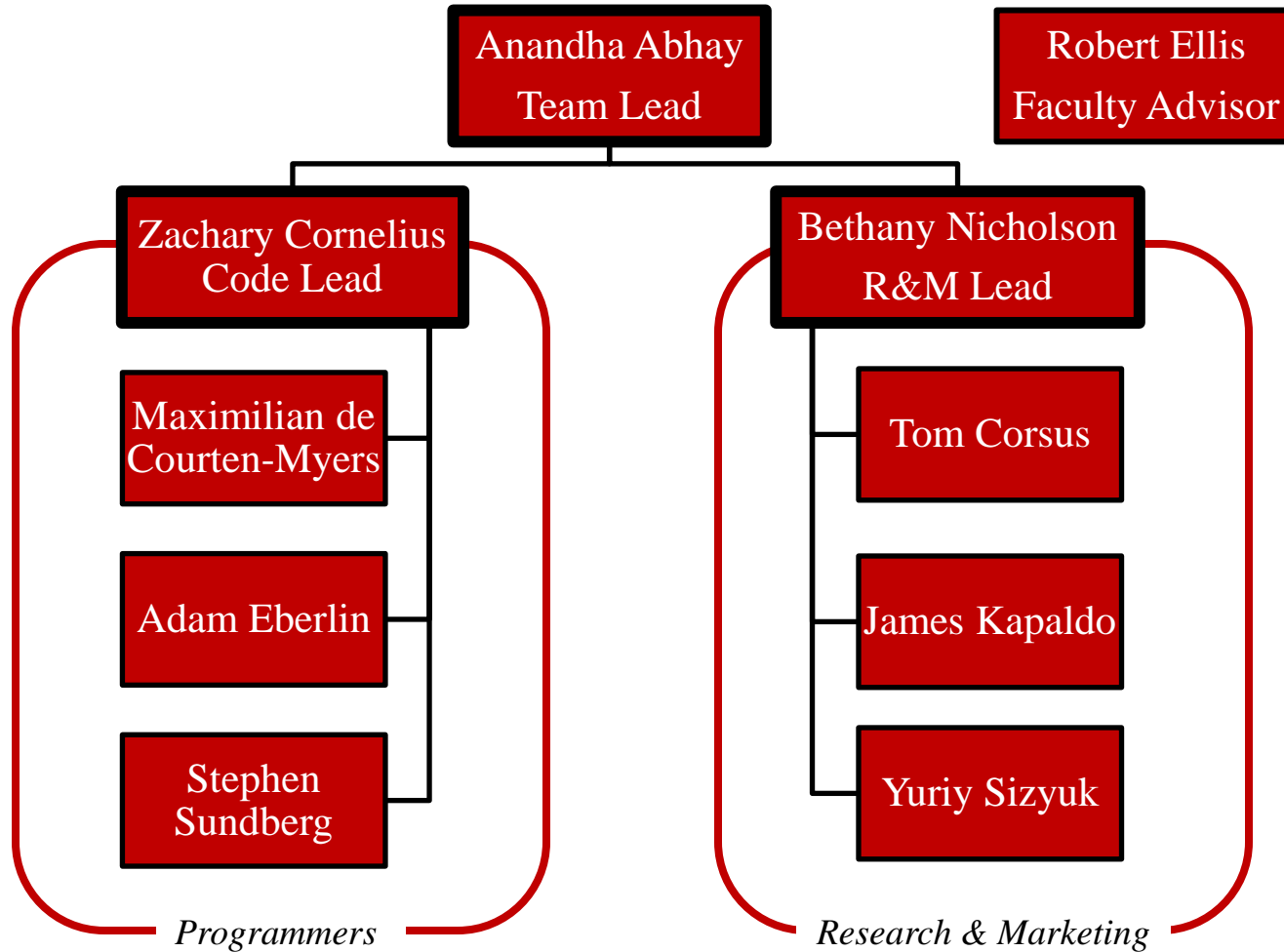
Figure 4: Spectrum of graph in Fig 3

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

Goals

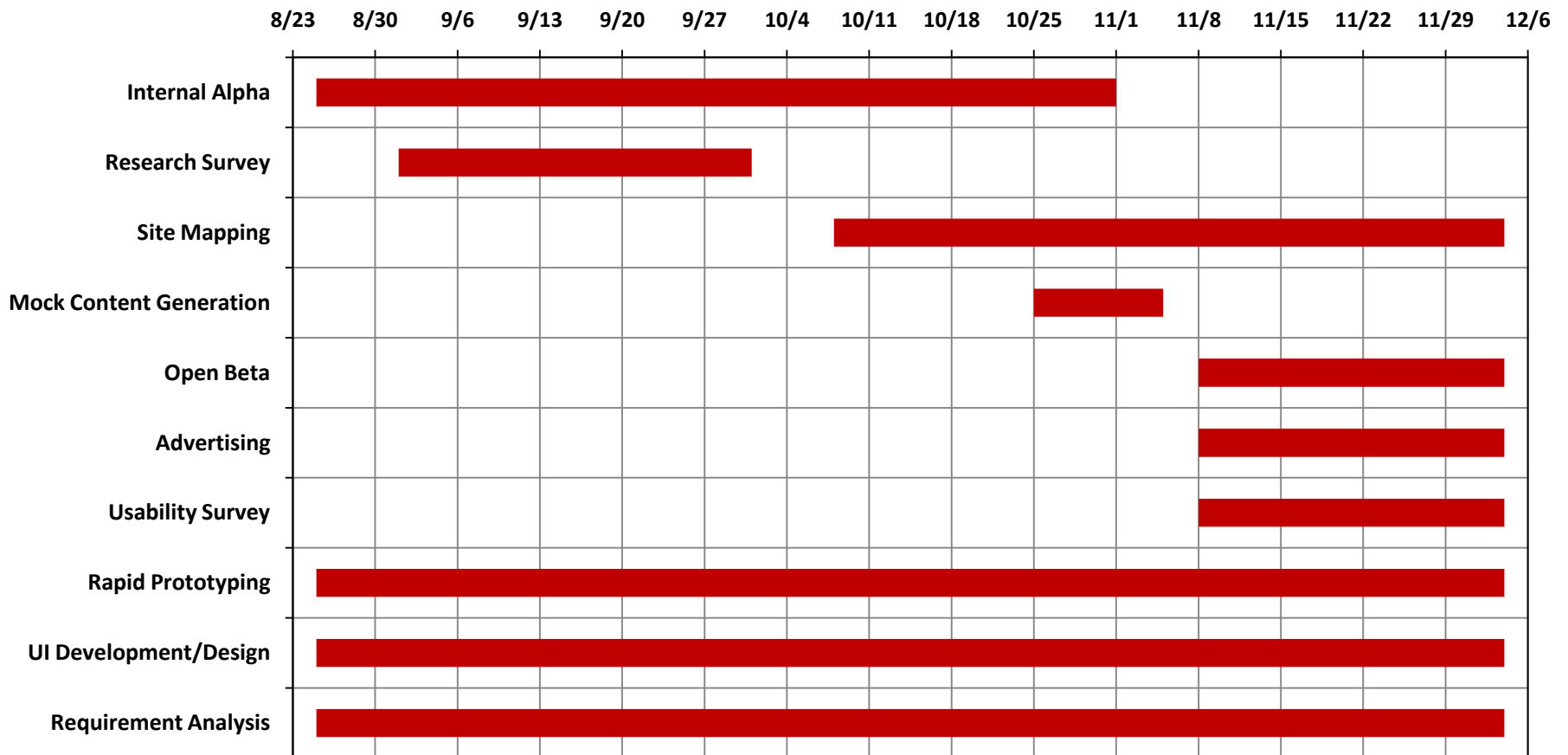
- **Improve and expand UG research at IIT**
- **Create a website that aids the research process**
- **Design all site interfaces and features**
- **Hold internal testing (alpha)**
- **Hold open testing (beta)**
- **Launch advertising campaign**

Team Organization



Team Planning

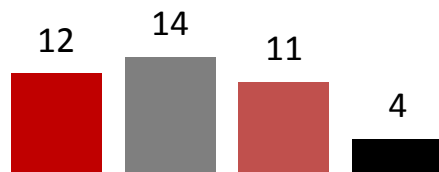
ResearchWeb Tasks



User Survey

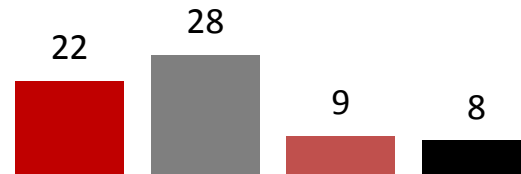
Hindrances to UG Research

- Student's Lack of Experience
- Time Commitment
- Knowledge of Opportunities
- Availability of Resources



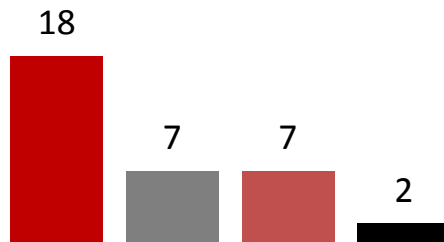
Preferred Methods of Communication

- Face-to-Face Meetings
- Email
- Phone
- Instant Messaging/Texting



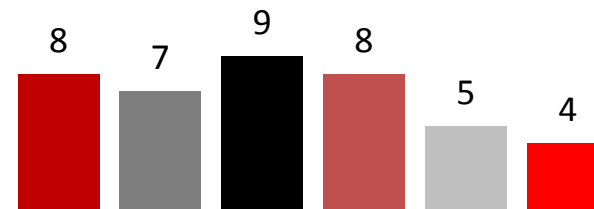
Are Privacy Settings Required?

- Yes
- No
- Should be Customizable
- Wouldn't Post Sensitive Data



Enticements to Use ResearchWeb

- Common Storage
- Streamlined Communication
- Research Community
- Simple Interface
- Opportunity Listings
- Place to Learn about Research



Current Resources

MENDELEY
RESEARCH NETWORK

How it Works

Create your bibliography database

The first thing to do is to import your research papers into Mendeley Desktop. You can do this manually by using the "Add Document" button on the interface or you can import existing EndNote, ISI, RIS or BibTeX files.

You can also drag and drop your PDFs into Mendeley Desktop, where it will then extract the document details, keywords and cited references. It also looks up CrossRef DOIs, arXiv IDs and PubMed document details automatically.

Your library of research papers will all be neatly and intuitively organized. You can search through your bibliography manager and filter by author, journal, keywords and even by assigning your own tags. This gives you immediate and quick access to your documents. Mendeley will even suggest papers not in your library which are similar in content or context.

To make life even easier, Mendeley can also take care of:

- PDF Annotations
- Metadata Extraction
- Automatic Updates
- Integration to EndNote
- Integration to Zotero

ILLINOIS INSTITUTE OF TECHNOLOGY

RESEARCH @ IIT

Undergraduate Research Opportunities

Undergraduate Research Opportunities

AGEEP database of undergrad research opportunities.

Student Opportunities

Extremesal

1. Engineering Research in Diabetes REU
2. College of Science and Letters Undergraduate Research Awards
3. Louis Stokes Alliance for Minority Participation
4. College of Science and Letters Summer Research Scholarships for Undergraduates

RESEARCH CHANNEL

Think Forward. The

ResearchChannel: Giving voice and visibility to discovery that is changing the world

ResearchChannel was founded by a consortium of leading research and academic institutions to give the valuable work of their researchers with the public. ResearchChannel is now available to many leading academic and applied research institutions and our team has a goal of a million members each year. The channel is also available on many major print and broadcast and other venues in the United States and in other countries.

ResearchChannel features, research and online present revolutionary thoughts and discoveries on ResearchChannel. The University of Michigan, the George Washington University and the National Science Foundation are just a few of the world-renowned institutions that participate and whose programs are featured.

labmeeting

make science easier.

Organize your PDFs | Discover New Papers | Manage Your Lab

Account Login

Join labmeeting

New to Labmeeting? Sign Up!

Google docs

Create documents, spreadsheets and presentations online

Create basic documents from scratch or start from a template. You can create all of the basic, working format documents, starting by columns, writing tables, images, comments, formulas, drop-down lists and more. And do this:

Upload your existing files.

Upload existing files to create the document, including DOC, XLS, ODT, ODS, RPT, CSV, PPT, etc. In a second and spend your existing files.

Available online for editing & sharing.

Click on the toolbar buttons to edit, comment, insert, change font or number format, change cell background color and so on.

IIT Undergraduate Research Project | Student - Mozilla Firefox

ILLINOIS INSTITUTE OF TECHNOLOGY

Greetings from the IIT Undergraduate Research Division. Students are requested to apply to any new undergraduate projects via this site. For more information, contact undergrad_research@iit.edu.

Search/View Undergraduate Projects

Edit/Submit Projects

© 2009 Illinois Institute of Technology • Office of Undergraduate Admission •裴尔林 101 • 10 West 33rd Street Chicago, IL 60618 • Phone: 312.567.3029 / 606.448.2229

Project Title	Apply/Edit	View
A virtual keypad for hand rehabilitation after stroke	Apply/Edit	PDF
An Investigation of the Utility of Relational Databases in the Finite Element Method	Not Eligible	PDF
Analyzing User Comments on Video Web Sites for Useful Information	Not Eligible	PDF
ANTIMICROBIAL PEPTIDES AND THEIR SYNTHETIC DMICs: TOWARDS "SUPER-ANTIBIOTIC" DRUGS	Apply/Edit	PDF
Design of "stealth cells" for transplantation procedures	Apply/Edit	PDF
Development of a diffusion tensor MRI template of the adult human brain	Not Eligible	PDF
Environmental Sustainability in		

Software



Ruby



Ruby on Rails



Ubuntu



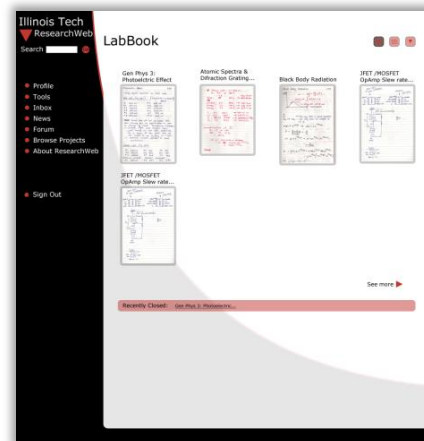
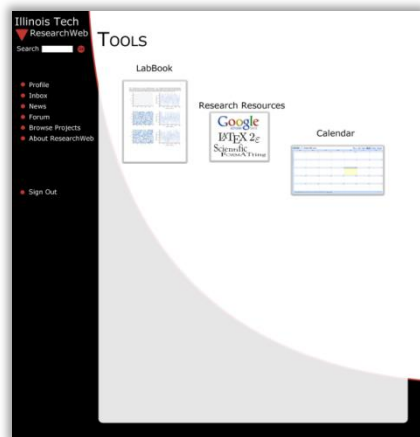
Server

Feature	Original Server	Temporary Server	Current Server	Virtual Private Server
Monthly Cost	Free	Free	Free	\$40.00
Student Administrative Access	✓	✓	*	✓
Secure Location		✓	✓	✓
Reliable Network Connection			✓	✓
Professional Maintenance			✓	✓
Guaranteed Up-time (5 9's)				✓

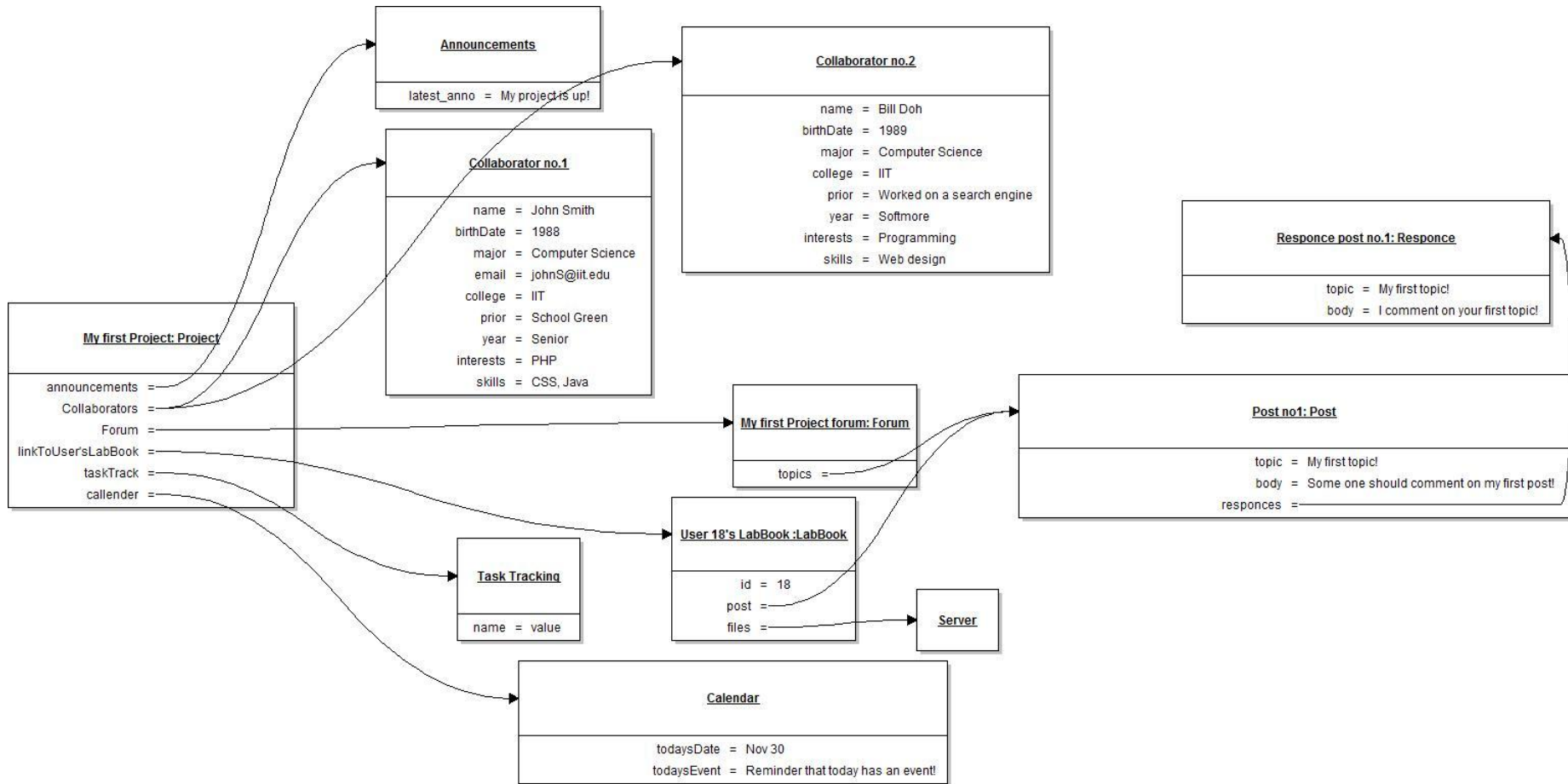
*** Students have limited access**

Website Design: Front-End

- User-centered design
- Bulletin board style



Requirement Specification



Ethical Issues

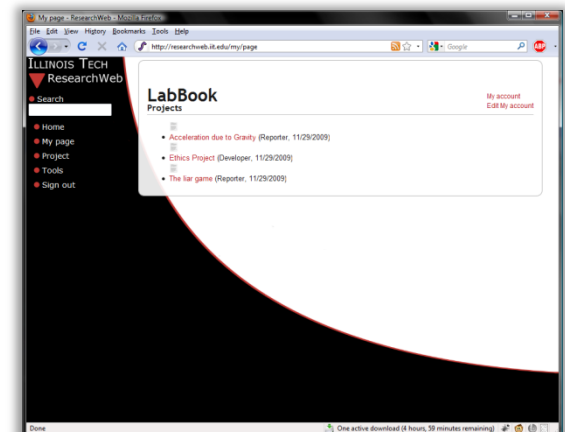
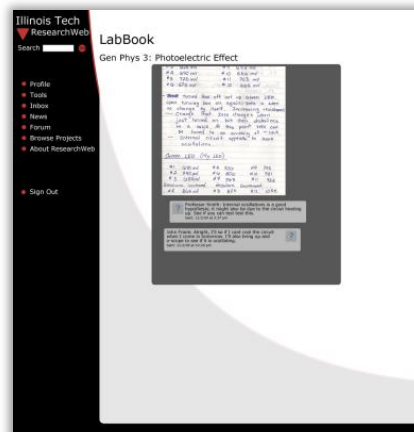
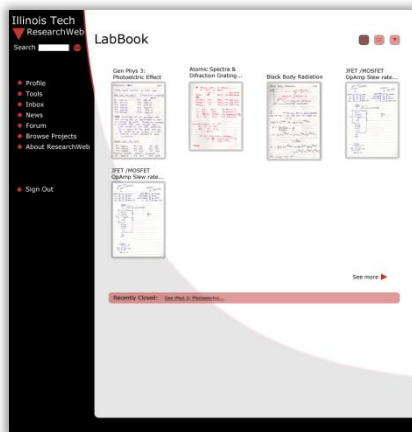
- **GNU general public license version 2**
- **Privacy protection**
- **Content ownership and rights**
- **Copyright**
- **Non-disclosure agreement**



Site Features

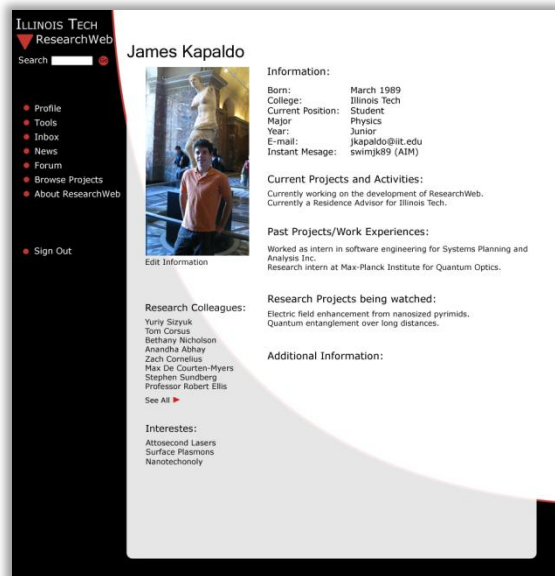
Projects & Lab Book

- Central place for data storage
- Private discussion space for collaborators



Social Networking

- Online research community




ILLINOIS TECH
ResearchWeb

Search

- Profile
- Tools
- Inbox
- News
- Forum
- Browse Projects
- About ResearchWeb
- Sign Out

James Kapaldo



Information:
Born: March 1989
College: Illinois Tech
Current Position: Student
Major: Physics
Year: Junior
E-mail: jkapaldo@it.edu
Instant Message: swimj89 (AIM)

Current Projects and Activities:
Currently working on the development of ResearchWeb.
Currently a Residence Advisor for Illinois Tech.

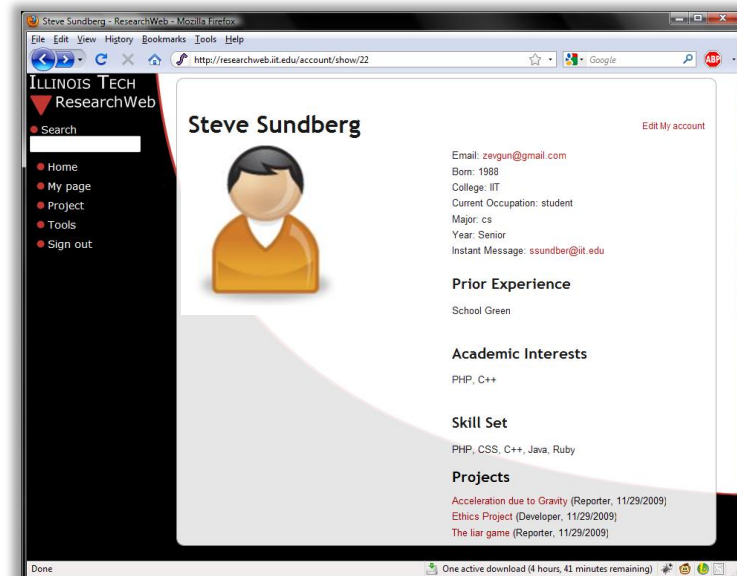
Past Projects/Work Experiences:
Worked as intern in software engineering for Systems Planning and Analysis Inc.
Research intern at Max-Planck Institute for Quantum Optics.

Research Projects being watched:
Electric field enhancement from nano-sized pyramids.
Quantum entanglement over long distances.

Additional Information:

Research Colleagues:
Yury Sizyuk
Tom Cerasi
Bethany Nicholson
Anantha Abhay
Zach Cornelius
Max De Courten-Myers
Stephen Sundberg
Professor Robert Ellis
See All ▶

Interests:
Attosecond Lasers
Surface Plasmons
Nanotechnology



Steve Sundberg - ResearchWeb - Mozilla Firefox

File Edit View History Bookmarks Tools Help


http://researchweb.it.edu/account/show/22

ILLINOIS TECH
ResearchWeb

Search

- Home
- My page
- Project
- Tools
- Sign out

Steve Sundberg



[Edit My account](#)

Email: csvgun@gmail.com
Born: 1988
College: IT
Current Occupation: student
Major: cs
Year: Senior
Instant Message: ssundber@it.edu

Prior Experience
School Green

Academic Interests
PHP, C++

Skill Set
PHP, CSS, C++, Java, Ruby

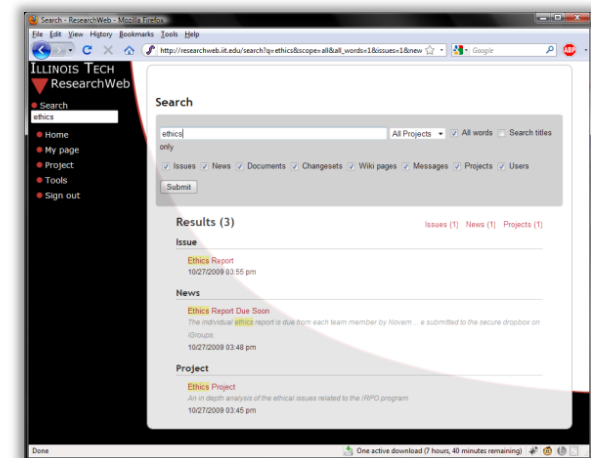
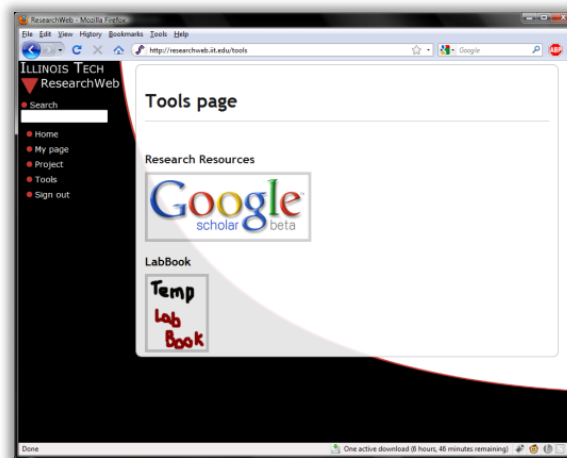
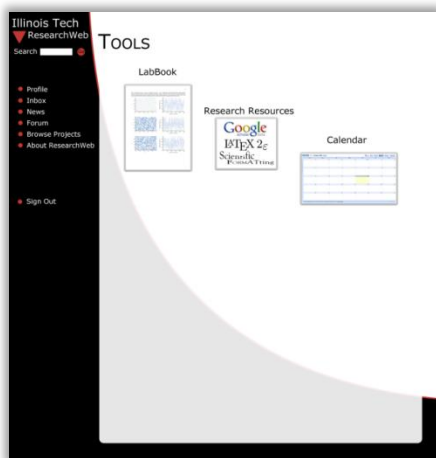
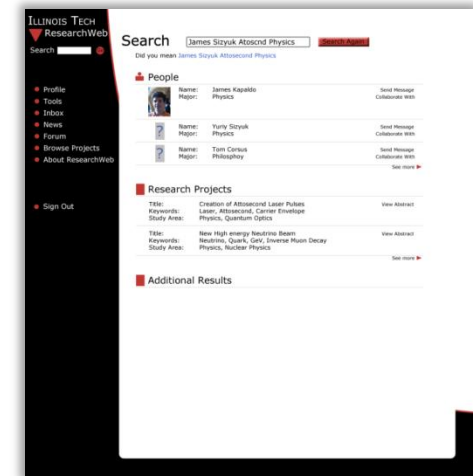
Projects
Acceleration due to Gravity (Reporter, 11/29/2009)
Ethics Project (Developer, 11/29/2009)
The liar game (Reporter, 11/29/2009)

Done

One active download (4 hours, 41 minutes remaining)

Bare Necessities

- Search
- Research Resources



Future of ResearchWeb

- **Additional tools and features**
Forums, opportunity listings, communication tools
- **Sandbox environment**
- **Flash based voip**
- **Integration of external systems**
- **Public release of ResearchWeb**



Acknowledgements

We would like to thank

- Prof. Robert Ellis, our advisor**
- Prof. Eric Brey, Asistant Dean Office of Undergraduate Research**
- Prof. Karl Stolley, Co-director of the Usability Testing and Evaluation Center**
- Nickolay Schwarz, software developer at Centro**
- Sourixat Thavisouk, Executive Producer and CEO of A List TV**
- Jeffery Lee, Marketing consultant of BET**
- Mark Cooney, current server administrator**



Questions?