VT Task Force on Instructional Technology

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“Computing and Instructional Technology”

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Point 1: Computing is Fundamental

- All of the technologies considered are based on, or depend upon, computing.
- => Faculty, students, staff should be proficient at computational thinking.
- => VT should ensure this, preparing the community for Living In the KnowlEdge Society (LIKES):
- http://www.livingknowledgesociety.org

Engineering Grand Challenges

http://www.engineeringchallenges.org/cms/challenges.aspx

- Those that relate to computing include:

- Restore and improve urban infrastructure
- Advance health informatics
- Engineer better medicines
- Reverse-engineer the brain
- Secure cyberspace
- Enhance virtual reality
- Advance personalized learning
- Engineer the tools of scientific discovery

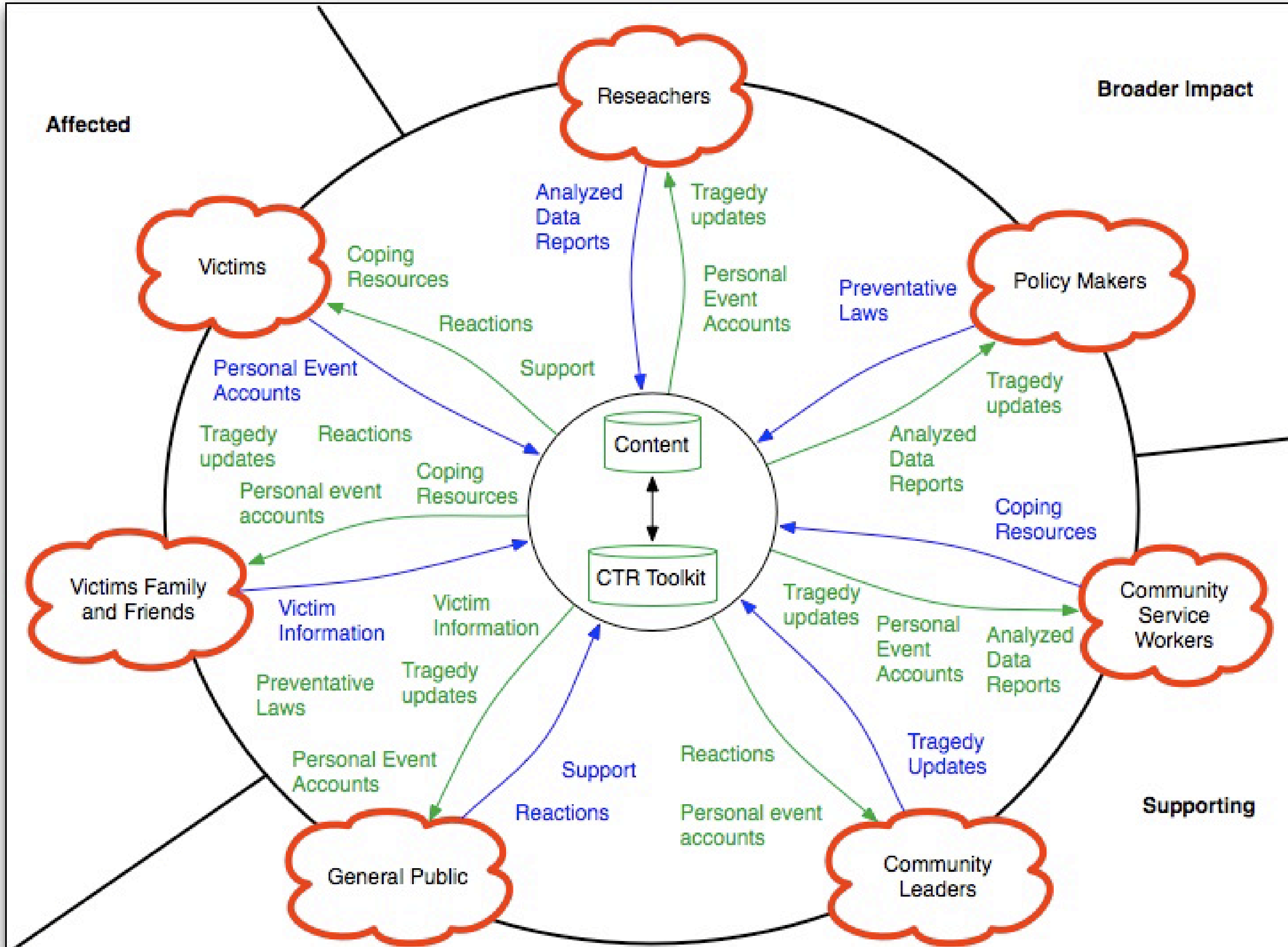
Computing Research for 21st Century
http://www.cra.org/ccc/initiatives

- Data to knowledge to action
- Evidence-based healthcare, new biology/med.
- Discovery in science and engineering
- Advanced intelligence and decision making for America's security; New transportation
- Energy future; Smart grid;   Quality of life
- Robotics; Ocean observatories; eScience
- Emergency informatics
- Personalized education, eLearning

Crisis, Tragedy & Recovery net

www.ctrnet.net

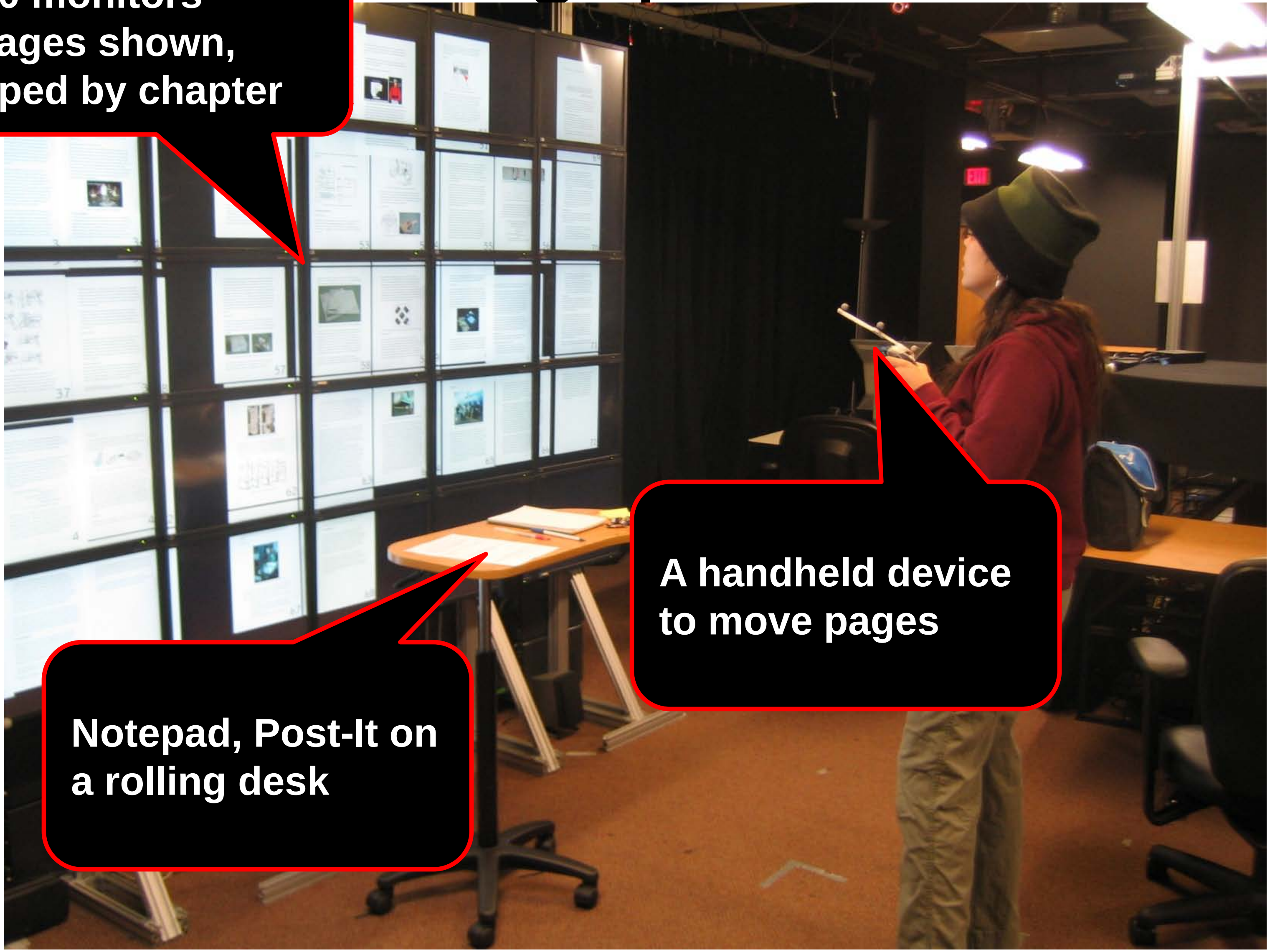
CTR stakeholders



LIKES and 4 Needs of Others

1. Processes
   – Programs, algorithms, workflows, business processes, packages/toolkits, problem solving
2. Modeling, simulation
   – Analyze, abstract, connect, validate, predict, refine
3. Managing information
   – Data, information, and knowledge
   – PIM, create/represent/search/retrieve/reuse/…
4. Sensory connection, interaction
   – HCI, games, visualization, collaboration

Gigapixel


5 x 10 monitors
All pages shown,
grouped by chapter
A handheld device
to move pages
Notepad, Post-It on
a rolling desk

Computational Thinking (Wing)

- Fundamental skill,   conceptualizing
- Mental tools that reflect breadth of CS
- Solving problems, designing systems, understanding human behavior
- Thinking recursively, parallel processing
- Abstraction, decomposition, representation, modeling, using invariants, heuristics, ideas, planning, learning, uncertainty, search
- Applying in (all) other disciplines

AP CS Principles: Big Ideas

1. **Computing is a creative human activity that engenders innovation and promotes exploration.**
2. **Abstraction reduces information and detail to focus on concepts relevant to understanding and solving problems.**
3. **Data and information facilitate the creation of knowledge.**
4. **Algorithms are tools for developing and expressing solutions to computational problems.**

AP CS Principles: Big Ideas (2)

5. **Programming is a creative process that produces computational artifacts.**
6. **Digital devices, systems, and the networks that interconnect them enable and foster computational approaches to solving problems.**
7. **Computing enables innovation in other fields including science, social science, humanities, arts, medicine, engineering, and business.**

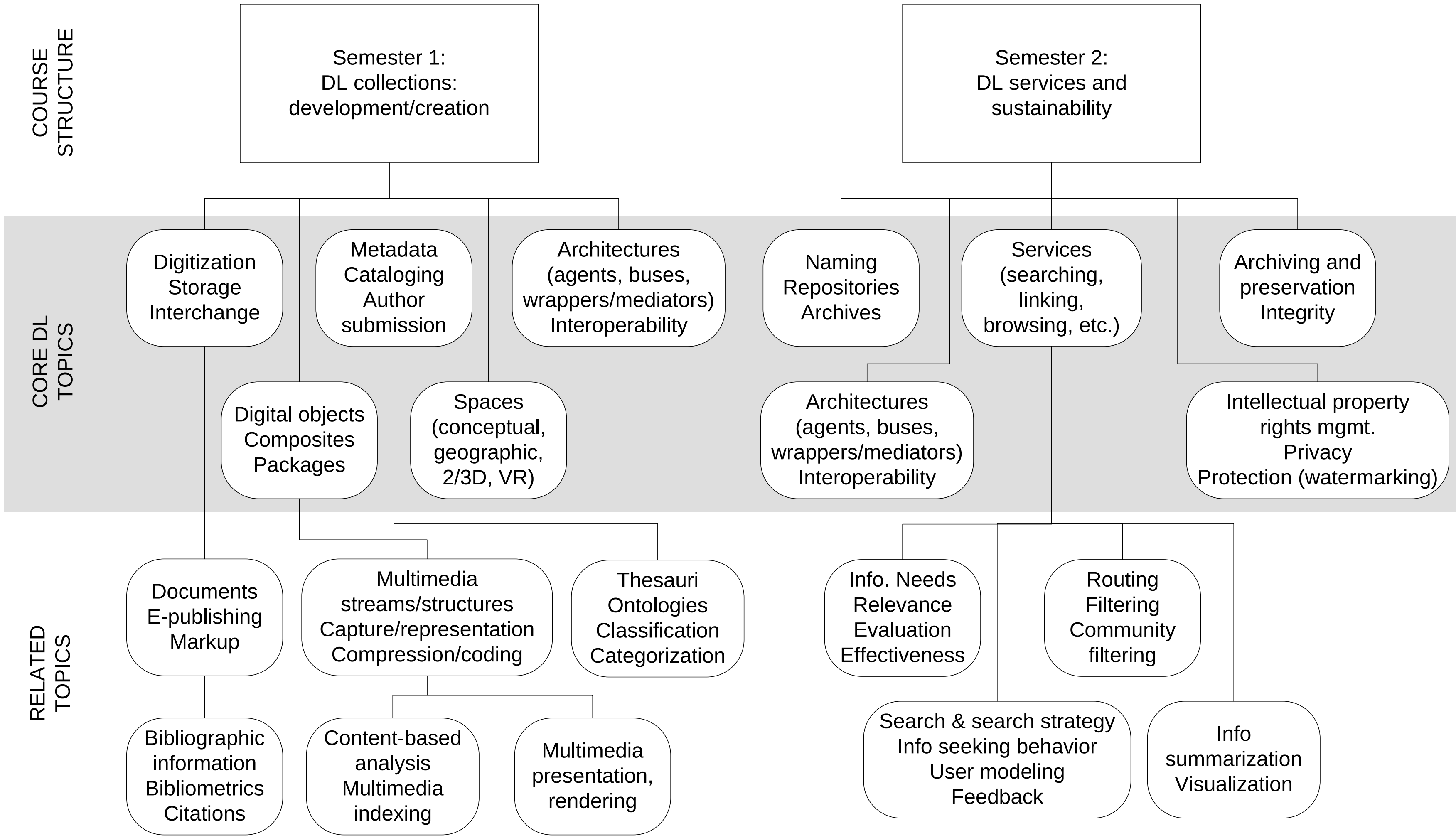
CC2001 Computer Science volume

- **DS. Discrete Structures**
- **PF. Programming Fundamentals**
- **AL. Algorithms and Complexity**
- **AR. Architecture and Organization**
- **OS. Operating Systems**
- **NC. Net-Centric Computing**
- **PL. Programming Languages**
- **HC. Human-Computer Interaction**
- **GV. Graphics and Visual Computing**
- **IS. Intelligent Systems**
- **IM. Information Management**
- **SP. Social and Professional Issues**
- **SE. Software Engineering**
- **CN. Computational Science**

CC2001 Information Management Areas	
IM1. Information models and systems*	IM8. Distributed DBs
IM2. Database systems*	IM9. Physical DB design
IM3. Data modeling*	IM10. Data mining
IM4. Relational DBs	IM11. Information storage and retrieval
IM5. Database query languages	IM12. Hypertext and hypermedia
IM6. Relational DB design	IM13. Multimedia information & systems
IM7. Transaction processing	IM14. Digital libraries

* Core components

DL Curriculum Framework



Point 2: Vision: Develop, Move To

- What is our vision?
- Who are the stakeholders?
- How do they interact?
- How will each advance maximally?
  - Optimization Goal: Learning
  - Everything else open for innovation
  - But aware of <u>real</u> constraints, e.g.:
- Continuous, sustainable, focused change

Vision: Student Abilities

- Effective learners
- Effective teamworkers
- Skilled in research, discovery, & innovation
- Mentees and tutors
- Multidisciplinary scholars
- Citizens in the knowledge society
- Problem solvers and problem posers
- Information managers

Vision: Education <-> Research

- Embrace VT’s other missions, including research and service
- Research: understanding reality, discovering, questioning, solving challenges/problems, creating opportunities
- Service: awareness, compassion, engagement
- Students at all levels: researching, serving

Vision: Support

- Institutionalization of innovation in all aspects of teaching and learning
- Distinguished innovator speaker series
- VP for Innovation
- All the campus groups focused on teaching and learning working together
  - Revisiting all assumptions (lectures, courses, …)
  - Funding, processes, rewards – reshaped
  - Deconstruct => flexible/dynamic synthesis
  - Repackage, e.g., college->dept.->program

Point 3: Ongoing: R&D -> Practice

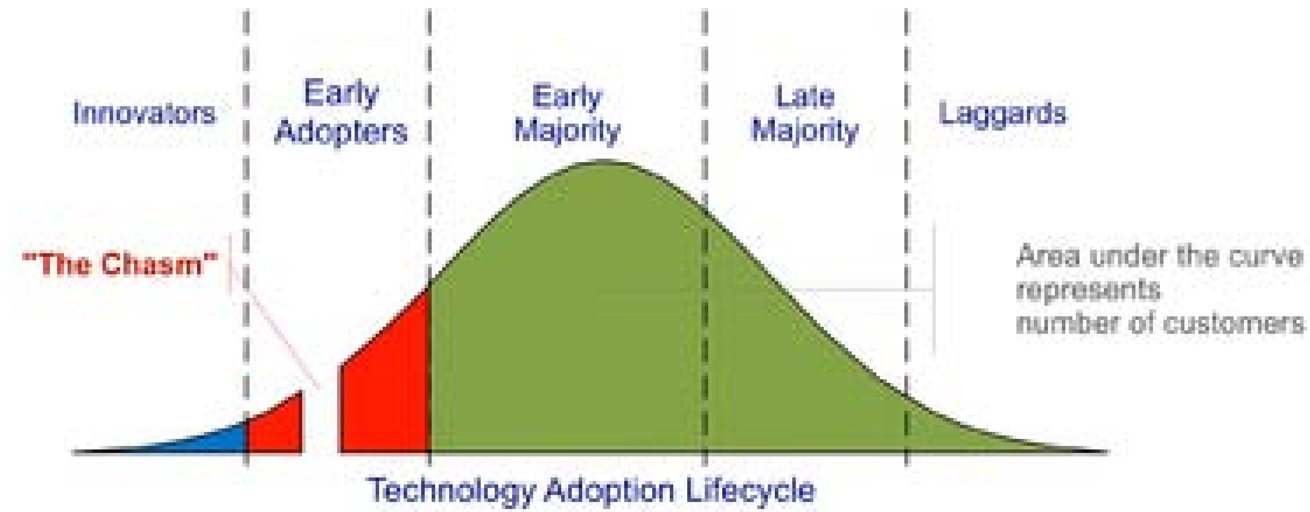
- Learning
  - Brain, cognitive science, communication
- Research
  - Novel research today is the foundation for practice in 10-30 years.
- Computing
  - Ubiquitous/pervasive, usable, effective, efficient
  - CS -> IT -> English/Engineering/… -> Practice

Carl E. Wieman

- Associate Director for Science in the White House Office of Sci. & Technology Policy
- Director of the Carl Wieman Science Education Initiative and Professor of Physics (2001 Nobel Prize Winner), U. British Columbia, www.cwsei.ubc.ca
- “Science Education for the 21st Century: Using the Insights of Science to Teach/Learn Science” (SIGCSE 2010)
- E.g., Brain-Based Learning/Education

Crossing the Chasm
(Geoffrey A. Moore, 1999)

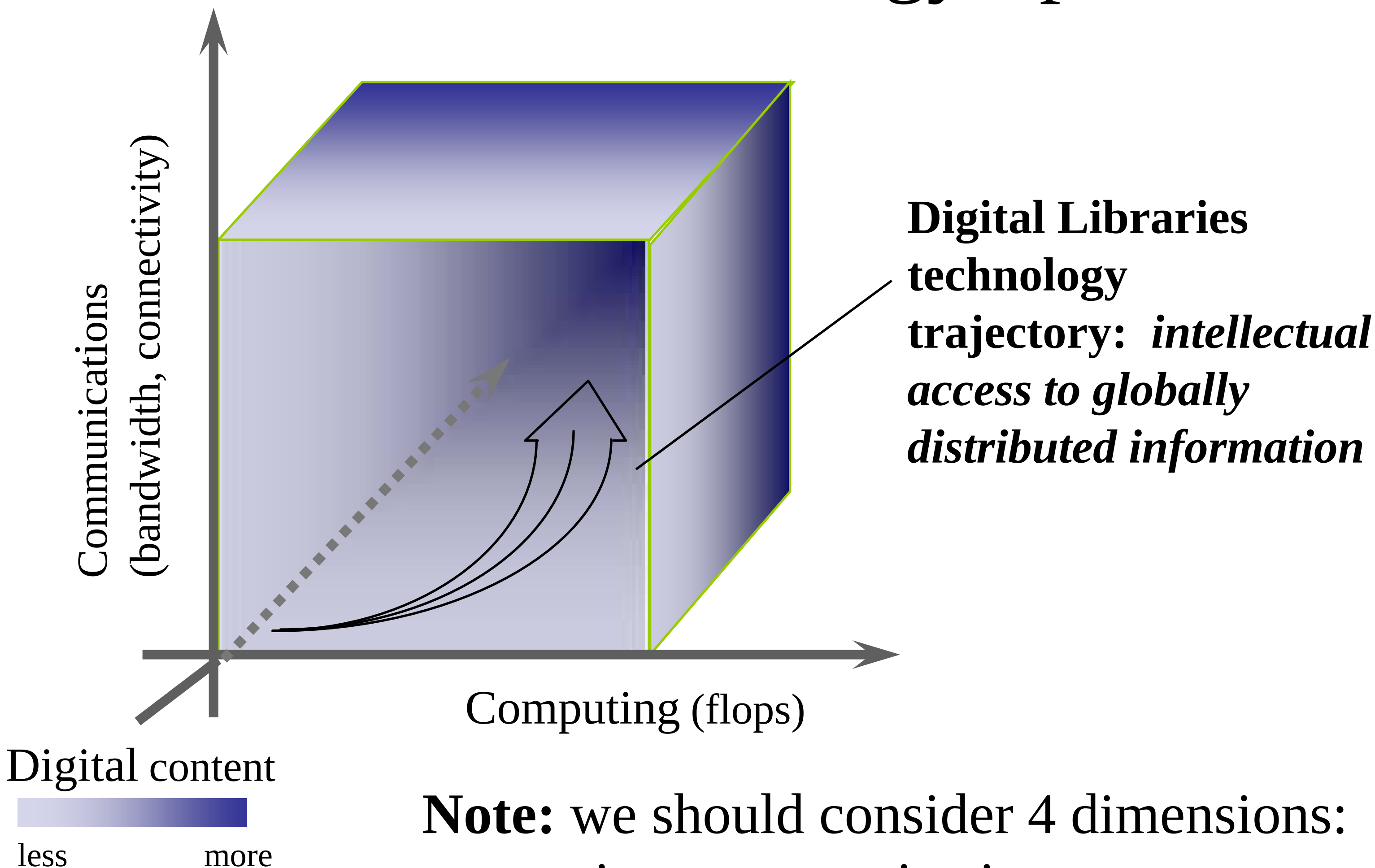
- **Diffusion of innovation**
- **Technology adoption lifecycle**
- Early adopters
- CHASM
- Early majority



Point 4: Illustrate with Examples

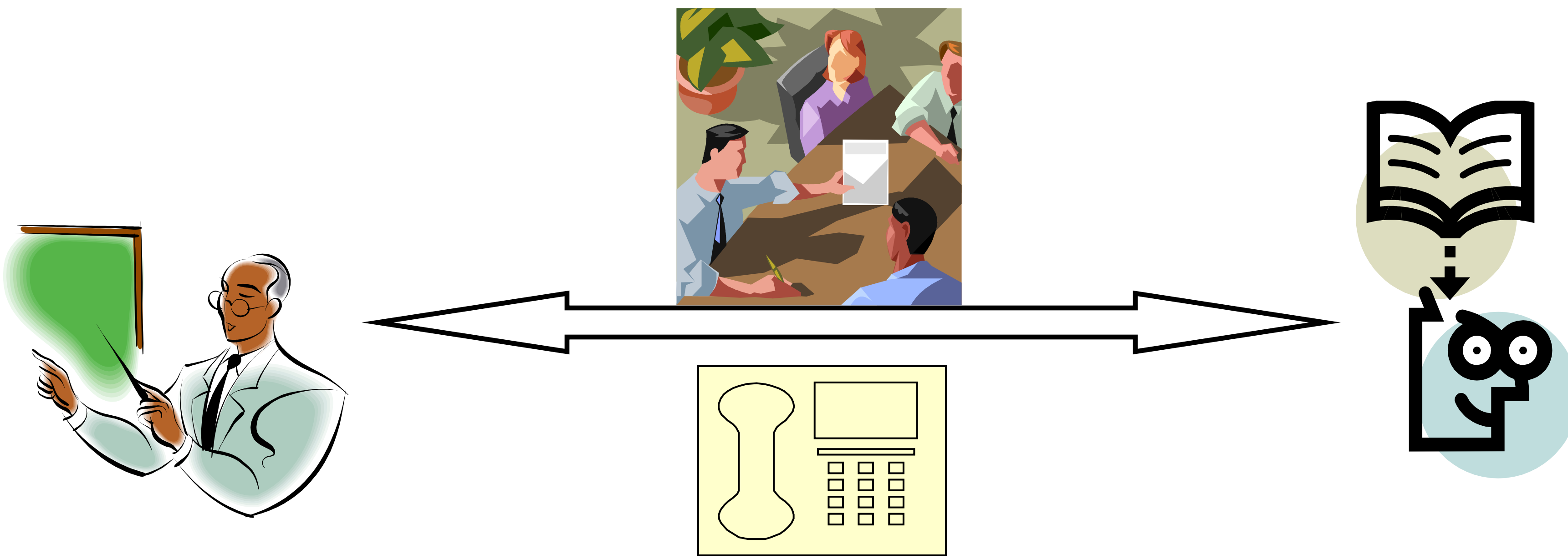
- Personalization
  - PCs: Personal Computers
  - PIM: Personal Information Management
  - User modeling, intelligent tutoring systems
    - Tutors are roughly 3 times more effective
  - Adaptive hypermedia, variable granularity
- Digital Libraries of Educational Resources

Locating Digital Libraries in Computing and Communications Technology Space



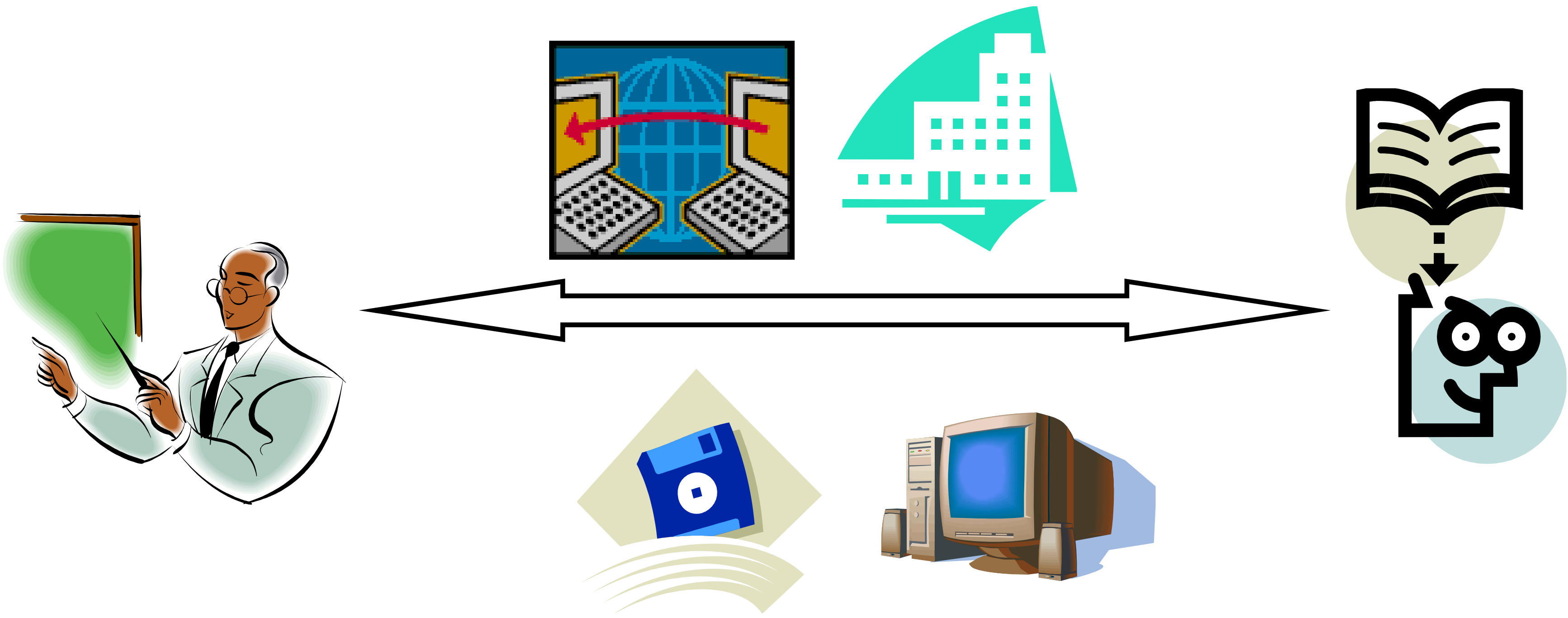
Note: we should consider 4 dimensions: computing, communications, content, and community (people)

Synchronous Scholarly Communication



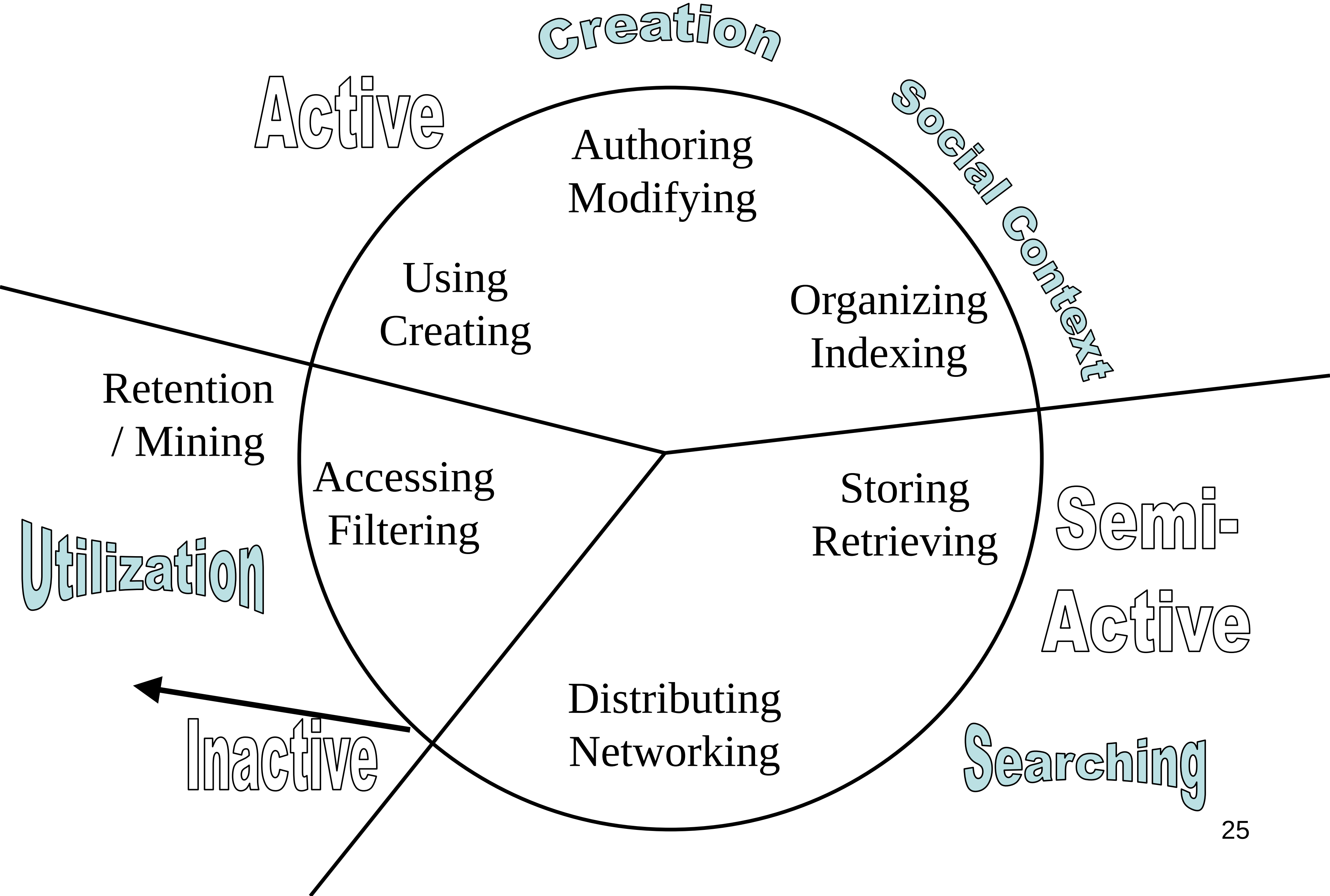
Same time, Same or different place

Asynchronous, Digital Library Mediated Scholarly Communication

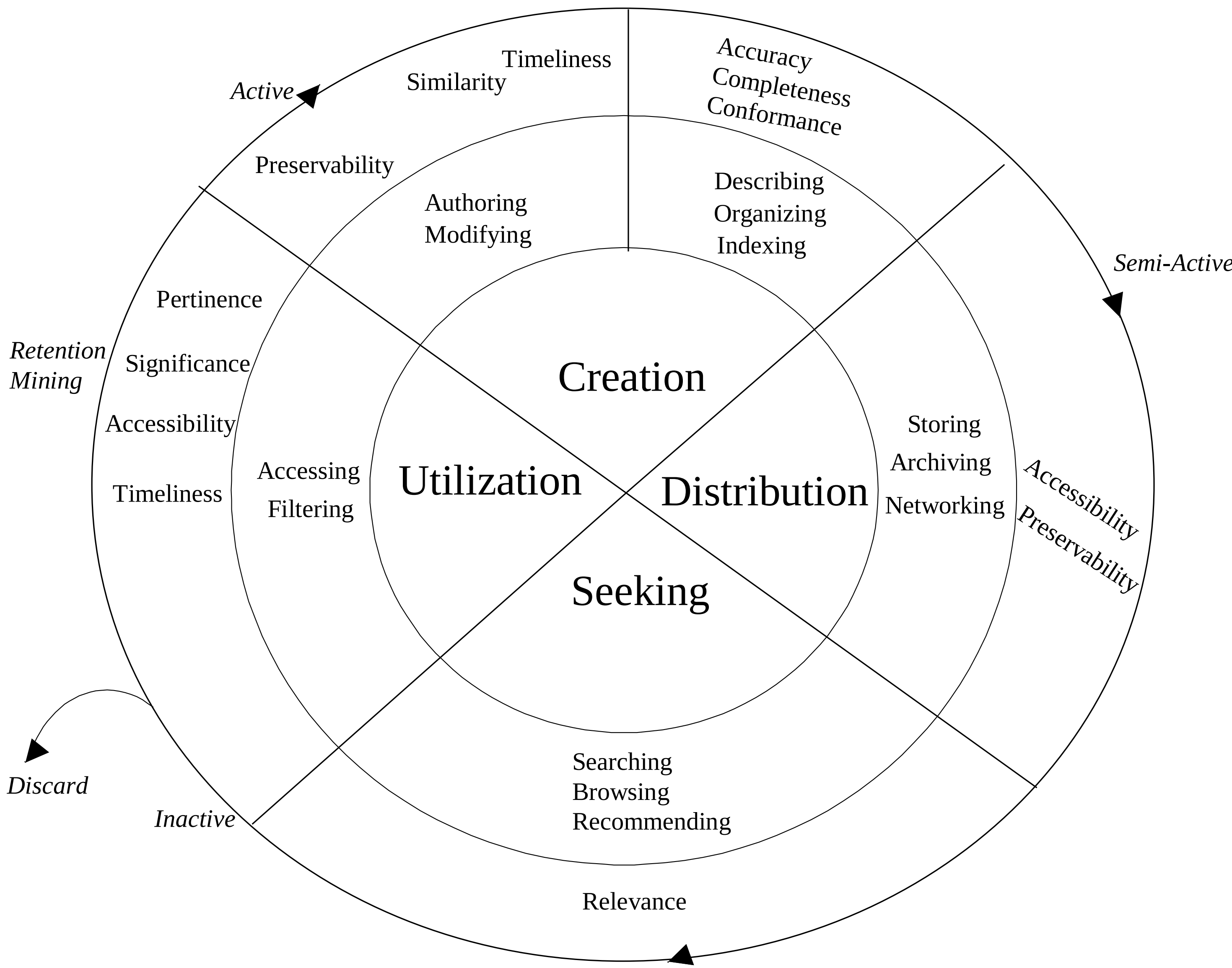


Different time and/or place

Information Life Cycle



Quality and the Information Life Cycle



Digital Libraries Shorten the Chain from

Author

Editor

Reviewer

Publisher

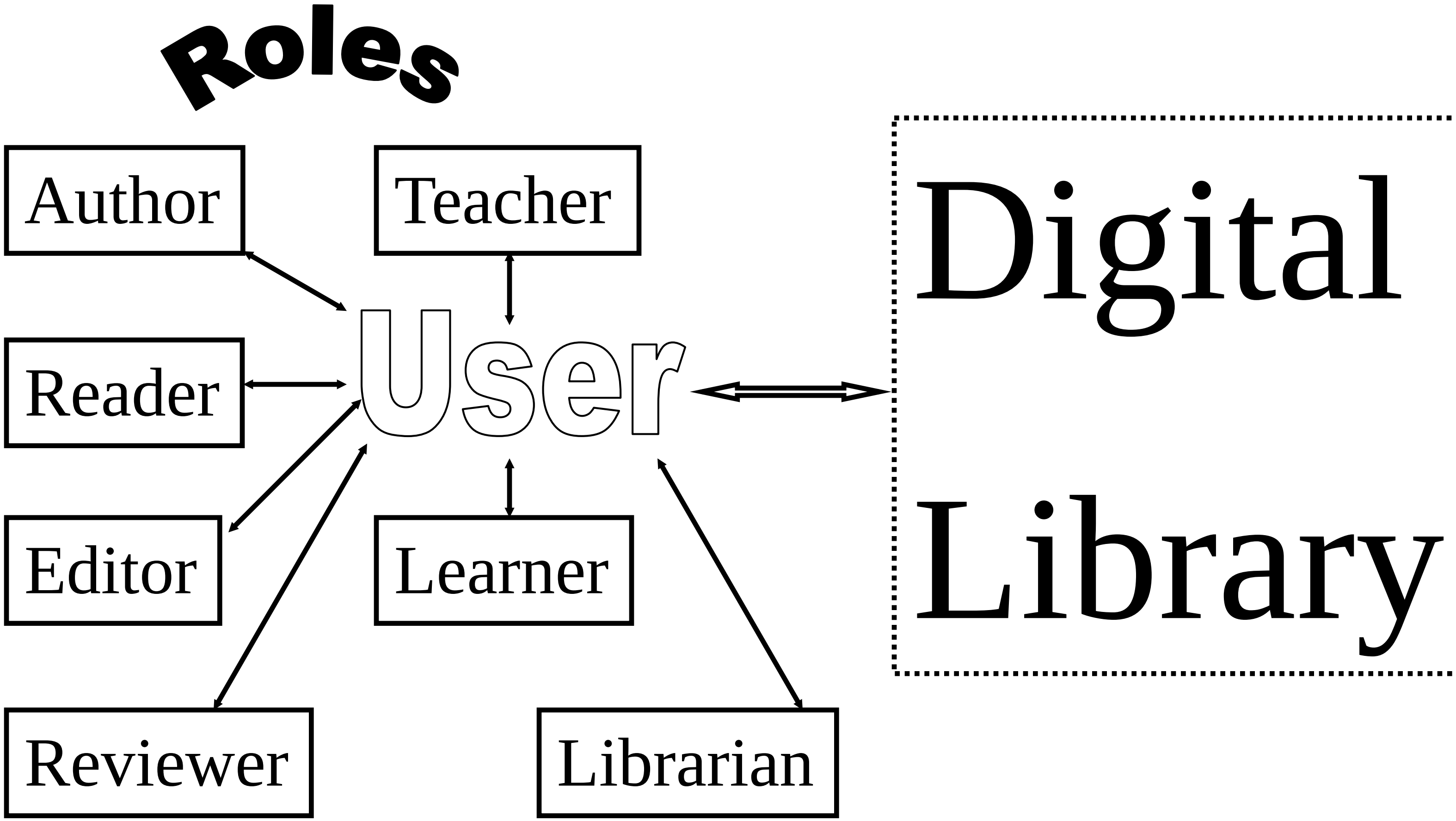
A&I

Consolidator

Library

Reader

DLs Shorten the Chain to



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**)

Degree of Structure

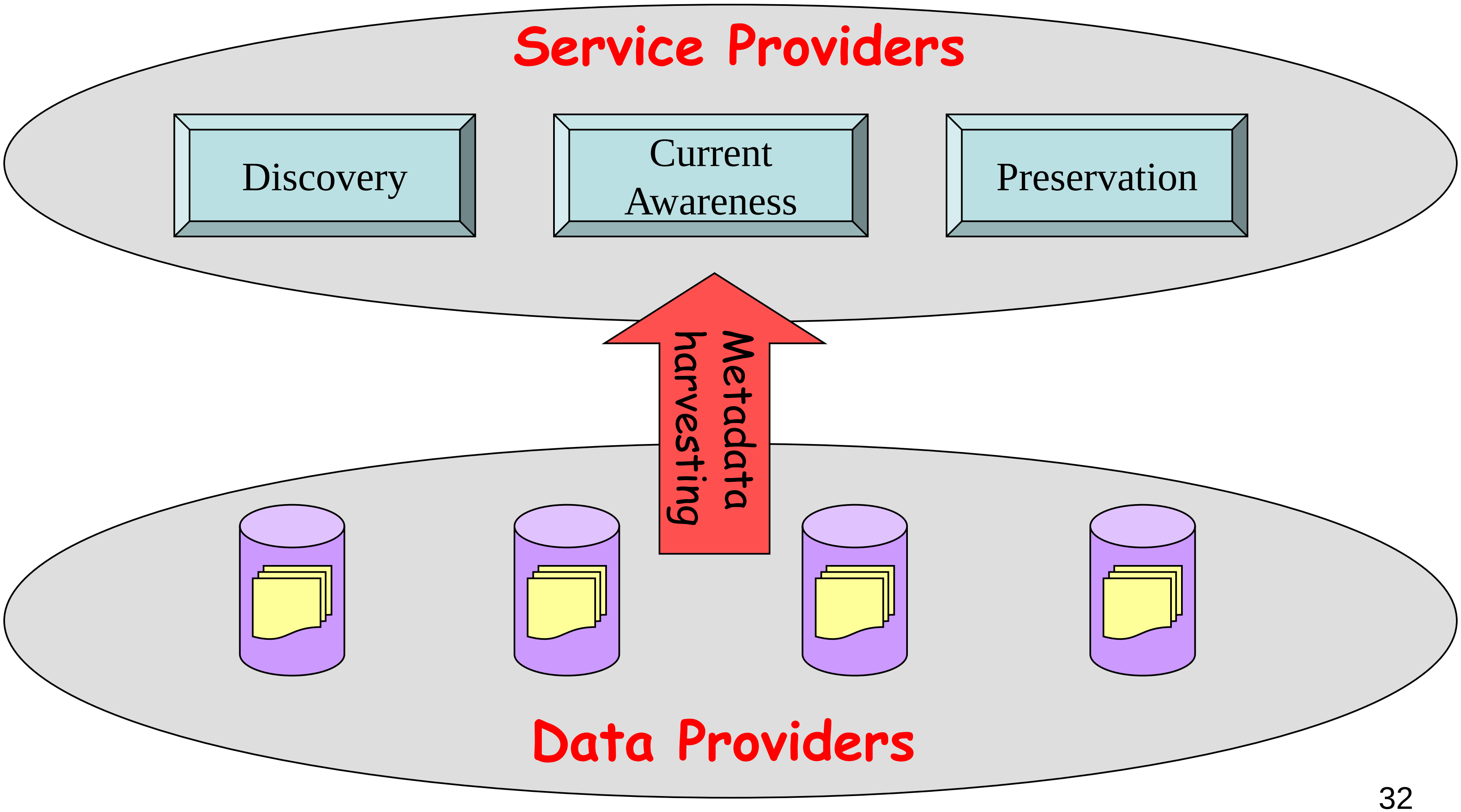
Web DLs DBs

Chaotic Organized Structured

Digital Objects (DOs)

- Born digital
- Digitized version of “real” object
  - Is the DO version the same, better, or worse?
  - Separation of structure, meaning, use
    - Rendered on paper, laptop, handheld – or CAVE
    - Semantic Web (human or machine processing)
- Surrogate for “real” object
  - Hybrid systems with real and digital objects
  - Data, documents, subdocuments, metadata

The World According to OAI



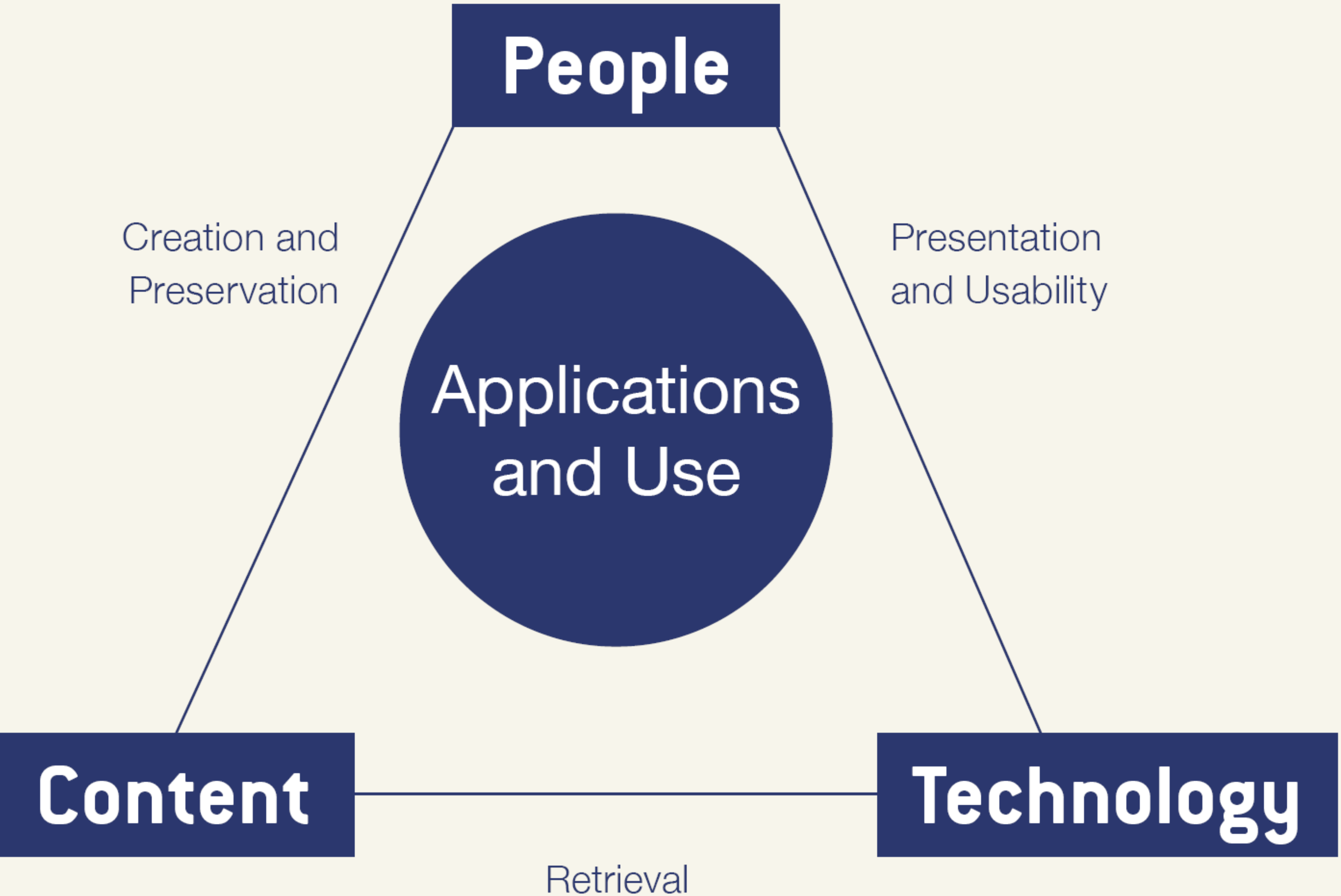
KNOWLEDGE LOST IN INFORMATION

Report of the NSF Workshop on Research Directions for Digital Libraries

June 15–17, 2003

Chatham, MA

National Science Foundation Award No. IIS-0331314


People
Creation and Preservation
Presentation and Usability
Applications and Use
Content
Technology
Retrieval

Educational Repositories Connect:

Users: students, educators, life-long learners

Content: structured learning materials; large real-time or archived datasets; audio, images, animations; primary sources; digital learning objects (e.g. applets); interactive (virtual, remote) laboratories; ...

Tools: search; refer; validate; integrate; create; customize; publish; share; notify; collaborate; ...

Collections

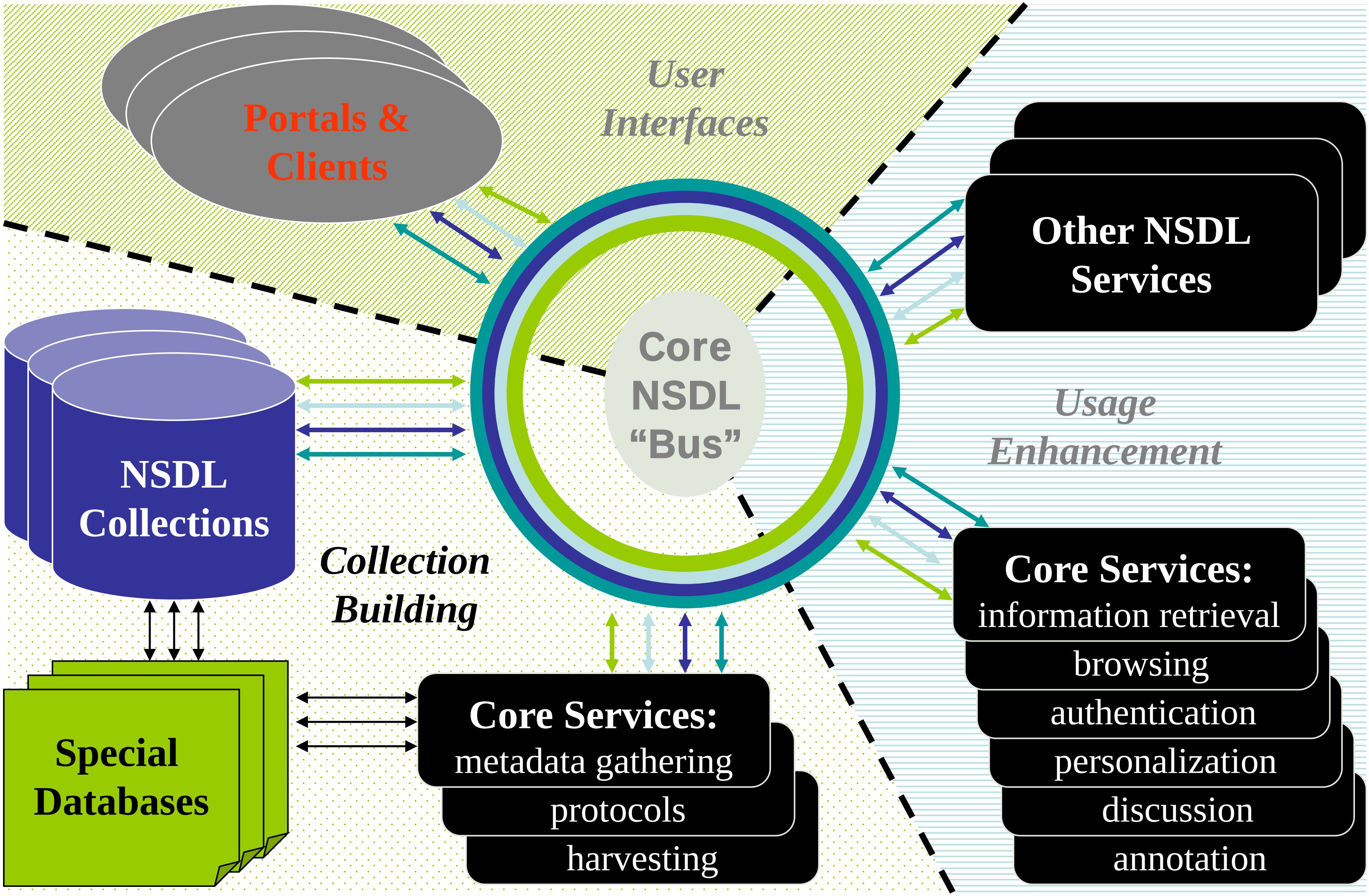
- Discovery of content
- Classification and cataloguing
- Acquisition and/or linking; referencing
- Disciplinary-based themes define a natural body of content, but other possibilities are also encouraged
- Access to massive real-time or archived datasets
- Software tool suites for analysis, modeling, simulation, or visualization
- Reviewed commentary on learning materials and pedagogy

Services

- Help services, frequently asked questions, etc.
- Synchronous/asynchronous collaborative learning environments using shared resources
- Mechanisms for building personal annotated digital information spaces
- Reliability testing for applets or other digital learning objects
- Audio, image, and video search capability
- Metadata system translation
- Community feedback mechanisms

NSDL Information Architecture

Essentially as developed by the Technical Infrastructure Workgroup



Digital Libraries in Education

- Analytical Survey, ed. Leonid Kalinichenko
- © 2003, www.iite-unesco.org, info@iite.ru
- Transforming the Way to Learn
- DLs of Educational Resources & Services
- Integrated/Virtual Learning Environment
- Educational Metadata
- Current DLEs: US (NSDL, DLESE, CITIDEL, NDLTD), Europe (Scholnet, Cyclades), UK (Distributed National Electronic Resource)

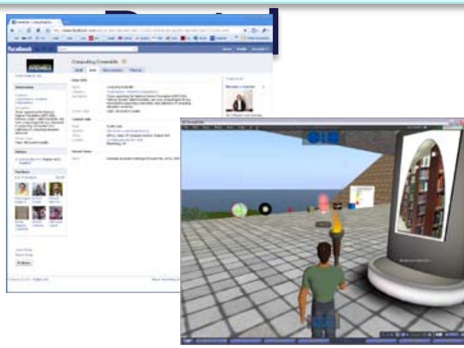
DLEs: Guiding Principles (p. 12)

- Driven by educational and science needs
- Facilitating educational innovation
- Stable, reliable, permanent
- Accessible to all
- Leverage prior research: DL, courseware, …
- Adaptable to new technologies
- Supporting decentralized services
- Resource integration thru tools/organization

The Ensemble Computing Portal

Many-to-Many Information Connections in a Distributed Digital Library Portal

Distributed DL



Collections

Services

Search

Forum

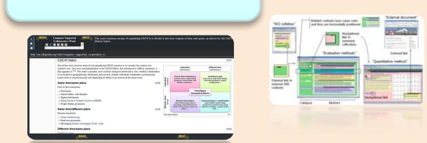
Group

Blog

Browse

Notification

Tools



Communities

ACM

CS1

FOCES

TECH Developers

Ensemble

LIKES

AP CS

A collaborative research project to build a distributed portal with up-to-date contents for all computing communities.

http://www.computingportal.org/

As data, information, and knowledge play increasingly central roles … digital library research should focus on:

- Increasing the scope and scale of information resources and services;
- Employing context at the individual, community, and societal levels to improve performance;
- Developing algorithms and strategies for transforming data into actionable information;
- Demonstrating the integration of information spaces into everyday life; and
- Improving availability, accessibility, and, thereby, productivity.

An appropriate infrastructure program will provide sustainability of digital knowledge resources among five dimensions:

1. Acquisition of new information resources;
2. Effective access mechanisms that span media type, mode, and language;
3. Facilities to leverage the utilization of humankind's knowledge resources;
4. Assured stewardship over humanity's scholarly and cultural legacy; and
5. Efficient and accountable management of systems, services, and resources.

Questions?
Discussion?

Thank You!