Computational Thinking for Everyone Workshop I
The National Academies, 2/19- 2/20/2009
Panel 3 – Computational Thinking Everywhere (Part II)

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Former: Chair, IEEE Technical Committee on Digital Libraries
Chair, ACM Special Interest Group on Information Retrieval

Mentors: JCR Licklider & Mike Kessler at MIT; Gerry Salton at Cornell
Outline

• Handouts
• Broad view of computing
• KID perspective -> digital libraries
  – Knowledge, Information, and Data
  – Rules, Text colls, Data structures, Databases
• Multidisciplinary connections
• Education and learning
Handouts

• Living In the KnowlEdge Society (LIKES) … Building Collaboration between …
• The National Science Digital Library … CITIDEL and the Ensemble pathways …
• CC2001 App. A: CS Body of Knowledge
• Cyber-Enabled Learning with Games in Middle School (Evans & Fox)
Broad View of Computing (CC2001)

- Discrete Structures
- Programming Fndmntls
- Algorithms, Complexity
- Architecture, Organiztn
- Operating Systems
- Net-Centric Computing
- Programming Languages
- Human-Computer Intrct
- Graphics & Visual
- Intelligent Systems
- Information Managmnt
- Social & Professional
- Software Engineering
- Computational Science & Numerical Methods
Net-Centric, Info Management

• Security
• Web client-server
• Web applications
• Compression
• Multimedia data technologies

• Models, systems
• Database systems
• Data modeling
• (Distrib) RDBMS, Queries
• Transaction processing
• Data mining
• Information retrieval
• Hypertext, hypermedia, multimedia info / systems
• Digital libraries
Locating Digital Libraries in Computing and Communications Technology Space

Digital Libraries technology trajectory: *intellectual access to globally distributed information*

Note: we should consider 4 dimensions: computing, communications, content, and community (people)

Acknowledgement: S. Griffin
From: Report on Chatham NSF workshop on future directions in digital libraries …
Digital Libraries
Shorten the Chain from

Author

Editor
Reviewer
Publisher
A&I
Consolidator
Library

Reader
DLs Shorten the Chain to

T. Friedman, The World is Flat, work flow, uploading, …
Student Gets Committee Signatures and Submits ETD

ETDs = Electronic Theses and Dissertations
Library Catalogs ETD, Access is Opened to the New Research
**Highlights**

**Solving a Big Math Problem**

An understanding of mathematics may be considered essential for an educated person today, but many Americans seem almost allergic to math. While there is much discussion about the importance of mathematics to scientific research, engineering, and technological innovation, the performance of American math students on international assessments is below that of math students in many other countries. In a new special report — "Math: What's the Problem?" — the National Science Foundation (NSF) uses video interviews and online resources to examine the state of math education and discuss the roles of culture, technology, and research on improving math learning and proficiency.

[View Highlight Archives](#)
Information Life Cycle

- Authoring
- Modifying
- Organizing
- Indexing
- Storing
- Retrieving
- Distributing
- Networking
- Using
- Creating
- Accessing
- Filtering
- Retention / Mining
- Utilization

Active

Social Context

Creations

Inactive

Searching

Semi-Active

Utilization
Informal 5S & DL Definitions

DLs are complex systems that

• help satisfy info needs of users (societies)
• provide info services (scenarios)
• organize info in usable ways (structures)
• present info in usable ways (spaces)
• communicate info with users (streams)
# 5Ss

<table>
<thead>
<tr>
<th>Ss</th>
<th>Examples</th>
<th>Objectives</th>
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</thead>
<tbody>
<tr>
<td>Streams</td>
<td>Text; video; audio; image</td>
<td>Describes properties of the DL content such as encoding and language for textual material or particular forms of multimedia data</td>
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<tr>
<td>Structures</td>
<td>Collection; catalog;hypertext; document; metadata</td>
<td>Specifies organizational aspects of the DL content</td>
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<td>Spaces</td>
<td>Measure; measurable, topological, vector, probabilistic</td>
<td>Defines logical and presentational views of several DL components</td>
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<tr>
<td>Scenarios</td>
<td>Searching, browsing, recommending</td>
<td>Details the behavior of DL services</td>
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<tr>
<td>Societies</td>
<td>Service managers, learners, teachers, etc.</td>
<td>Defines managers, responsible for running DL services; actors, that use those services; and relationships among them</td>
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5S and DL formal definitions and compositions (April 2004 TOIS)
## 5S Services Taxonomy

<table>
<thead>
<tr>
<th><strong>Infrastructure Services</strong></th>
<th><strong>Repository-Building</strong></th>
<th><strong>Add Value</strong></th>
<th><strong>Information Satisfaction Services</strong></th>
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<tbody>
<tr>
<td><strong>Creational</strong></td>
<td><strong>Preservational</strong></td>
<td></td>
<td><strong>Browsing</strong></td>
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<tr>
<td>Acquiring</td>
<td>Conserving</td>
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<td>Collaborating</td>
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<td>Cataloging</td>
<td>Converting</td>
<td></td>
<td>Customizing</td>
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<tr>
<td>Crawling (focused)</td>
<td>Copying/Replicating</td>
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<td>Filtering</td>
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<tr>
<td>Describing</td>
<td>Emulating</td>
<td></td>
<td>Providing access</td>
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<tr>
<td>Digitizing</td>
<td>Renewing</td>
<td></td>
<td>Recommending</td>
</tr>
<tr>
<td>Digitizing</td>
<td>Translating (format)</td>
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<td>Requesting</td>
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<tr>
<td>Federating</td>
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<td>Searching</td>
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<tr>
<td>Harvesting</td>
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<td>Visualizing</td>
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<td>Purchasing</td>
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<td>Submitting</td>
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**Add Value**
- Annotating
- Classifying
- Clustering
- Evaluating
- Extracting
- Indexing
- Measuring
- Publicizing
- Rating
- Reviewing (peer)
- Surveying
- Translating
- (language)

**Information Satisfaction Services**
- Browsing
- Collaborating
- Customizing
- Filtering
- Providing access
- Recommending
- Requesting
- Searching
- Visualizing
5S Software Engineering and HCI

- Requirements
- 5S
- 5SGraph
- 5SL
- 5SLGen
- OO Classes
- Workflow
- Components
- Implementation
- Design
- Analysis
- Formal Theory/Metamodell

- DL XML Log
- DL Evaluation
- Test
5S Suite

5S Graph

5S Gen

Mapping Tool

Requirements (1)

Analysis (2)

Design (3)

Implementation (4)

DL Expert

DL Designer

Practitioner

Teacher

Researcher

Component pool

ODL Search, ODL Browse, ODL Rate, ODL Review, ....

5S Meta Model

5S Graph

5S DL Model

5S LGen

Tailored DL Services
Data Fusion, Information Integration thru DL in Archaeology
Architecture of a Union DL

DL1
- Society
  - smiley
archaeologists
- Service
  - Searching
- Catalog1
- Repository1

Union DL
- Union Society
  - smiley
  - Archaeologists
  - smiley
  - General Public
- Union Service
  - Harvesting
  - Mapping
  - Searching
  - Browsing
  - Clustering
  - Visualization
- Union Catalog
- Repository

DL2
- Society
  - smiley
  - smiley
  - General Public
- Service
  - Browsing
- Catalog2
- Repository2
Digital library architecture for local and interoperable CITIDEL services

Computing and Information Technology Interactive Digital Educational Library
Example of Union Service: CitiViz
Multidisciplinary Connections

- Problem orientation
  - Grand challenges, problem based learning

- Theme orientation
  - Living In the KnowlEdge Society (LIKES)

- Bilateral
  - Digital government, e-commerce, ...
  - Computing + (science|humanities|arts|…)

- National curriculum for computing + others
  - Which sub-areas of computing fit best?
  - Best examples, educational resources
LIKES Goals

• Transform computing education so graduates can help build (systems, services, tools, … for) the knowledge society.

• Establish collaboration between computing educators and all other disciplines to guide the emergence of the knowledge society.
LIKES

- Promote
- Educate
- Spread
- Utilize

Computing concepts
Computing tools
Computational thinking
Collaboration among different disciplines
Multidisciplinary Connections cont’d


• Disciplinarity: functional differentiation -> distinct worldview or discourse; system of power -> nature of work in discipline

• Historical context & pedagogy: integration, new interdisciplinary fields, themes, projects, constructivism, complex issues and problems
Education and Learning

- Education, pedagogy – see Evans & Fox
- Learning resources – NSDL, Ensemble
- Student publishing – ETDs, reports
- University settings
  - Majors
  - Minors
  - Core / Liberal education / general education / interdisciplinary studies
    - Service / team teaching courses
    - Pathways – LIKES
Education and Learning cont’d

• Levels of understanding
  – Core
  – Important
  – Worthwhile

• Contextualization, analogy, transfer
  – Learn in context, with special motivation
  – Generalize, connect, analogical reasoning
  – Patterns, re-use, application of methods
Summary

• Handouts
• Broad view of computing
• KID perspective -> digital libraries
• Multidisciplinary connections
• Education and learning