

# **Collaboration in Software Engineering: A Roadmap**

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# Who Am I?

- Created and led Internet Engineering Task Force working group on Web Distributed Authoring and Versioning
  - ▶ WebDAV, DeltaV standards
  - ▶ Built on top of HTTP
- Brought people together to collaborate (working group)
  - ▶ ...on the creation of a collaboration protocol (WebDAV)
  - ▶ ...that was infrastructure for a coordination protocol (DeltaV)
  - ▶ WebDAV is now being used as infrastructure for CalDAV
    - Calendar access protocol



# The Future is Now

“The future is here, it’s just not evenly distributed yet.”

- Attributed to novelist William Gibson

Predicting the future by studying the present



# Why collaborate?

- Human limitations drive need to collaborate
  - ▶ At high levels of abstraction, we are slow and error-prone
  - ▶ Hence, must work together to create large projects
- Working together creates new set of problems
  - ▶ Natural language ambiguity
  - ▶ Human memory cannot recall all project details
  - ▶ Cannot track everyone's activities in a large group
  - ▶ Need to converge on a single architecture and design



# Goals for Software Engineering Collaboration

- Establish scope and capabilities of a project
  - ▶ What are we doing?
- Converge on architecture and design
  - ▶ How are we doing it?
- Manage dependencies among activities, artifacts, and organizations
  - ▶ Who is doing what, when?
- Reduce dependencies among engineers
  - ▶ Reduce need for collaboration
- Identify, record, and resolve errors
  - ▶ Engineers make errors. Deal with it.
- Record organizational memory
  - ▶ Record what has been decided and done.



# Meeting the goals: communication

- Software engineers have adopted every mainstream communication technology
  - ▶ Telephone, teleconferences, email, voice mail, discussion lists, Web, instant messaging, text messaging, video conferences, voice over IP
  - ▶ Useful at every stage of a project's lifecycle
- Face to face
  - ▶ meetings, informal discussions in hallways, doorways, and offices
- In general, this communication is **unstructured**
- Similar to collaboration in other disciplines
  - ▶ What makes software engineering collaboration unique?



# Model-based collaboration

- What makes software engineering collaboration unique?
  - ▶ Software enhanced collaboration around models
  - ▶ In contrast to general study of computer supported collaboration which generally lacks this focus on models
- Software engineering collaboration is **model-based**
  - ▶ production of new models
  - ▶ creation of shared meaning around models
  - ▶ elimination of error and ambiguity within models
- Much collaboration around formal and semi-formal artifacts
  - ▶ requirements specification, architecture diagrams, UML, source code, bug reports



# Future Directions for Collaboration in SE

- Shift to web-based development environments
  - ▶ Improving access to artifacts
- Broadening participation in software projects
  - ▶ Increasing number of collaborators
- Capturing design rationale as an argumentation structure
  - ▶ A new artifact for improved organizational memory
- Use of 3D virtual environments (games)
  - ▶ Adoption of a new mainstream communication technology



# Shift to Web-based Environments

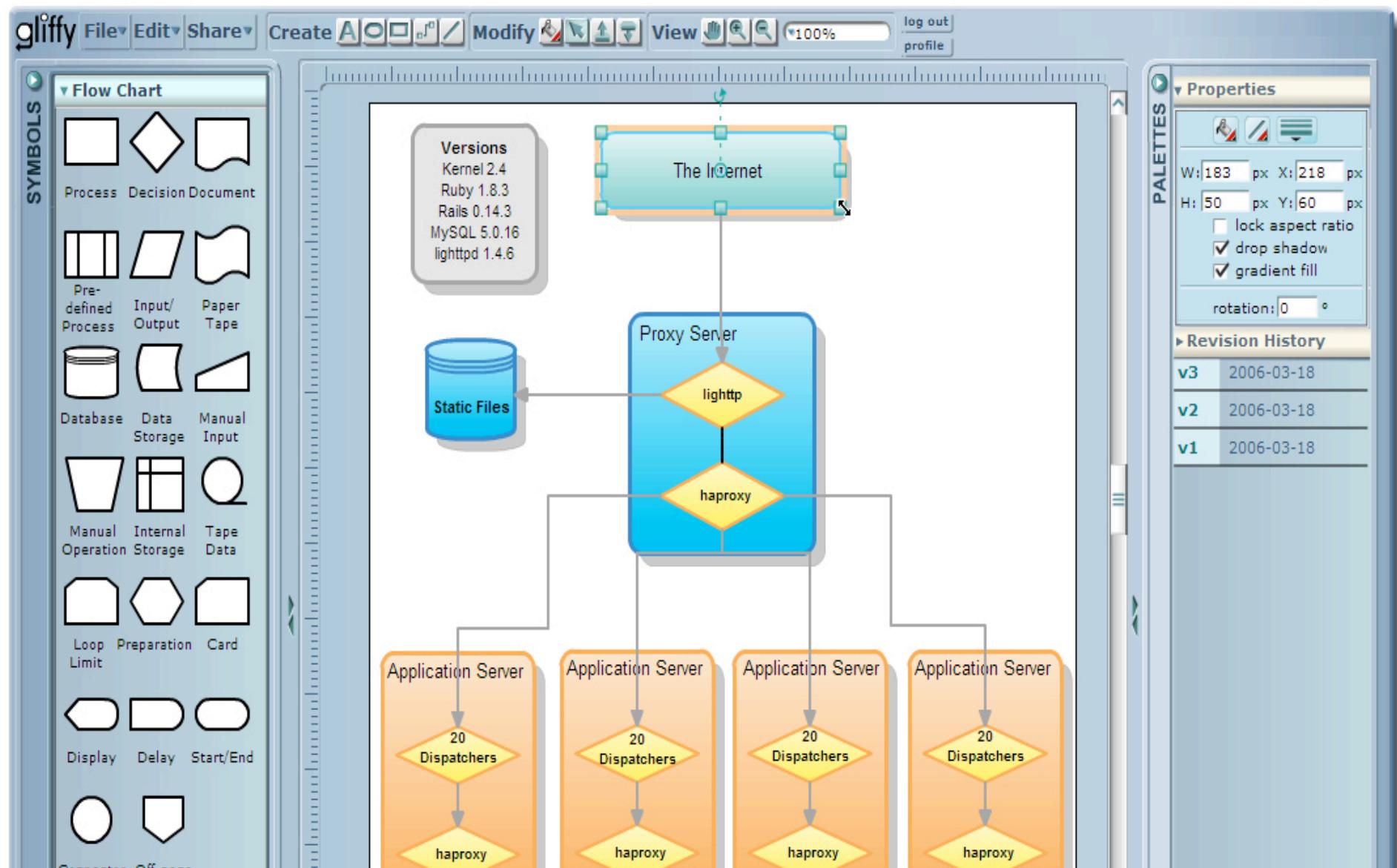


# Historical Progression of Environments

- Up until the mid 90's:
  - ▶ Collaborating collections of tools
  - ▶ Locally run, accessing local networked file system
  - ▶ Remote collaboration involved synchronization of data to a remote site
- 1999
  - ▶ Broad adoption of web-based environments: Sourceforge
  - ▶ Mostly network services
    - SCM repository, mailing lists
  - ▶ As well as some web-based applications
    - Bug tracking
  - ▶ Requirements, design diagrams, editing, compiling: all still local



# Gliffy



# eRequirements, Gatherspace

The screenshot shows the eRequirements software interface. At the top, there's a toolbar with various icons. Below the toolbar is a navigation bar with links like 'File', 'Edit', 'View', 'Insert', 'Format', 'Tools', 'Help', and 'About'. The main area is titled 'eRequirements' and contains several sections:

- SEARCH RESULTS**: A table with columns 'Key', 'Title', and 'Description'.
- SEARCH CRITERIA**: A table with columns 'Search In', 'Search By', 'Key (ID)', and 'Value'.
- Project**: A table with columns 'Name', 'Status', and 'Description'.
- Issues**: A table with columns 'Key', 'Title', and 'Description'.
- Links**: A table with columns 'Link Type', 'Link Name', and 'Description'.

The screenshot shows the Gatherspace software interface. At the top, there's a header with the Gatherspace logo and navigation links: 'Gatherspace Home', 'Project Center', 'Reporting', 'Account Management', 'Help | Getting Started | Customer Support'.

The main area has the following sections:

- Project:** Online Bookstore
- Current View:** Show Features and Associations
- Preview:** Feature Help

A sidebar on the left lists project components:

- Online Bookstore
  - Packages
  - Features
  - Requirements
  - Actors
  - Use Cases
  - Glossary
  - Issues
- Reports
  - Vision Document **Updated**
  - Use Case Specifications
  - Feature Report
  - Requirement Report
  - Use Case Model
  - Traceability Report
  - Issues/Bug Tracking Report

The main content area displays a table of features and associations:

Key	Title	Description	Package	Priority	Assigned To	Status
FEAT2599	System will offer CRM functionality	CRM	High	Not assigned	Submitted	
UC4727	Pick up CSR (customer service requests)					
UC4728	Send emails back to the customer					
FEAT17	Marketing upsell after purchase		High	Not assigned	Released	
SR512	Change quantities in basket					
UC52	Sends out books					
FEAT15	Purchase books online	Ecommerce	High	dannerlevy@gmail.com	Submitted	
SR260	Manage your payment information					
SR261	Manage your account information					
UC84	Buys books					
FEAT14	Browse books online	Ecommerce	Medium	Not assigned	Cancelled	
UC1057	Manages Account					
FEAT13	Shopping Cart Functionality		High	Not assigned	Submitted	
SR27	System will render pages within 2 seconds.					
SR513	Delete items from basket					
UC1061	Put books in shopping cart					
UC1062	Remove book from shopping cart					
UC1063	Clear Shopping Cart					

At the bottom, there are buttons for 'Add Feature' and 'Feature Help'.

# Google Docs

Google Docs & Spreadsheets

google@newspaperindex.com | New features! | Docs Home | Help | Sign out

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A horizontal toolbar with various icons for document manipulation, including bold, italic, underline, font size, alignment, and style.

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# Today: Web 2.0 and Environments

- Requirements
  - ▶ Gatherspace, eRequirements
- UML diagrams
  - ▶ Gliffy supports UML diagrams, among many
- Inspections
  - ▶ Multiple web-based tools (1997-)
- Editors
  - ▶ Google Docs & Spreadsheets
    - Potential for rich web-based editors



# Moving IDEs to the Web

- To enhance collaboration, and reap administrative benefits:
  - ▶ Development environment capabilities will increasingly shift to the web
  - ▶ Opportunity exists to create first complete lifecycle web-based development environment
- Desktop-based tools will not disappear
  - ▶ Eclipse, Visual Studio, etc.
  - ▶ Instead, will be tightly integrated into web-based environments
    - More than just SVN integration



# Integrating Desktop and Web IDEs

- Need to create interface standards to allow within-application access to web-based data
  - ▶ Bug tracking
  - ▶ Requirements
  - ▶ Design diagrams and design rationale
  - ▶ Unit and system test results
  - ▶ SOA type interfaces?
- Permits delivery of rich assistance services (agent-based SE)



# Facebook

Profile edit Friends | Networks | Inbox home account privacy logout

**List Your Stuff in Marketplace** Hide  
Looking for a couch? Trying to get rid of your textbooks? Selling your car? List what you have or want in Facebook Marketplace.

**News Feed** Preferences

**Chris Ward added new photos.** 2:36pm Share +



**Thé Party**  
28 photos by Chris Ward Location: Porter Quad

**Beki Grinter and Mark Stringer are now friends.** 10:24am

**Chris Ward was tagged in an album.** 3:41am Share +



**Flash Dance and Tea Party**  
38 photos by Roby A. Behrens

**Requests**  
1 event invitation

**Find Your Friends**  
Use our contact importer to find friends you didn't know were on Facebook.

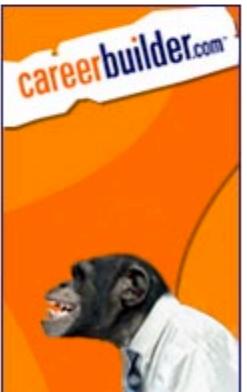
**Status Updates** see all

 Jim is attending the 2007 International Conference on Software Engineering (ICSE) in Minneapolis, Minnesota. on Sunday edit show friend updates

**Gifts** see all  
You have 1 gift to give. show today's gift | browse

**Birthdays** see all  
No upcoming birthdays.

**The Next Step** see all  
Find out what's happening behind the scenes

**careerbuilder.com™**  


# Potential directions for Web-based IDEs

- Integration with network-of-relationship sites
  - ▶ Facebook, MySpace, LinkedIn
  - ▶ Improved team awareness and cohesion
    - IBM Dogear: bookmarking among social network of employees
  - ▶ Expertise finding
- Integration with web-based code search engines
  - ▶ Searching your own code (privately), or integrating found OSS code (with compatible license)
    - Krugle, Google Code Search, Splunk
  - ▶ Integration with normal search engines too
- Access to analysis tools offered as a service
  - ▶ SOA model for static analysis, test case generators, etc.
- Requirements integrated with CRM
  - ▶ Trace requirement back to individual customer



# Broadening Project Participation



# Broadening Project Participation

- Many types of software lock-in their users
  - ▶ Organizations dependent on this software have strong incentive to ensure it meets their needs
- Currently:
  - ▶ Customers consulted during requirements...
  - ▶ ... then get to give feedback during beta testing
- Opportunity:
  - ▶ Develop means to engage customers during all phases
  - ▶ Allow them to actively ensure needs are met



# Challenge: What to control

- Most organizations do not want to cede total control over software to customers
  - ▶ Not complete open source
- Selective opening of projects
  - ▶ Choose portions of the code to make available
    - No need to reveal trade secrets, distinctive IP
    - Foreign language translations
  - ▶ Give customer participants control over some decisions, but not all
    - Or, reserve veto authority
  - ▶ Or, just capture how users are using the software
    - Analyze use logs to improve software
- Ideal
  - ▶ Customers add features and fix bugs most relevant to them, increasing satisfaction



# Capturing Project Argumentation



# Capturing Project Argumentation

- Even experienced engineers disagree on portions of the requirements and design of large systems
  - ▶ “Design for change” means “predict the future”
    - An argument ensues
- Architecture and design can be viewed as **argumentative processes**
  - ▶ Resolution of differences of prediction and interpretation among skilled practitioners to develop system structure
  - ▶ Since only one model can prevail, architecture and design are simultaneously cooperative and competitive

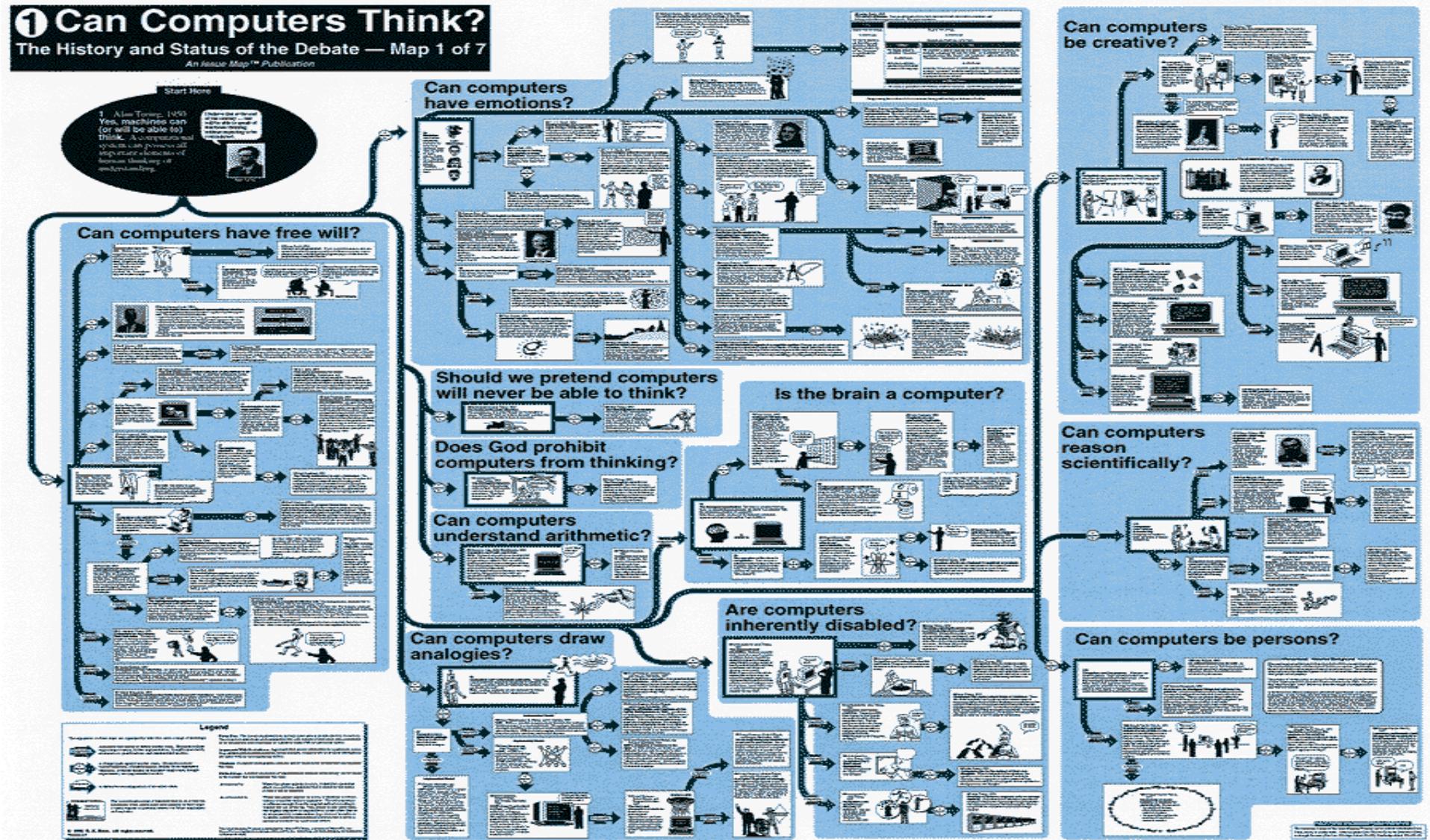


# Capturing Project Argumentation Structure

- Need to record why a decision was made
  - ▶ Primary argument
  - ▶ Supporting facts
- Also important to record alternatives considered, but rejected
  - ▶ Why another engineer thought it could be done differently
  - ▶ As assumptions change, these alternatives may become relevant
- Argumentation structure gives insight into both the design as-is, as well as design variations



# Robert Horn: Can Computers Think?



# Opportunity: Web-based Argumentation

- Design argumentation Wiki
  - ▶ Instead of static posters...
    - Dynamic, living argumentation structures
  - ▶ Within-Wiki support for argument structure
    - Major/minor points
    - Pro/Con arguments
    - Supporting facts
    - Ability to link to (extract out) requirements
    - Activity awareness, hotspots
  - ▶ Analysis of argumentation structure
    - Summarization of arguments
    - Consistency checking
  - ▶ Support software variability analysis
    - Why select a specific feature? Here's why, and why not.
- Some ongoing work in this direction
  - ▶ Compendium [Shum et al. 2005]



# **Collaboration in Networked 3D Virtual Worlds**



# Appropriating Novel Communications

- Software engineers have a long history of adopting novel coordination technologies
  - ▶ Better communication
    - Email, instant messaging, text messaging, voice over IP
  - ▶ Improved presence information
    - Instant messaging
  - ▶ Multi-way discussions
    - Wikis, collaborative editors
  - ▶ Change tracking, collision avoidance
    - Software configuration management
- If a new communication technology emerges, it is reasonable to expect it to be adopted too



# Networked 3D Virtual Worlds (MMOs)

- Since 2000, a proliferation of Massively Multiplayer Online (MMO) worlds
  - ▶ World of Warcraft (WoW), Everquest, Eve Online
  - ▶ Millions of users
  - ▶ Revenue for WoW in 2006: \$471million
  - ▶ Player controls avatar, performs quests in the world
    - Towns, cities, dungeons, etc.
  - ▶ Communication features:
    - Instant messaging
    - Email-like services
    - Presence (seeing another player's avatar)
    - Often coupled with use of third-party voice conferencing
  - ▶ Most explicitly framed as entertainment spaces



# World of Warcraft



# Second Life

- MMO that is aimed at primarily adult audience
  - ▶ Not framed as a fantasy space
  - ▶ Lack of explicit game framing makes professional use possible
  - ▶ User generated content
    - Programming language and environment
    - Within world P2P commerce encouraged
- Businesses are exploring use
  - ▶ IBM has business unit for 3D virtual worlds
    - Appx. 1000 IBM employees active in Second Life
    - Sun, Dell also have presence
    - Sweden has embassy in Second Life



# Scenes from Second Life



# Potential Benefits

- A space that can help merge local workers and remote workers
- 3D topology can provide a landscape for structuring online interactions
  - ▶ Virtual meeting rooms
    - Can show people gathered for a meeting
  - ▶ Project spaces
    - Browsing of project information space
    - Know that people in a vicinity are interested in/working on a project
- Many issues still to address...



# Early Days



- Australian Broadcast Commission (ABC) victim of virtual terrorism attack on May 22, 2007
  - ▶ Perhaps by “Second Life Liberation Army”



# Novel Narrative and Reward Structures

- What makes MMOs so compelling?
  - ▶ Narrative structure of quests
  - ▶ Compelling reward structure
    - Leveling up
    - Completing a quest
    - Officer of a guild
- An advance in **reward structure engineering**
- Can this reward structure be harnessed for engineering project work?
  - ▶ Work in real world on a project might yield benefits in a parallel game world?
  - ▶ Apply leveling up idea to professional education?
    - I'm a level 70 software engineer
  - ▶ For many young people, these reward structures are as familiar as traditional hierachic advancement



# Questions?

Students at UCSC  
collaborated to  
recreate a scene from  
Donkey Kong using  
8800 Post-It notes on  
the Engineering 2  
building (April 2007)

