Virginia Tech Perspective on Digital Libraries: From Hardware to Software to Projects to Theory

October 2000

Edward A. Fox
fox@vt.edu http://fox.cs.vt.edu
CS DLRL Internet TIC
Virginia Tech, Blacksburg, VA, USA

Acknowledgements (Selected)

- **Sponsors:** ACM, Adobe, IBM, Microsoft, NSF, OCLC, SOLINET, SURA, US Dept. of Ed. (FIPSE), …
- **VT Faculty/Staff:** Marc Abrams, Tony Atkins, Thomas Dunbar, Debra Dudley, John Eaton, Gwen Ewing, Peter Haggerty, H. Rex Hartson, Deborah Hix, Gary Hooper, Gail McMillan, Len Peters, James Powell, …
- **VT Students:** Emilio Arce, Fernando Das Neves, Brian DeVane, Robert France, Marcos Goncalves, Scott Guyer, Robert Hall, Neill Kipp, Paul Mather, Tim McGonigle, Todd Miller, Constantinos Phanouriou, William Schweiker, Ohm Sornil, Hussein Suleman, Patrick Van Metre, Laura Weiss, …

JCDL 2001

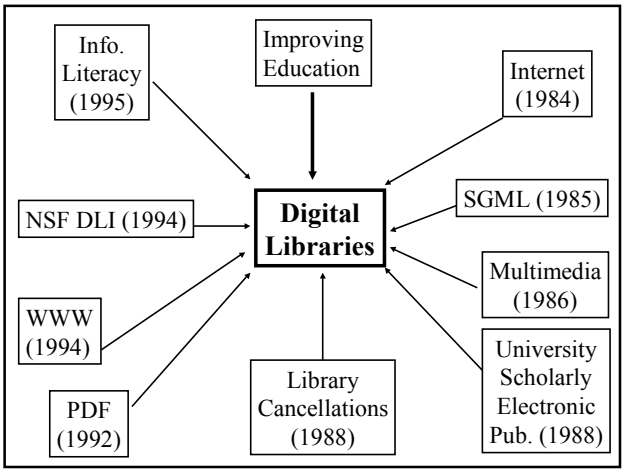
- **First Joint ACM/IEEE Conference on Digital Libraries**
- **http://www.jcdl.org**
- **June 24-28, 2001 in Roanoke, VA**
- **Conference Committee:**
- **General Chair: Edward A. Fox, Virginia Tech**
- **Program Chair: Christine Borgman, UCLA**
- **Treasurer: Neil Rowe, Naval Postgraduate School**
- **Posters: Craig Nevill-Manning, Rutgers U.**

Virginia Tech Background

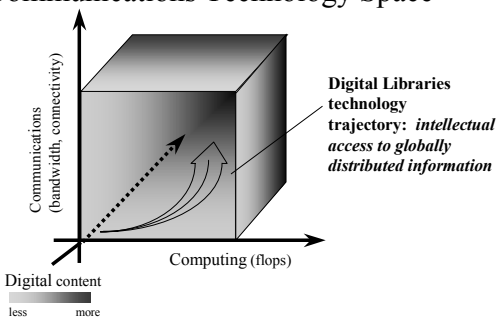
- Largest university in Virginia, land-grant, football, town population 35K plus 25K students
- Blacksburg Electronic Village, since 1992, with > 80% of community on Internet
- Net.Work.Virginia, largest ATM network, with over 750 sites, for education, research, government
- LMDS, Local Multipoint Distribution Service, gigabit wireless networking - 1/3 of Virginia
- Math Emporium, 500 workstations
- Faculty Development Initiative, round 2
- DLRL is in 2030 Torgersen Hall, $30M Advanced Communications and Information Technology Center

Digital Libraries --- Virginia Tech

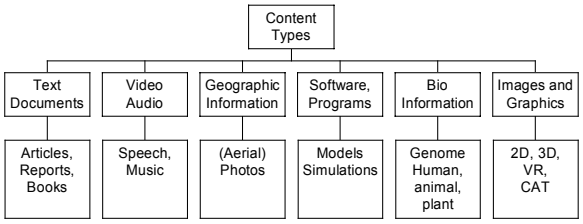
- MARIAN (NLM)
- CS DL Prototype - ENVISION (NSF, ACM)
- TULIP (Elsevier, OCLC)
- BEV History Base (NSF, Blacksburg)
- DL for CS Education - EI (NSF, ACM)
- WATERS, NCSTRL (NSF)
- NDLTD (SURA, US Dept. of Education)
- CSTC (NSF, ACM), CRIM (NSF, SIGMM)
- WCA (Log) Repository (W3C)
- VT-PetaPlex-1 (Knowledge Systems)



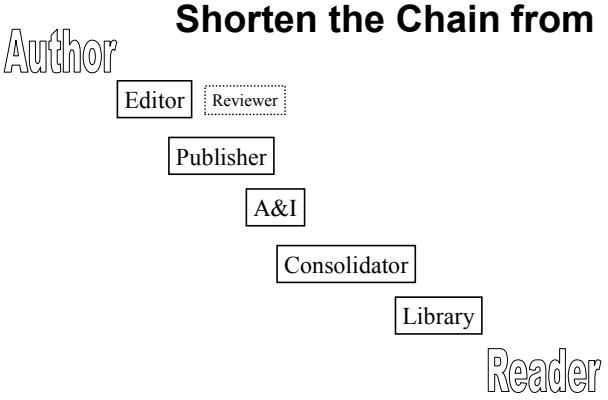
Locating Digital Libraries in Computing and Communications Technology Space



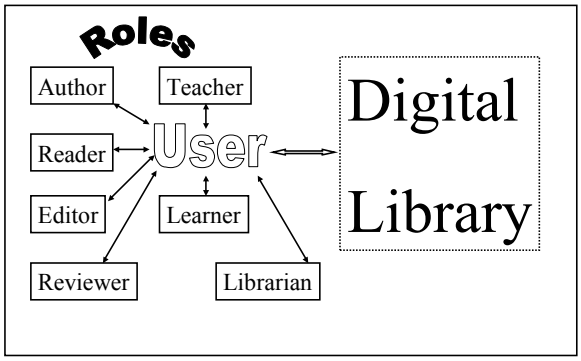
Digital Library Content



Digital Libraries Shorten the Chain from



DLs Shorten the Chain to



Digital Libraries --- Objectives

- World Lit.: 24hr / 7day / from desktop
- Integrated "super" information systems: 5S: streams, structures, spaces, scenarios, societies
- Ubiquitous, Higher Quality, Lower Cost
- Education, Knowledge Sharing, Discovery
- Disintermediation -> Collaboration
- Universities Reclaim Property
- Interactive Courseware, Student Works
- Scalable, Sustainable, Usable, Useful

Benefits

- Ease of use
- Effectiveness
- "The benefits of digital libraries will not be appreciated unless they are easy to use effectively." - IITA Workshop report

DLs: Why of Global Interest?

- **National projects** can preserve antiquities and heritage: cultural, historical, linguistic, scholarly
- Knowledge and information are essential to economic and technological **growth, education**
- DL - a **domain for international collaboration**
  - wherein all can **contribute** and **benefit**
  - which leverages investment in **networking**
  - which provides useful **content** on Internet & WWW
  - which will **tie nations and peoples together** more strongly and through **deeper understanding**

DL Challenges

- Preservation - so people with trust DLs
- Supporting infrastructure - networks, ...
- Scalability, sustainability, interoperability
- DL industry - critical mass by covering libraries, archives, museums, corporate info, govt info, personal info - "quality WWW" integrating IR, HT, MM, ...
  - Need tools & methods to make them easier to build

Digital Library Courseware

- http://ei.cs.vt.edu/~dlib/
- WWW pages or large PDF copy files
- Online quizzes based on book by Michael Lesk (Morgan Kaufmann Publishers)
- Contents based on book, with several other popular topics added (e.g., agents)
- Separate pages to supplement: Definitions, Resources (People, Projects), and References

Definitions

- Library ++ (library+archive+museum+…)
- Distributed information system + organization + effective interface
- User community + collection + services
- Digital objects, repositories, IPR management, handles, indexes, federated search, hyperbase, annotation

Definition: Digital Libraries 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)

5S Layers

Societies

Scenarios

Spaces

Structures

Streams

Document Models, Representations, and Accesses

- Doc = stream + structure + use-scenario; hybrid (paper/electronic), digital only
- Multilingual: content, summary, metadata
- Multimedia: structure, quality (oS), search
- Structured: MARC, SGML, by user: MVD
- Distributed collection: Kleisli, CIMI, Z39.50
- Federated search: collecting, picking site(s), parallel search / fall-back, fusing results
- Access: IPR, payment, security, scenarios

Architectural Issues

- Internet middleware
- Independent system / part of federation
- Decompositions vary
  - search engine, browser, DBMS, MM support
  - repository, handle server, client
  - information resources + mediators, bus or agent collection + client with workspace/environment
- Metrics: e.g., for federated search

Standards

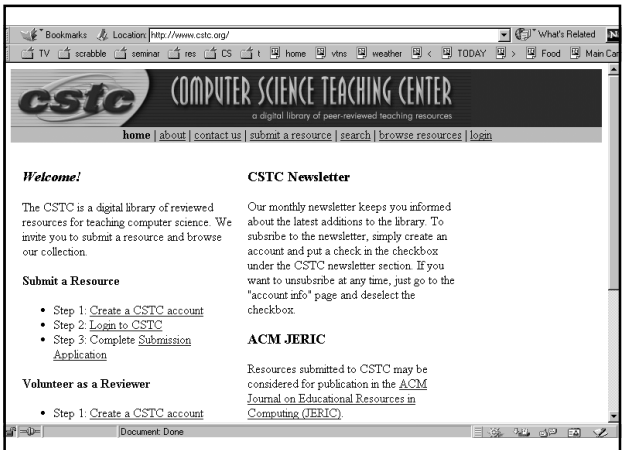
- Protocols/federation
  - Z39.50, CIMI
  - Dienst, NCSTRL
  - OAI protocol
- Metadata
  - TEI: inline, detailed (structure in stream)
  - MARC: two-level, fine-grained
  - Dublin Core: high-level, 15 elements
  - RDF: describing resources/collections, annotation

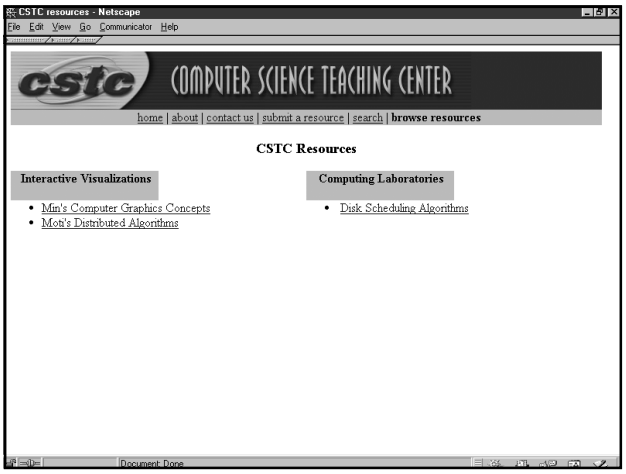
CS -> CSTC -> CRIM

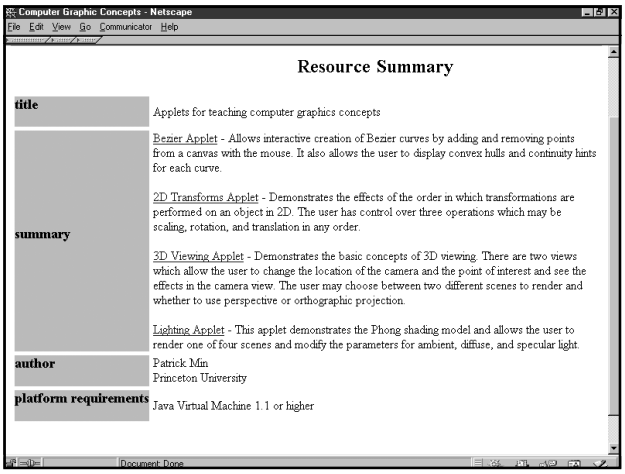
- NSF and ACM Education Committee are funding a 2 year project "A Computer Science Teaching Center" - CSTC - http://www.cstc.org/
- College of NJ, U. Ill. Springfield, Virginia Tech
- Focus initially on labs, visualization, multimedia
- Multimedia part is also supported by a 2nd grant to Virginia Tech and The George Washington University: http://www.cstc.org/~crim/ (with curricular guidelines also under development)

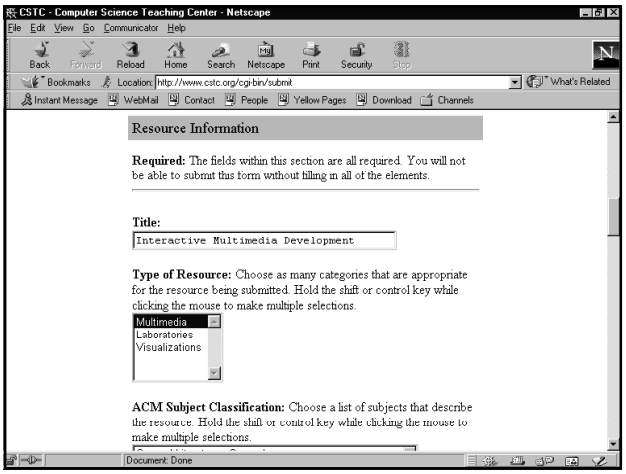
CS Teaching Center (CSTC)

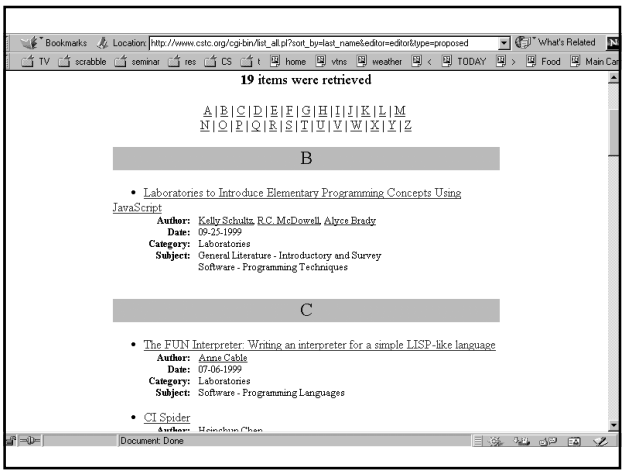
- Instead of building large, expensive multimedia packages, that become obsolete and are difficult to re-use, concentrate on **small knowledge units**.
- Learners benefit from having well-crafted modules that have been **reviewed and tested**.
- Use digital libraries to build a **powerful base** of support for learners, upon which a variety of courses, self-study tutorials & reference resources can be built. [See NSF NSDL - National Science (math, engineering, technology education) Digital Library (formerly SMETE-lib) at http://www.dlib.org/smete/public/smete-public.html]
- ACM Education Board and SIG support, new NSF grant with COLLEGIS Research Institute/Eduprise and others …

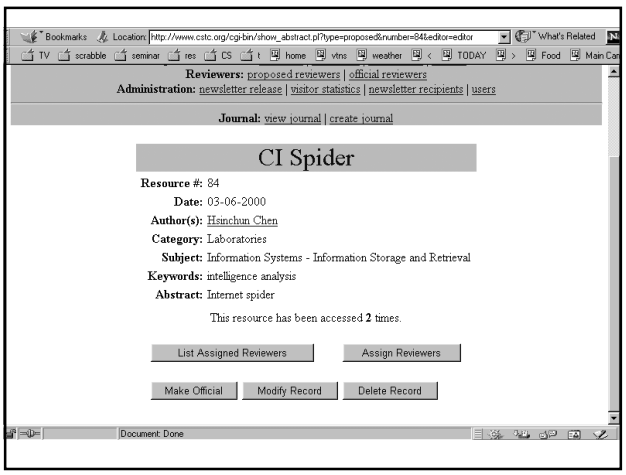












Curriculum Resources in Interactive Multimedia (CRIM)

- MM field needs properly trained personnel
- Support this with resources + curricula
- Benefits will go to teachers (who have more to build upon) and students (who will have a richer environment for learning
- CSTC, CRIM have led to ACM Journal of Educational Resources in Computing, **JERIC**
- Together these help us move forward: DL for Interactive MM -> CS -> NSDL

SMETE Library -> NSDL (from www.dlib.org to NSF DLI-2)

- Context: Global movement toward Digital Libraries (see April 1998 CACM)
- NSF effort: Science, Mathematics, Engineering, and Technology Education Digital Library (focussed on undergraduates)
  - 3 workshops, yearly increasing funds / new calls
- NSDL will operate as a distributed federation, with separate parts for each key discipline, and should lead to a global effort.

Selected NSDL Projects/Topics

COLLEGIS Res. Inst.	IMS, **CS,** Math, Viz., …
Columbia University	Earth sciences
Stanford University	Medicine (images)
U. California Berkeley	Engineering
University of Maryland	K-12 education
U. Texas at Austin	Physical anthropology

Open Archives Initiative

OAI

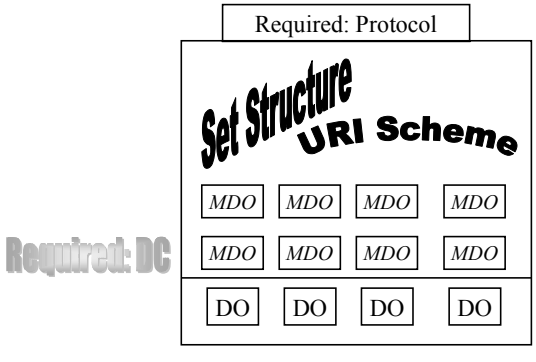
www.openarchives.org

openarchives@openarchives.org

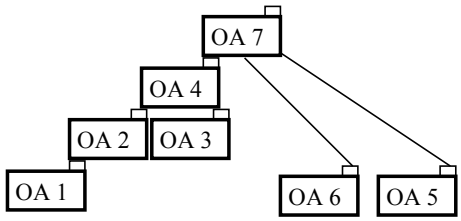
Open Archives Initiative (OAI)

- xxx@LANL, high-energy physics (Ginsparg, 1991)
- CSTR + WATERS = NCSTRL (Lagoze,1994)
- xxx + NCSTRL = CoRR collaboration (1998)
- Universal Preprint Service protoproto, Oct. 21-22, 1999, Santa Fe – led by LANL, CNI, DLF, Mellon --> OAI
- Santa Fe Convention (see Feb. D-Lib Magazine article)
- Follow-on mtgs: 6/3@San Antonio, 9/21@Lisbon (ECDL)
- Archives -> Open Archives
  - Support unique archive identifiers
  - Implement Open Archives metadata set (DC, using XML)
  - Implement OA harvesting protocol (derived from Dienst protocol)
  - Register the archive
- Build tools, layer other services: linking, searching, …

OAI – Repository Perspective



OAI – Black Box Perspective



Tiered Model of Interoperability

Mediator services

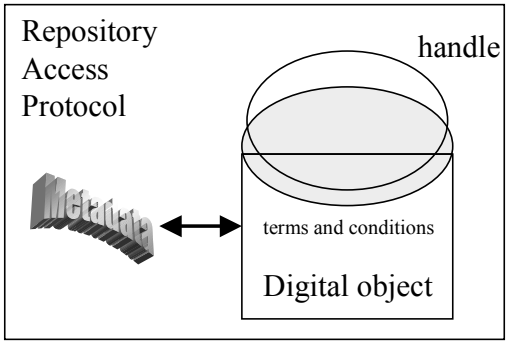
Metadata harvesting

Document models

OAI Philosophy

- Self-archiving = submission mechanism
- Long-term storage system = archive
- Open interface = harvesting mechanism
- Data provider + service provider
- Start with "gray literature"
  - e-prints/pre-prints, reports, dissertations, …

Repository of Digital Objects



Open Archives (protoproto)

- **ArXiv** & Los Alamos National Lab
- **CogPrints** & U. Southampton
- **NACA** & NASA (reports)
- **NCSTRL** & Cornell U.
- **NDLTD** & Virginia Tech
- **RePEc** & U. Surrey
- Total of around 200K records

Original Open Archives Members

- **American Physical Society**
- **California Digital Library**
- **Caltech**
- **Coalition for Networked Info.**
- **Cornell University**
- **Harvard University**
- **Library of Congress**
- **Los Alamos Nat'l Lab**
- **Mellon Foundation**
- **NASA Langley Research Cntr**
- **Old Dominion University**
- **Stanford University**
- **U. of Ghent**
- **U. of Surrey**
- **U. of Southampton**
- **Vanderbilt University**
- **Virginia Tech**
- **Washington University**

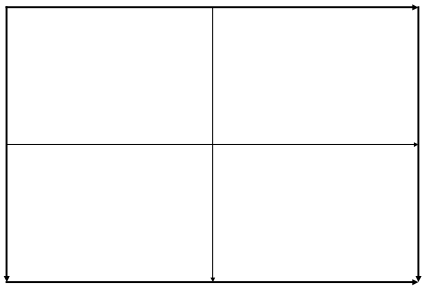
Open Archives Future

- EconWPA (U. Washington)
- e-biomed -> PubMed Central (NIH)
- PubScience (DOE)
- Clinical Medicine Netprints (+ other HighWire Press holdings)
- University ePub (California Digital Library)
- All public e-prints (MIT)
- Scholar's Forum (Caltech)
- Int'l: CERN, Germany, India, Mexico, …
- **Goal: millions of books/articles/reports / yr**

Approaches to Open Archives

Build By Institution

Build By Discipline



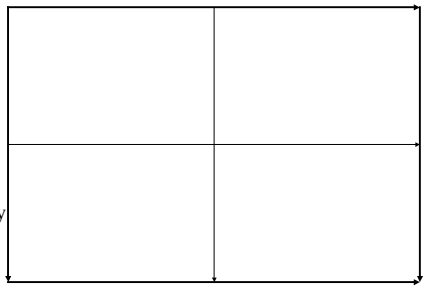
Approaches to Open Archives

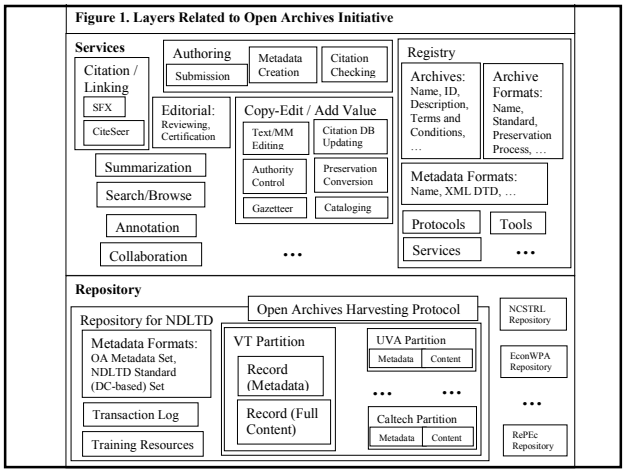
Build By Institution

Build By Discipline

Access by

Author
Category
Interdisciplinary
Year
Language
Query …





Mechanisms

- **Sharing**
  - **Join federation, run software**
  - **Make metadata and archive available**
- **Aggregating**
  - **By discipline**
  - **By institution**
  - **By genre**
- **Automating**
  - **Workflow**
  - **Harvesting and providing services**
  - **Federated searching**
  - **Dynamic linking (e.g., with SFX)**

Virginia Tech Projects

- MARC XML-DTD
- Computer Science Teaching Centre (CSTC)
- W3C Web Characterization Repository
- OAI Repository Explorer
- Networked Digital Library of Theses and Dissertations (NDLTD)

MARC XML-DTD

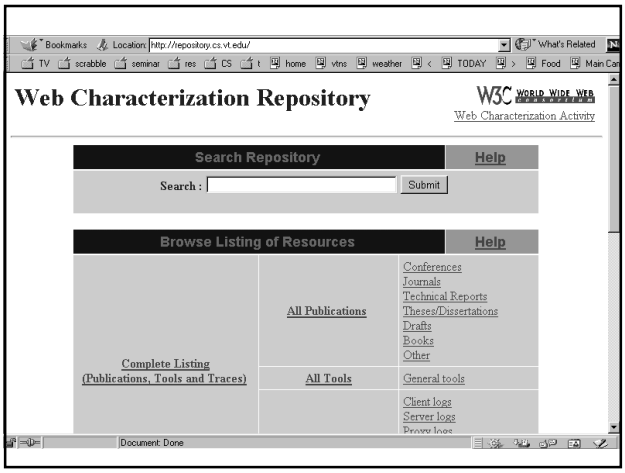
- XML Transport format for US-MARC records
- Standardized metadata exchange format for traditional library services joining OAI

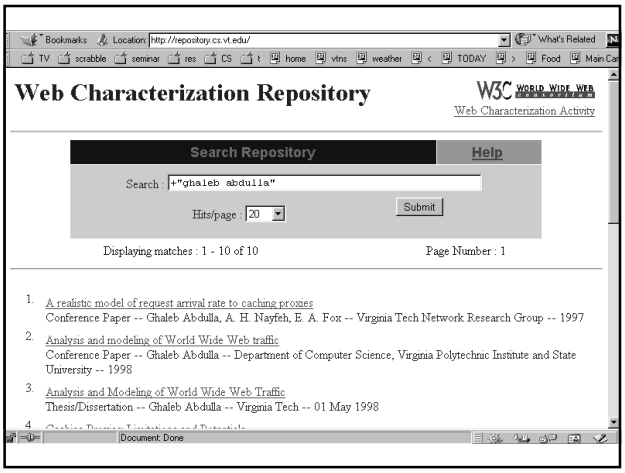
CS Teaching Center (CSTC)

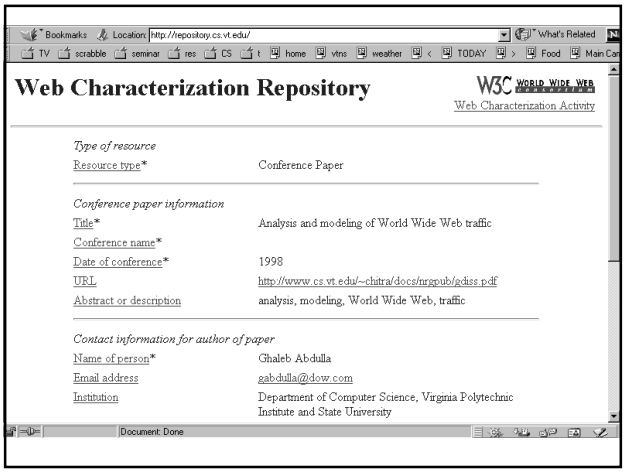
- Collection of reviewed online resources used to aid in teaching of Computer Science
- Supports author submission and peer-review process for new ACM Journal of Educational Resources In Computing (JERIC)
- Connected with NSDL (NSF 00-44)
- http://www.cstc.org

W3C Web Characterization Repository

- Online database of metadata related to publications, tools and data sets dealing with Web characterization
- Project of the Web Characterization Activity working group of the World-Wide-Web Consortium (www.w3c.org/WCA)
- http://purl.org/net/repository

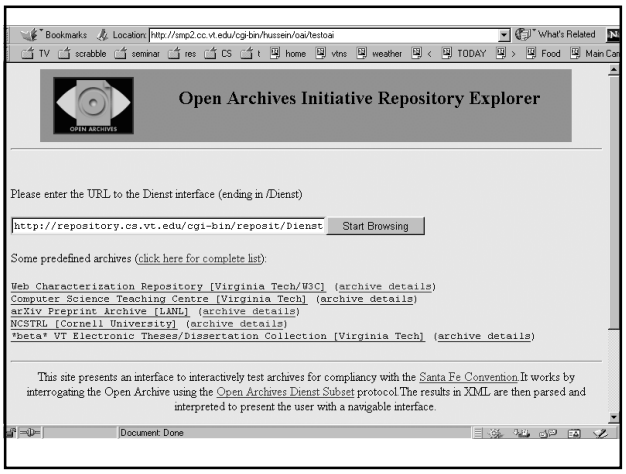


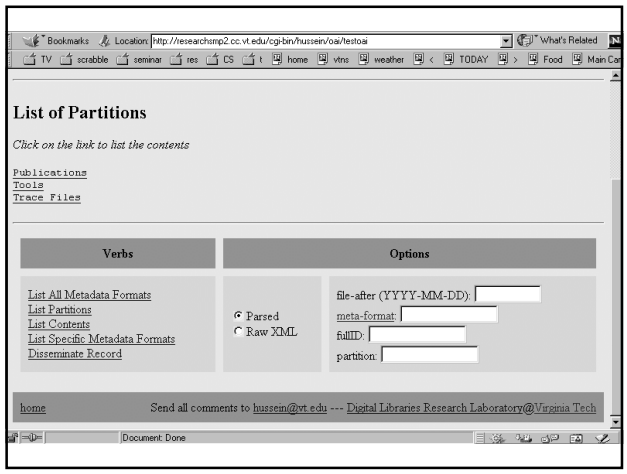


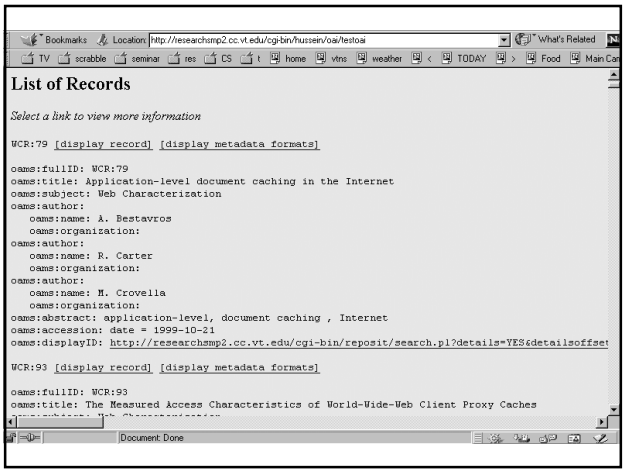


OAI Repository Explorer

- Serves as a compliancy test
- Allows browsing of open archives using only OAI protocol
- Sends requests on behalf of user, parses and checks responses and displays browsable interface
- Will detect most discrepancies in protocol
- http://purl.org/net/explorer







A Digital Library Case Study

- Domain: graduate education, research
- Genre:ETDs=electronic theses & dissertations
- Submission: http://etd.vt.edu
- Collection: http://www.theses.org

Project:

Networked Digital Library of Theses & Dissertations (NDLTD)

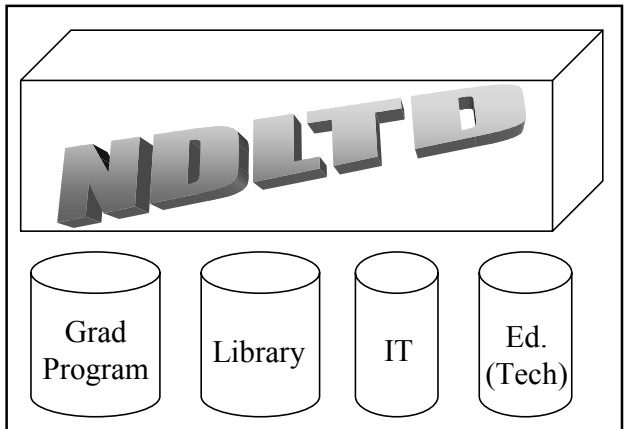
http://www.ndltd.org

The Networked Digital Library of Theses and Dissertations

www.NDLTD.org

Training Authors
Expanding Access
Preserving Knowledge
Improving Graduate Education
Enhancing Scholarly Communication
Empowering Students & Universities

Leader of the Worldwide ETD (Electronic Thesis and Dissertation) Initiative

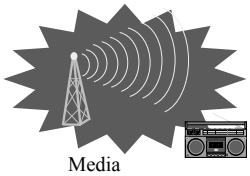


ETDs Got Your Interest?

ETD Web Site
http://www.ndltd.org/

Graduate Students

U. Laval



Media

Singapore AM
Chronicle of Higher Ed.
National Public Radio
NY Times ...

Key Ideas:

Scalability
- Networked infrastructure
- University collaboration
- Workflow, automation

Maximal Access
- Education is the rationale
  - 8th graders vs. grads
  - Authors must submit
- Standards
  - PDF, SGML, MM, MARC, DC, URNs, Federated search

What led to today's meeting?

- 1987 mtg in Ann Arbor: UMI, VT, …
- 1992 mtg in Washington: CNI, CGS, UMI, VT and 10 universities with 3 reps each
- 1993 mtg in Atlanta to start Monticello Electronic Library (MEL): SURA, SOLINET
- 1994 mtg in Blacksburg re ETD project: std of PDF + SGML + multimedia objects
- 1996 funding by SURA, US Dept. of Education (FIPSE) for regional, national projects
- 1997 meetings in UK, Germany, ...
- 1998 – 1st symposium – Memphis (20)
- 1999 – 2nd symposium – Blacksburg (70)
- 2000 – 3rd symposium – St. Petersburg (225) -> Caltech

What are the long term goals?

- 400K US students / year getting grad degrees are exposed / involved
- 200K/yr rich hypermedia ETDs that may turn into electronic portfolios (images, video, audio, …)
- Dramatic increase in knowledge sharing: literature reviews, bibliographies, …
- Services providing lifelong access for students: browse, search, prior searches, citation links
- Hundreds/thousands of downloads / year / work

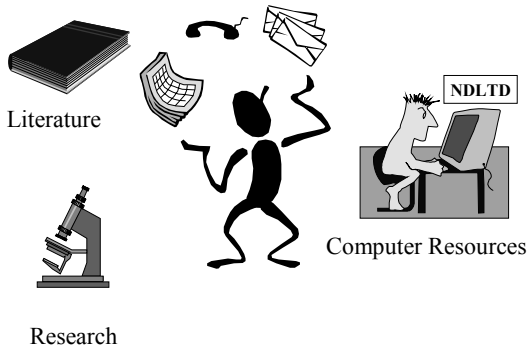
ETDs: Library Goals

- Improve library services
  - Better turn-around time
  - Always available
- Reduce work
  - catalog from e-text
  - eliminate handling: mailing to UMI, bindery prep, check-out, check-in, reshelving, etc.
- Save space

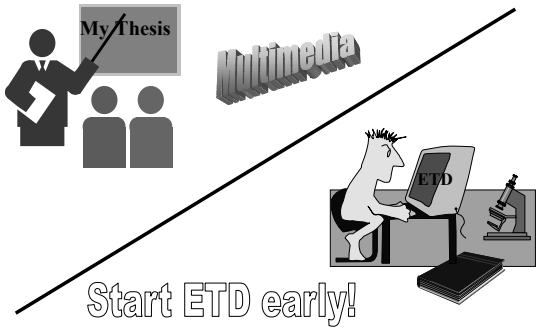
What are we doing?

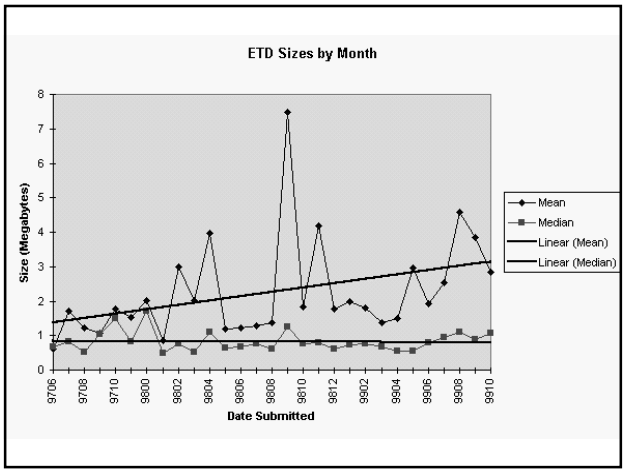
- Aiding universities to enhance graduate education, publishing and IPR efforts
- Helping improve the availability and content of theses and dissertations
- Educating ALL future scholars so they can publish electronically and effectively use digital libraries (i.e., are Information Literate and can be more expressive)

Student Prepares Thesis/Dissertation

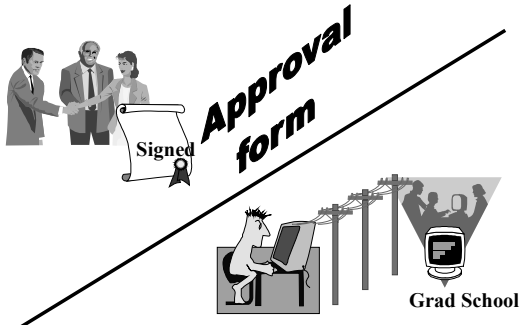


Student Defends & Finalizes ETD

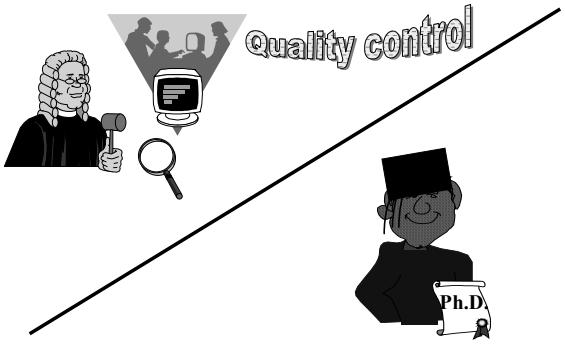




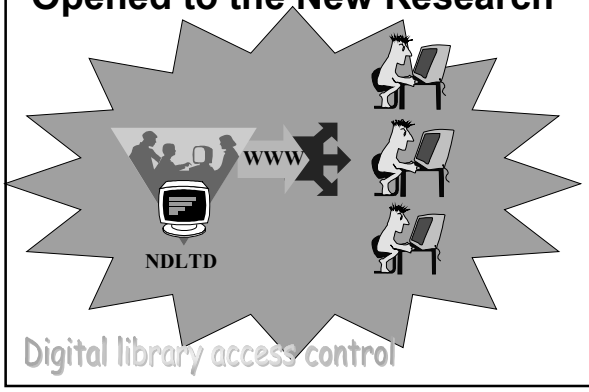
Student Gets Committee Signatures and Submits ETD



Graduate School Approves ETD, Student is Graduated



Library Catalogs ETD, Access is Opened to the New Research



Status of the Local Project

- Approved by university governance Spring 1996; required starting 1/1/97
- Submission & access software in place
- Submission workshops for students (and faculty) occur often: beginner/adv.
- Faculty training as part of Faculty Development Initiative
- Over 2500 ETDs in collection – some have audio, video, large images, software, …

Archiving ETDs

- Every 15 minutes back-ups made of not-yet-approved submissions
- Hourly back-ups of newly approved ETDs
- Weekly back-ups of entire ETD collection
- Copies stored on-site and off-site

VT ETD Cataloging

- same as current cataloging policies, except:
  - author-assigned keywords (not LCSH)
  - generic (not LC) call no.
  - fields/subfields as required for computer files
  - full abstracts
- time savings
  - cataloger familiar with computer files
  - equipment, software for word processing
  - 5 minutes avg. (10-15 minutes for paper TDs)

Library Costs

- $12/vol. for paper thesis processing
  - catalog, bind, security strip, label, shelve
  - @950 vols./yr. = $11,466
- $3.20/vol. ETD processing
  - cataloging @950 vols./yr. = $3040
- $.07/vol. shelving
- $.04/vol. circulation

Costs/Savings at VT

- Graduate School stopped shipping to the library 3000 copies of paper TDs/year
- Library stopped binding, shelving, and circulating 3000 copies of TDs/year
- 166 ft of shelf space saved/year by the library
- VT used existing equipment in Library (vs. start-up costs for staff, hardware and software from from a zero-base estimate: $65,000 – see http://scholar.lib.vt.edu/theses/)

Institutional Members

- **Coalition for Networked Information (CNI)**
- **Committee on Institutional Cooperation (CIC)**
- **Diplomica.com**
- **Dissertation.com**
- **Dissertationen Online (Germany)**
- **ETDweb, a Division of Answer4.com**
- **Ibero-American Science & Technology Education Consortium (ISTEC)**
- **National Documentation Centre (NDC), Greece**
- **National Library of Portugal (for all universities)**
- **OCLC Online Computer Library Center**
- **Organization of American States (SEDI/OAS)**
- **Southeastern Library Network (SOLINET)**
- **UNESCO (www.unesco.org/webworld/etd)**

National / Regional Projects

- **Australia**
  - U. New South Wales (lead)
  - U. of Melbourne
  - U. of Queensland
  - U. of Sydney
  - Australian National U.
  - Curtin U. of Technology
  - Griffith U.
- **Germany**
  - Humboldt University (lead)
  - 3 other universities
  - 5 learned societies: Math, Physics, Chemistry, Sociology, Education
  - 1 computing center
  - 2 major libraries
- OhioLINK: 79 colleges/univs
- Consorci de Biblioteques Universitàries de **Catalunya**, as group, www.cbuc.es:
  - Universitat de Barcelona
  - Universitat Autonòma de Barcelona
  - Universitat Politècnica de Catalunya
  - Universitat Pompeu Fabra
  - Universitat de Girona
  - Universitat de Lleida
  - Universitat Rovira i Virgili
  - Universitat Oberta de Catalunya
  - Biblioteca de Catalunya

OhioLINK

- Statewide Consortium
- Represents 79 colleges, universities, libraries
- Public Universities
- Private Universities and Colleges
- 2-Year Colleges
- Only a few (e.g., Miami U. of Ohio) are also NDLTD members on their own

US University Members (44)

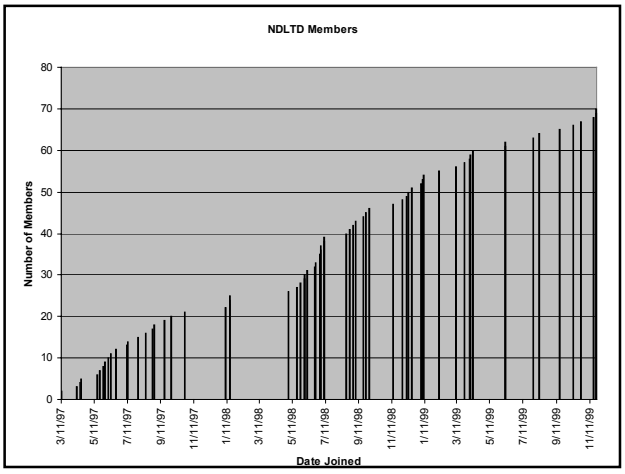
- **Air University (Alabama)**
- **Baylor University**
- **Brigham Young University (part, whole)**
- **Caltech**
- **Clemson University**
- **College of William & Mary**
- **Concordia University (Illinois)**
- **East Carolina University**
- **East Tenn. State U. – require fall 2000**
- **Florida Institute of Technology**
- **Florida International University**
- **George Washington University**
- **Louisiana State University**
- **Marshall University (W. Va.)**
- **Miami University of Ohio**
- **Michigan Tech**
- **Mississippi State University**
- **MIT**
- **Naval Postgraduate School (CA)**
- **New Mexico Tech**
- **North Carolina State University**
- **Penn. State University**
- **Rochester Institute of Tech.**
- **U. of Colorado Health Science Center**
- **U. of Florida**
- **U. of Georgia**
- **University of Hawaii, Manoa**
- **U. of Iowa**
- **U. of Kentucky**
- **U. of Maine**
- **U. of North Texas – required since 8/99**
- **U. of Oklahoma**
- **U. of South Florida**
- **U. of Tennessee, Knoxville**
- **U. of Tennessee, Memphis**
- **U. of Texas at Austin – required in 2001**
- **U. of Virginia**
- **U. Wisconsin - Madison**
- **Vanderbilt U.**
- **Virginia Commonwealth U.**
- **Virginia Tech - required since 1/97**
- **West Virginia U. - required fall 1998**
- **Western Michigan U.**
- **Worcester Polytechnic Inst.**

Other Countries with Members

- Belgium
- Brazil
- Canada
- Germany
- Hong Kong
- India
- Italy
- Korea
- Mexico
- Netherland
- Norway
- Russia
- Singapore
- **S. Africa**
- S. Korea
- Spain
- Taiwan
- UK

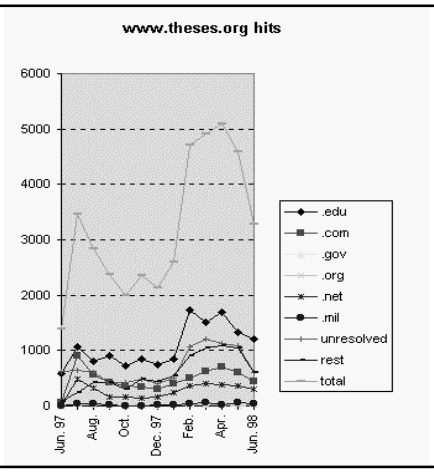
For professional societies

- Like "writing across the curriculum", e.g., Chemical Markup Language, MathML, …
- Besides writing: computing/communications, information literacy, personal digital library management, tool use, research methods, collaboration, archiving/preservation
- Data sets, communities of users of them
- Classification systems / browsing / searching
- NRC's "On becoming a researcher"



Usage of ETDs in VT Collections

	1996	1997	1998	1999 Jan-Aug
Total requests	37,171	247,537	465,974	907,104
Daily Requests	102	685	1,722	3,121
Abstract requests	25,829	112,633	177,647	143,056
Hosts served	9,015	22,725	28,022	52,663



Popular Works 1996

458 Seevers, Gary L. Identification of Criteria for Delivery of Theological Education Through Distance Education: An International Delphi Study (Ph.D., Educational Research and Evaluation, April 1993; 1353Kb)

432 Hohauser, Robyn Lisa. The Social Construction of Technology: The Case of LSD (MS in Science and Technology Studies, Feb. 1995; 244Kb)

390 Childress, Vincent William. The Effects of Technology Education, Science, and Mathematics Integration Upon Eighth Grader's Technological Problem-Solving Ability (Ph.D. in Vocational and Technical Education, July 1994; 285Kb)

310 Kuhn, William B. Design of Integrated, Low Power, Radio Receivers in BiCMOS Technologies (Ph.D. in Electrical Engineering, Dec. 1995; 2Mb)

287 Sprague, Milo D. A High Performance DSP Based System Architecture for Motor Drive Control (MS in Electrical Engineering, May 1993; 878Kb)

165 Wallace, Richard A. Regional Differences in the Treatment of Karl Marx by the Founders of American Academic Sociology (MS in Sociology, Nov. 1993; 479Kb)

150 McKeel, Scott Andrew. Numerical Simulation of the Transition Region in Hypersonic Flow (Ph.D. in Aerospace Engineering, Feb. 1996; 3Mb)

Popular Works 1997

9920 Liu, Xiangdong. *Analysis and Reduction of Moire Patterns in Scanned Halftone Pictures* (Ph.D. in Computer Science, May 1996; 6.6Mb)

7656 Petrus, Paul. *Novel Adaptive Array Algorithms and Their Impact on Cellular System Capacity* (Ph.D. in Electrical Engineering, March 1997; 5Mb)

2781 Agnes, Gregory Stephen. *Performance of Nonlinear Mechanical, Resonant-Shunted Piezoelectric, and Electronic Vibration Absorbers for Multi-Degree-of-Freedom Structures* (Ph.D. in Engineering Mechanics, Sept. 1997; ? + 7926Kb)

2492 Gonzalez, Reinaldo J. *Raman, Infrared, X-ray, and EELS Studies of Nanophase Titania* (Ph.D. in Physics, July 1996; 4607Kb)

1877 Shih, Po-Jen. *On-Line Consolidation of Thermoplastic Composites* (Ph.D. in Engineering Mechanics, Feb. 1997; 3.3Mb)

1791 Saldanha, Kevin J. *Performance Evaluation of DECT in Different Radio Environments* (MS in Electrical Engineering, Aug. 1996; 3.2Mb)

1431 DeVaux, David. *A Tutorial on Authorware* (MS in CS, April 1996; 2.3Mb)

1394 Kuhn, William B. *Design of Integrated, Low Power, Radio Receivers in BiCMOS Technologies* (Ph.D. in Electrical Engineering, Dec. 1995; 2518Kb)

International Use

1996	**1997**	**1998**
850	2992	8170 United Kingdom
608	2,501	4223 Australia
346	2378	7373 Germany
713	2367	3970 Canada
387	1264	2201 South Korea
463	1161	4431 France
250	725	2553 Italy
191	867	2781 Netherlands
183	1130	1449 Brazil
22	967	1089 Thailand
83	958	1414 Greece

Who are sponsors / cooperators?

- **Funding, Donations of hardware/software**
  - **SURA**
  - **US Dept. of Education (FIPSE)**
  - **Adobe Systems**
  - **IBM**
  - **Microsoft**
  - **OCLC**
- **Others Serving on Steering Committee**
  - **National/Regional Projects: Australia, French speaking group, Germany, IberoAmerica (ISTEC), UK (UTOG)**
  - **CGS, National Lib. Canada, NSF, OAS, SOLINET, UMI, UNESCO, ...**

Relationship with publishers

- **Concern** of faculty and students that still wish to publish books or journal articles, voiced: campus, Chronicle, NPR, Times
- **Solution**: Approval Form gives students, faculty choices on access, when to change access condition; use IPR controls in DL
- **Solution**: by case, work with publishers and publisher associations to increase access
  - **AAP, AAUP**
  - **AAAS, ACM, ACS, Elsevier, ...**

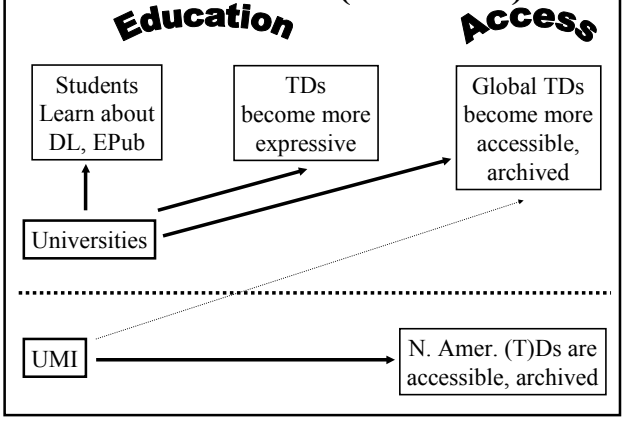
Some responses from publishers

- **ACM**: need to acknowledge copyright
- **Elsevier**: need to acknowledge copyright
- **IEEE-CS**: endorse initiative
- **ACS**: After first publication, can release
- **Textbook publishers**: different market, manuscript significantly reworked
- **General**: restricting access to local campus will not cause any problems

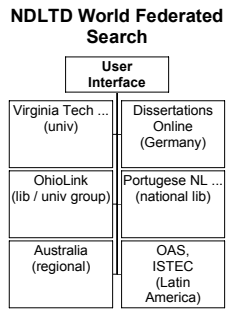
How does this relate to UMI?

- **Generally, they are independent decisions.**
- 1987 UMI workshop was first to explore ETDs.
- UMI wrote support letter for US Dept. of Ed. proposal.
- UMI is on Steering Committee.
- ProQuest Direct pilot of scanning works started 1/1/97, with free 2 yr access to front part.
- We are collaborating on:
  - **accepting electronic author submissions**
  - **standards (e.g., representation)**

ETD Initiative (and UMI)



User Search Support
(multilingual, XML)



Note: All groups shown are connected with NDLTD.

www.theses.org

- James Powell student project, D-Lib Magazine description in Sept. 1998
- XML description of each site
  - type of search engine / service
  - language
  - coverage (for resource discovery)
- Adding Z39.50 gateway capability and integrating with MARIAN, along with Harvest and Open Archives protocols

Access Approaches

- Goal: Maximize access and services, e.g., by encouraging:
- UMI centralized services
- VTLS: planned free union collection of metadata
- Distributed service: Dienst, Z39.50
- Regional services (e.g., OhioLink, AZ/NM)
- Local servers with browse, search
  - From local catalogs to local archives
- WWW robot indexing and search services

Access Possibilities



Web search engines	www.theses.org	www.openarchives.org	library catalog clients	3rd Party Services (e.g., UMI)

Virginia Tech	MIT	National Library of Portugal	CBUC (Spain)	Ohio Link	National Projects: AU, GE, …

Why might a university want to be involved?

- To improve graduate education / better prepare your students / increase their knowledge and visibility
- To unlock university information
- To save money for students and for the university / improve workflow
- To build an important digital library

DL Submission Software

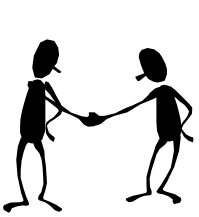
- **Similar software developed for W3C's WCA, CSTC, and NDLTD**
- **CSTC version field-tested to manage papers for ACM Digital Libraries '99**
- **May generalize for**
  - **conferences**
  - **electronic journal**
  - **resource description (e.g., courses, Web content)**

How can a university get involved?

- Select planning/implementation team
  - **Graduate School**
  - **Library**
  - **Computing / Information Technology**
  - **Institutional Research / Educ. Tech.**
- Send us letter, give us contact names
  - **www.ndltd.org/join**
- Adapt Virginia Tech solution
  - **Build interest and consensus**
  - **Start trial / allow optional submission**

Contact Our Project Team


E-mail
etd@ndltd.org

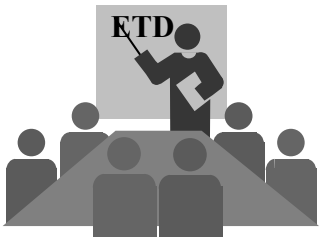



Video Tape


Phone Call


Visit

Convene Local Planning Group



Build Local ETD Site

Workshop/Training

Policies

Digital Library

Inspection/Approval

Support Services Developed

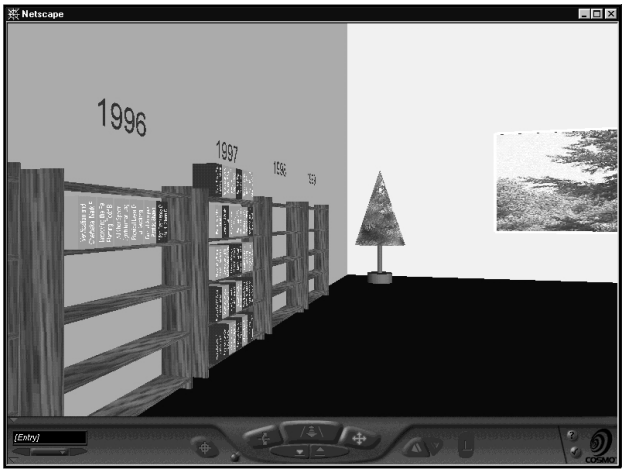
- WWW site with > 300 Mb, CD, videotape
- Automated submission system (MySQL, UNIX, WWW scripts - grad school/library)
- Student guidelines, style sheets, multimedia training materials, FAQs, press info
- SGML and XML DTDs for ETDs
- SGML to HTML (web generator)
- LaTeX, Word templates, converters
- FTP site for PS to PDF conversion with UNIX distiller

Accessibility Activities / Plans

- **Interface design (simple, 3D, VR)**
- **Usability studies**
- **Generic multi-lingual support**
- **Support for those with disabilities**
- **Hybrid collection (paper, MARC, abstracts, full-text, multimedia)**
- **Disciplinary classifications, tools**
- **Visualization of results, collection**

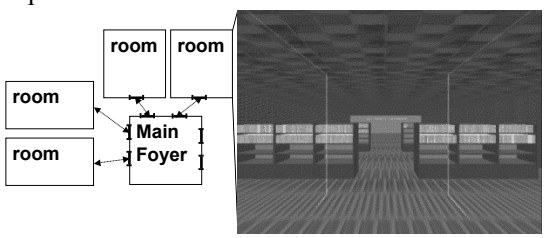
CAVE Experiments

- **Use a familiar metaphor**
  - **building / floor / room / shelf / book**
- **Rearrange orderings / shelving**
  - **use categories, clustering, ranking**
  - **use visualization: colors and gaps**
  - **study space mappings: physical, logical**
- **Simplify movement for key tasks**

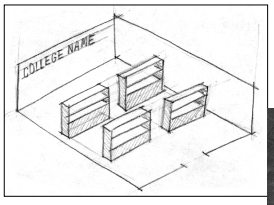


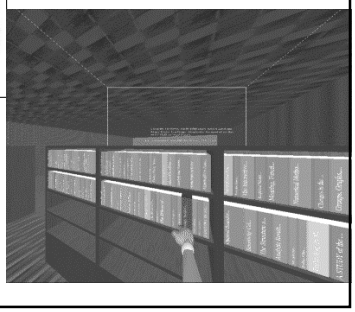
CAVE-ETD

- CAVE-ETD is a simulation of a library that runs in a CAVE (VR environment).
- Populated with a subset of ETD records.

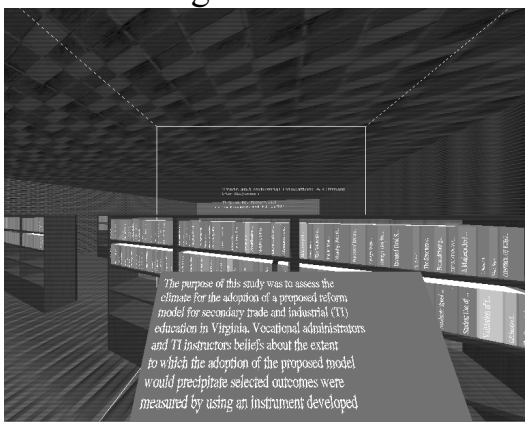


Book Browsing





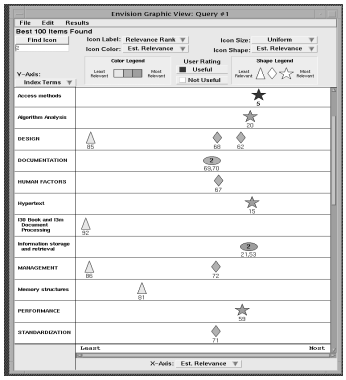
Reading Book Abstract



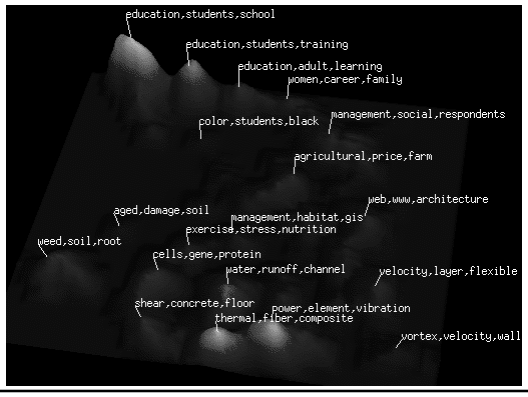
ENVISION

- NSF "A User-Centered Database from the Computer Science Literature" (1991-93)
- Collected bib/typesetter data, converted to SGML
- Scanned thousands of page images
- MARIAN search engine - can be made available (also applied to the Virginia Tech library catalog) used as part of a prototype object-based DL, with tailored visualization interface (L. Nowell dissertation)

Envision Results Window



SPIRE Visualization



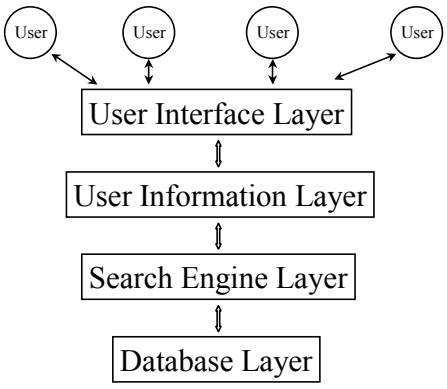
Support Offered

- Software, documentation, tech support
- Email, listservs (etd-l@listserv.vt.edu, -eval, -grad, -library, -technical)
- Donations: Adobe, Microsoft
- Evaluation: instruments, analysis http://scholar.lib.vt.edu - solutions/statistics
- (Temporary storage / archiving; aid - in setting up an int'l service & archive)

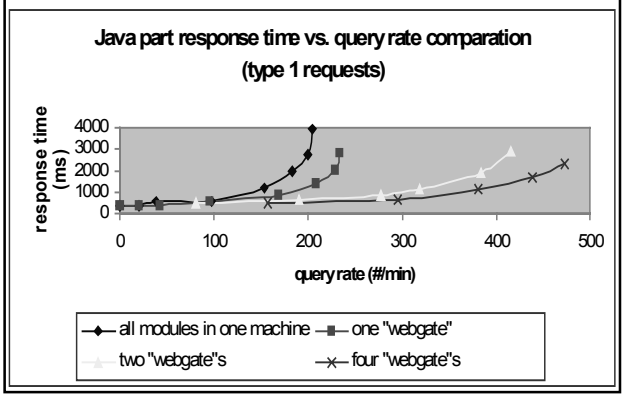
MARIAN

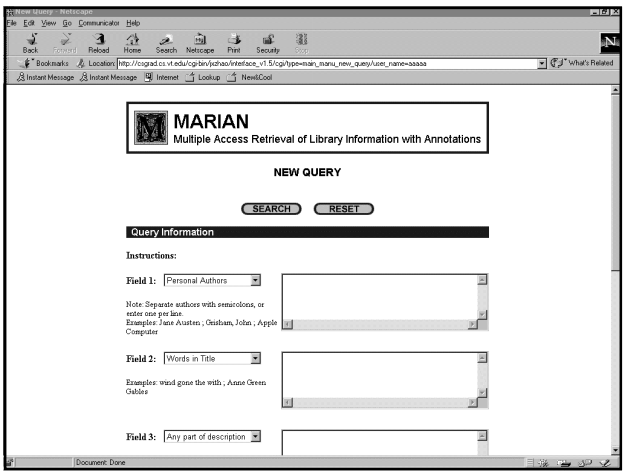
- **Multiple Access Retrieval of Information with Annotations**
- **(Marian the Librarian …)**
- **Evolved from CODER system to a distributed Online Public Access Catalog (OPAC), then DL backend, now becoming a full DL system**
- **From C/C++ to Java**
- **Future: NDLTD, NUDL, PetaPlex**
- **Use for campus collection management**
- **Use for www.theses.org as centralized system with gateway services: OAI, Harvest, Z39.50, …**

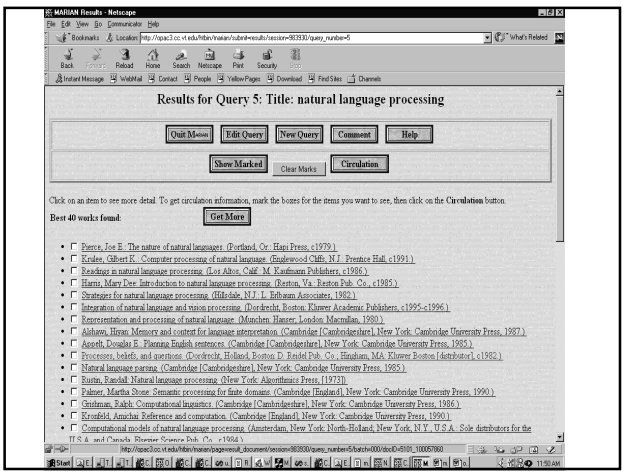
MARIAN Layers

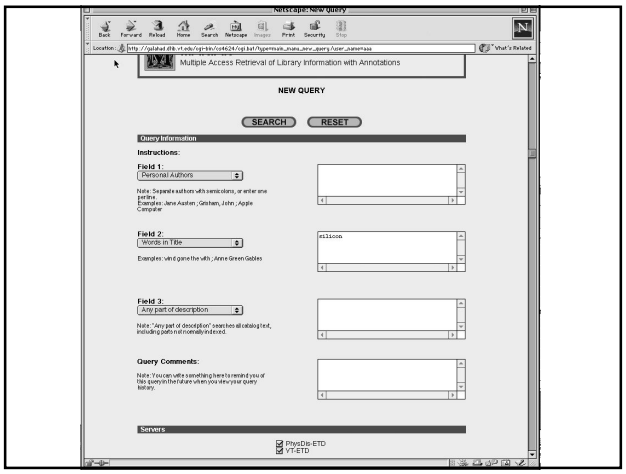


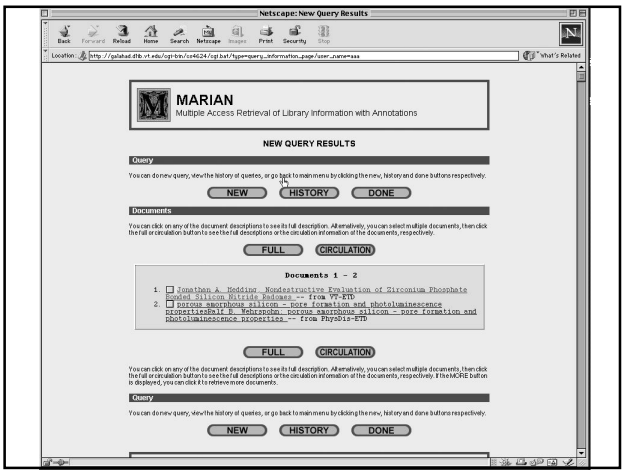
MARIAN Parallelism

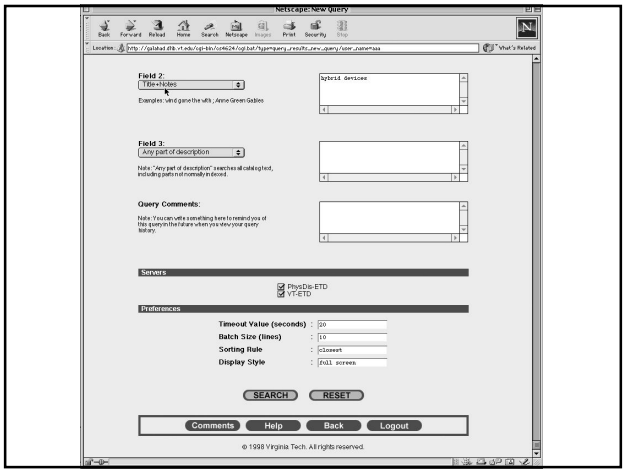


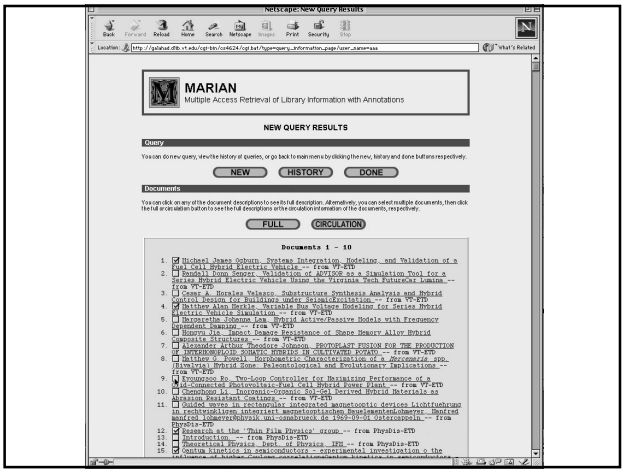


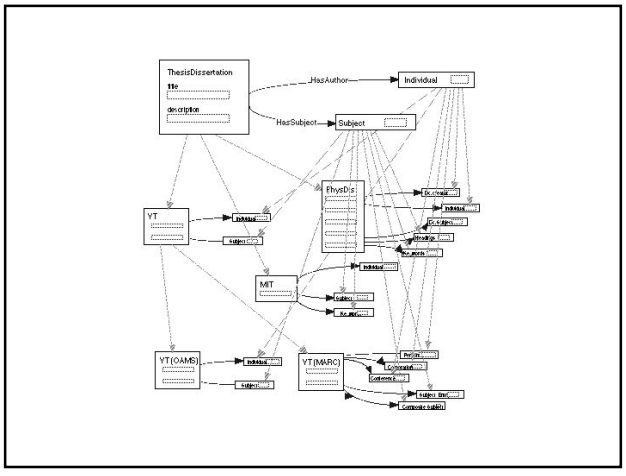


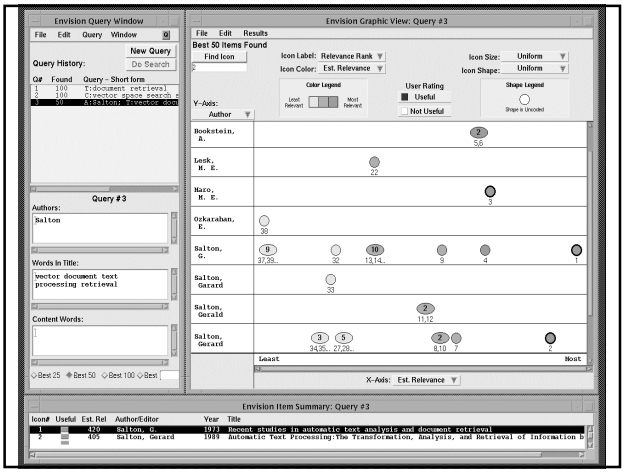

Netscape: New Query
Multiple Access Retrieval of Library Information with Annotations
NEW QUERY
SEARCH
RESET
Query Information
Instructions:
Field 1:
Personal Authors
Field 2:
Words in Title
silicon
Field 3:
Any part of description
Query Comments:
Servers
PhysDis-ETD
VT-ETD

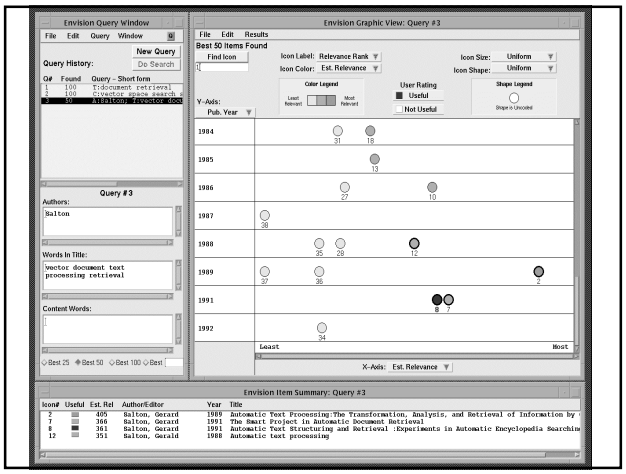

Netscape: New Query Results
MARIAN
Multiple Access Retrieval of Library Information with Annotations
NEW QUERY RESULTS
Query
NEW
HISTORY
DONE
Documents
FULL
CIRCULATION
Documents 1 - 2
Query

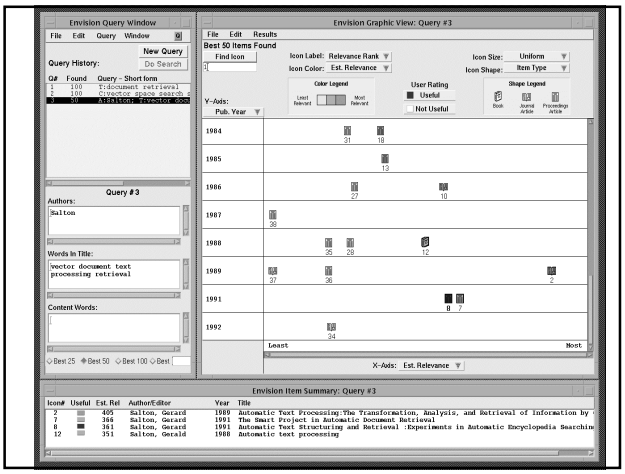

Netscape: New Query
Field 2:
Title+Notes
hybrid devices
Field 3:
Any part of description
Query Comments:
Servers
PhysDis-ETD
VT-ETD
Preferences
Timeout Value (seconds) : 30
Batch Size (lines) : 10
Sorting Rule : closest
Display Style : full screen
SEARCH
RESET
Comments
Help
Back
Logout
© 1998 Virginia Tech. All rights reserved.

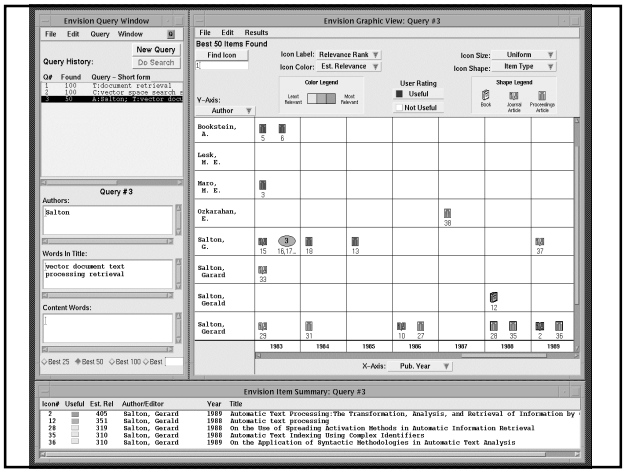

Netscape: New Query Results
MARIAN
Multiple Access Retrieval of Library Information with Annotations
NEW QUERY RESULTS
Query
NEW
HISTORY
DONE
Documents
FULL
CIRCULATION
Documents 1 - 10

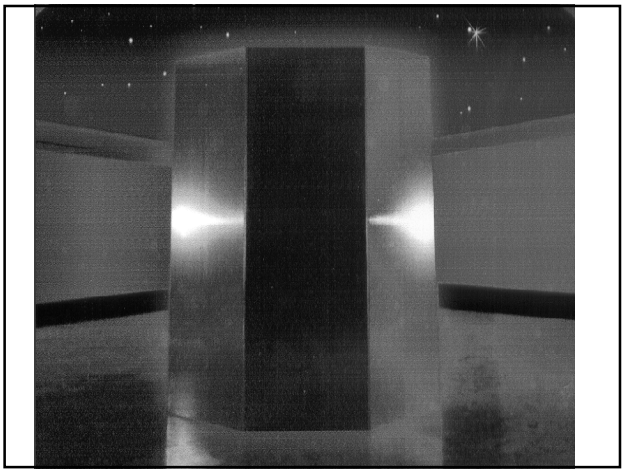

ThesisDissertation
title
description
HasAuthor
Individual
HasSubject
Subject
PhysDis
VT
MIT
VT(OAMS)
VT(MARC)


Envision Query Window
File Edit Query Window
New Query
Query History:
Do Search
Query #3
Authors:
Salton
Words In Title:
vector document text processing retrieval
Content Words:
Envision Graphic View: Query #3
File Edit Results
Best 50 Items Found
Find Icon
Icon Label: Relevance Rank
Icon Color: Est. Relevance
Icon Size: Uniform
Icon Shape: Uniform
Color Legend
User Rating
Useful
Not Useful
Shape Legend
Y-Axis:
Author
Bookstein, A.
Lesk, M. E.
Maro, M. E.
Ozkarahan, E.
Salton, G.
Salton, Gerard
Salton, Gerald
Salton, Gerard
Least
Most
X-Axis: Est. Relevance
Envision Item Summary: Query #3
Icon# Useful Est. Rel Author/Editor Year Title
4 70 Salton, G. 1973 Recent studies in automatic text analysis and document retrieval
5 405 Salton, Gerard 1989 Automatic Text Processing:The Transformation, Analysis, and Retrieval of Information b

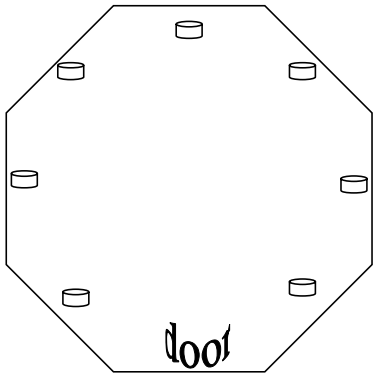








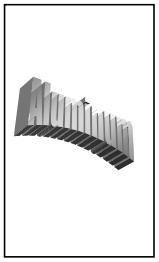
PetaPlex Top View



4 ft. side

PetaPlex Side View

Roles:
* Support
* Cooling
* Power



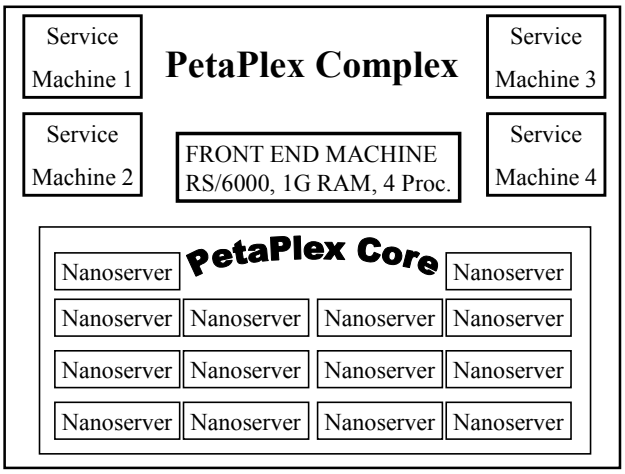
15 shelves

8 ft. high

4 ft. wide

PetaPlex

- Digital Library Machine ("super" object store): Parallel computer / storage utility
- Research: inverted files, video server, …
- Knowledge Systems Incorporated is supplying VT-PetaPlex-1 with 2.5 terabytes through 100 nodes:
  - Net connection + 25GB disk + 233 MHz Pentium + Linux



Comparison

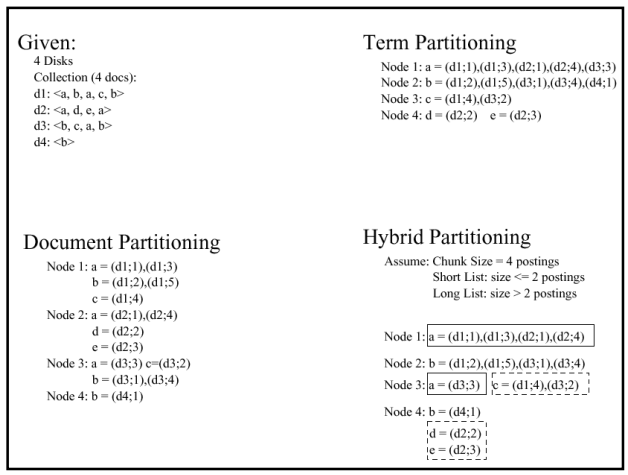
	Network of Workstations (NOW)	Beowulf	PetaPlex
Archi-tecture	Cluster of general purpose workstation class machines using off-the-shelf network interconnect	General purpose PCs, interconnected with a custo-mized network	Special purpose architecture tuned for superstorage. Uses a mix of off-the-shelf PC compo-nents and specialized network interconnects.
Cost per node	Workstation prices. Between $2000-$2500/node	Mid to low-end PC prices. Between $1200-$1800 per node	Mass produced components will reduce price to around $100/node
Target area	Computation	Computation	Storage, computation is a secondary function
Filesystem support	UNIX flavors	UNIX flavors	Replaces location dependant files with location independent fine-grained URN named objects

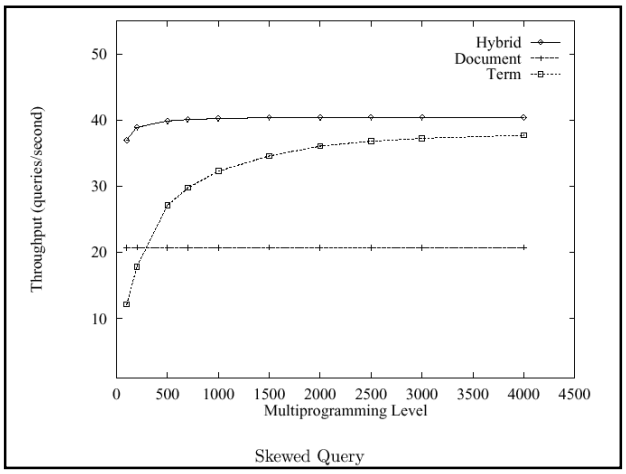
PetaPlex Service Machine Possibilities

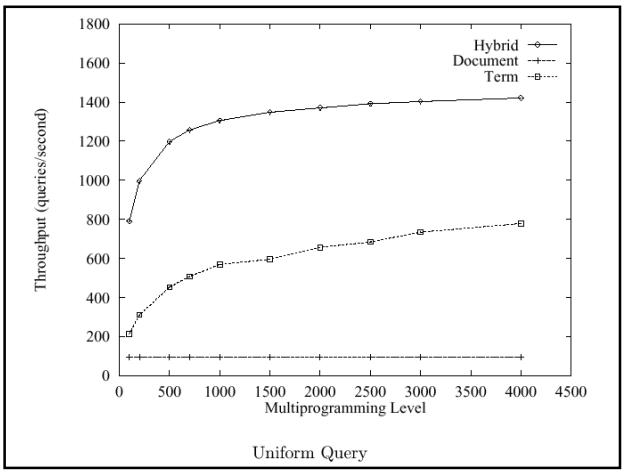
- Front-end provides handle/repository abstraction through hashing
- Small object server
- Large object server
  - video on demand
  - streaming audio
- Information retrieval server
- Proxy / cache server (e.g., 1 terabyte server of 1000 worldwide for Comsat/Intelsat)

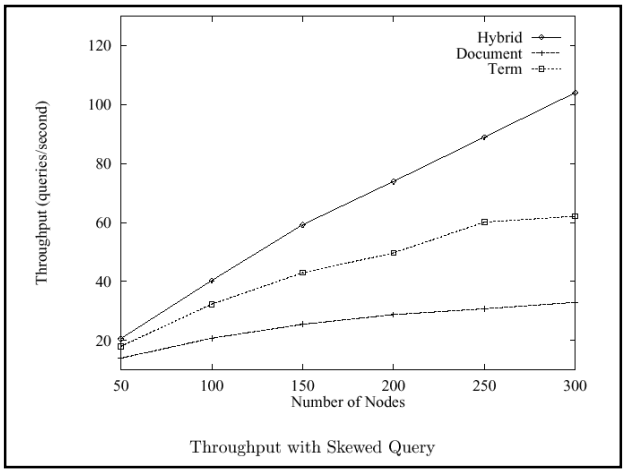
Sornil & Mather Dissertations

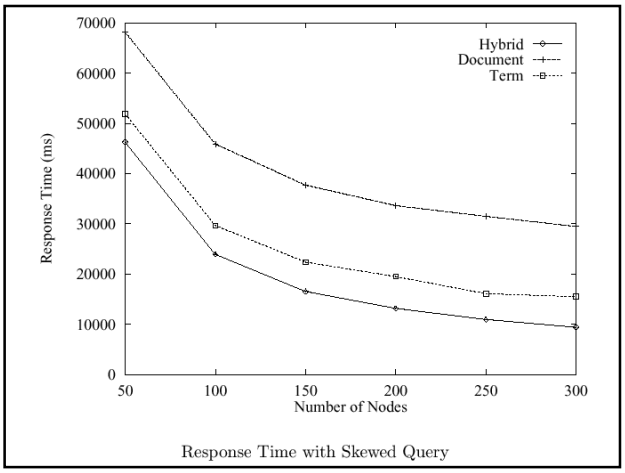
- Mather: efficiently handling very large numbers of objects of varying sizes
- Sornil: efficiently handling IR for very large dynamic collections, large numbers of users, high transaction rates, large inverted files
  - modeling and simulation
  - data organization
  - parallelization of algorithms, alone and in combination for retrieval (related) tasks











Future Work - 1 of 2

- Working with publishers to increase level of access as much as possible
- Interoperability tests among universities and with UMI to provide integrated services
- Study with testbed that emerges, to improve information retrieval, browsing, interface, and other types of user support
- Evaluation, improving learning experience, spread to worldwide initiative, sustainable support and coordination

Future Work - 2 of 2

- Adding services currently prototyped
  - annotation and SDI (routing) capabilities
  - Dublic Core metadata, crosswalk to MARC
  - support with IBM DL, OCLC SiteSearch
- Adding other services planned
  - building and using citation database (w. SFX)
  - implementing plagiarism check (like “SCAM”)
- Developing NDLTD as a sustainable self governing global institution (w. committees)