

## Knowledge Systems



PSYC305  
Applied Cognition & Neuroscience

## An information explosion!

### *What does this mean?*

Continued increase in the amount of written information we (personally) have to keep track of.

*Why do we have more paper to keep track of?*

**Because it has become easier to produce!**

printing press    typewriter    carbon paper    photocopier    computer



Problem: Need a way of managing the paper so you can find the information when you want it

*What do you use at home?*

*How is it organised?*



*Why do you do it that way?*

*Can you find what you need?*

The Wooten Patent Desk (circa 1872)  
an early attempt to deal with the problem



Wooten style desks were a breakthrough in organising paper information

Information was organized by size & location

**Advantage:**

ease of storage  
*(a place for everything & everything in its place)*

**Drawbacks:**

retrieval difficulties  
single-user system (idiosyncratic)  
limits on size & shape  
upper limit on slots (categories)

Overcoming size limitations  
Businesses needed more storage

Pigeon Hole Filing Cabinet    Document Filing Cabinet  
Sectional, Elastic or Expansion Filing Cabinet

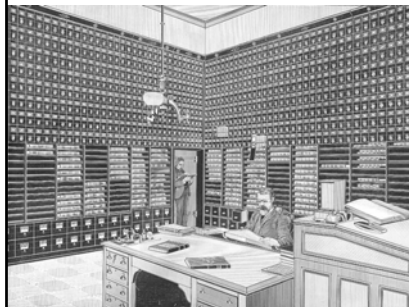
(Circa 1880-1900)

Information organised spatially

**Drawbacks?**

multiple users  
retrieval (finding the info)  
difficult to re-organise if  
new categories are added

## Document Filing Rooms



US Dept of Justice, Washington DC, Circa 1895

All of these methods rely on spatial organisation of information

(even though the information wasn't spatial)

*What do you need to make spatial arrangements work?*  
a map or catalogue

*What else uses a spatial arrangement?*

**grocery store / supermarket**  
Location of individual items can be difficult with large spatial arrangements  
need location aids

**hardware stores**  
even more items than a grocery store  
often too complex for signs alone  
also need specialist advice

**libraries**

Rely on file catalogues & specialist advisors

Filing specialists were trained and employed to manage office information

Filing systems had to become increasingly standardised: alphabetically, chronologically, or by customer number

Letter Filing Cabinets  
Organised alphabetically – not spatially

Still needed specialists to manage the filing and retrieval of information

**Vertical Filing System**

A very different information organisation system



The vertical filing system was invented in 1898 by Edwin G. Seibels (1866-1954). One of his original filing cabinets is in the Smithsonian museum. Earliest advertisement 1901

**Seibels' vertical filing system revolutionised record-keeping**

1. Hierarchical organisational principle based on drawers & folders (built into the design)
2. Flexible categorisation of information; could be chronological within alphabetical within topic
3. Vertical orientation means you don't have to go through layers (as in flat document file – but still have FIFO vs LIFO issues)
4. Potentially unlimited number of categories, levels, and files

**The vertical filing system still has some drawbacks**

1. Filing categories require careful thought
  2. Can take more time to store information properly
  3. Can require considerable space
- Specialist filing consultants are still employed

**Filing systems are a cognitive tool**

*Why do we need them?*

**Limitations of human memory:**

Working memory capacity limit  
Time & effort required to memorise information  
Constructive processes in long-term memory

*How are they similar to human memory?*

Some info organised by content (not spatially)  
Some info organised hierarchically (not spatially)

**Filing systems are a cognitive tool**

*How are they different from human memory?*

permanence & accuracy  
range of content & categories  
ease of cross-referencing  
physical size & portability  
amount that can be stored  
time required to file      time required to retrieve

*Depends on what kind of memory*

## Filing systems are a cognitive tool

*We have more than one type of memory system & we rely on more than one type of information management system*

### Office design example

*The office as a cognitive tool*

From: chris@xxxx.edu  
To: dnorman@ucsd.edu  
Subject: My office . . .

You asked me to describe how I organize my office. Here it is:

I've worked pretty hard to make my office environment help me as much as possible.

Much of the office organization is designed to help me find things and remember to do things. I also want to remind myself to work on "important" things, like writing papers, that might easily be pushed aside by less important but more time-critical items. My desk is arranged in an L shape, and I have placed a large calendar on one wall and a large "to-do" list on the other wall. (I also have a special calendar on my door to remind me about the most critical items I have left to do on my major project, which I can read from my desk and see whenever I come in.)

The calendar shows the current month and lists things that I have to do, including meetings, deadlines, and reminders, such as "drop off Chapter 3" or "send E-mail to Executive Committee." I use Post-it Notes, so that I can easily deal with

changes. The calendar is arranged chronologically and includes items that are both important and rather unimportant.

I update the "to-do" list every 3 or 4 months, whatever seems reasonable. This shows all the major activities that I want to accomplish in the next quarter. I think of it as a plan for writing a quarterly report—I want to be able to say that I accomplished everything on the list. (I usually accomplish about 85% and roll over the rest.) The most important items on this list are talks and papers, but I also list reviews, travel, reports, items from home (e.g., income tax), and activities for the professional society that I am now president of.

These items usually require a minimum of 3–4 hours. I use Post-it Notes, which get a large check mark when I'm done with the item. I am careful to leave these up, as a reminder that I'm really getting something done. When I set up my next 3–4-month interval, I take off the items that have been checked and place them in a random collection on the side of the "to-do" list, as a reminder of what I actually got done. This turns out to be very important to me psychologically (if I may indulge in a little self-psychanalysis)—constantly displaying a list of accomplishments helps me want to accomplish more and helps make the tradeoff of putting smaller items aside in order to add another check mark.

I also have a 3-level filing system for handling papers. My desk is my working surface—I don't mind having it messy while I'm working on a project, but I like to clear it off pretty regularly, probably once every 3–4 days. (Longer if I'm working on a paper.) On the side of the desk with the calendar, I keep items that I use constantly, including the phone, answering machine, tape, stapler, stamps, Rolodex, Post-it Notes in various colors, pens, dictionary, Strunk & White, and thesaurus, and, for aesthetic reasons, a very pretty kaleidoscope. I also have a homemade envelope attached to a file cabinet wall that contains address labels and

another for receipts. I use "mini folders" in different colors to keep track of different things (e.g., papers, letters to write, reviews, a stolen car radio claim) and keep the "current" ones on my desk. I also keep empty slash folders behind them.

In my desk, I have 6 drawers: one holds envelopes and blank pads of paper, which I use whenever I want to jot down ideas. Another holds food (tea, soup, spoon, etc.) and medicine. Another holds my finances (checkbooks, mortgages envelopes, calculator, old calendars and checks, emergency greeting cards ()), old letters, small notepads. Another holds basic stationery supplies (paper clips, pens, Write-out, subway tokens, staples, etc.). Another holds less commonly used items (business cards, file folder labels, file cabinet keys, marker pens, etc.). The last is a file drawer that contains miscellaneous commonly used files (expenses, résumé, current bills and pay stubs, forms, administrative information from my employer). I clear out extra files from here about once a year, usually after I've finished a major project and am looking for something nonintellectual to do.

The other side of my desk, under my "to-do" list, has a notebook full of 35mm slides for talks, black transparencies, phone books, software manuals, and, for some reason, videotapes. (I guess because they're too tall to fit on my bookshelf!) I have several stacking "to-boxes," which get used for phone lists, copies, fax info, "political documents," and an out-box, generally for outgoing mail. I don't use an in-box, per se.

I also have a lot of file cabinets. I have a 2-drawer file cabinet on the left of my desk but rarely use the files. (It used to contain my current writing projects, but those have been shifted to the pile cabinet. Now it mostly contains projects that were started but never finished.) I have two more 4-drawer file cabinets to the right of my desk. I use three of the drawers all the time. Two contain a chronological listing of my papers, including extra copies to give to people who visit. One contains current files for the professional society.

I have another file drawer for ancient society files and several others full of old files from work. I look in these drawers about once every 3–4 months.

The pile cabinet has turned out to be a very successful way to deal with current projects. I started using it about 3 years ago. I found that if I put things into file drawers, I'd forget them. Yet my desk isn't big enough to handle everything that I'm currently working on. I converted a cabinet designed to display brochures and labeled it with Post-it Notes. (I generally rethink the categories when I update my "to-do" list.) My current set of projects includes several piles of current society things, such as things to sign, finances, local groups, etc. I also have documentation, specs, meeting notes, etc., from two different software projects, and I have several piles devoted to different aspects of my current project (committee notes, comments from colleagues, the original proposal, different chapters). I also keep different sets of data that I'm working on and have another pile for relevant articles. (This is hard to keep to a manageable size.)

I have 5 bookshelves, which hold my books, articles I someday plan to read (]), and journals. I also have moved about 4 shelves full of articles and other items to shelves outside my office.

I have a whiteboard for scribbling ideas and making lists. I also keep a few figures there all the time so that I don't have to redraw them when I talk about them. I also don't have to redraw them when I talk about them. I also have a flip-chart pad behind the door and periodically use it to think through ideas that I want to keep. I tape these up on the walls, to keep me thinking about the ideas until I have a chance to write them down.

## Office design example *The office as a cognitive tool*

### Features of Chris' Office:

To do list (3–4 months)

Calendar (time-critical items) post-its for changes

3-level information system:  
desk, file cabinets, & pile cabinet

## Look at each feature

**Desk** – work surface with frequently used materials (tools & references)  
drawers for admin-non-intellectual items  
easy to file, cleaned annually

*Why does she need the desk drawers?*

items that don't fit other file categories, garbage collection?

*What aspect of human memory does this remind you of?*

Look at each feature

**File cabinets:** Three cabinets, but four systems  
Copies of papers (chronologically organised)  
Old (historical) records  
Current work files (discontinued)  
Projects started but not finished  
(rarely used)

*Why does she need these different categories?*

*What aspect of human memory does this remind you of?*

Look at each feature

**Pile cabinet:** Active projects

Widely used – broad range of styles

*Why did this replace "current work" files?*

needed to remember to work on them  
*Why not a file cabinet or drawer?*

out of sight & ease of storage/retrieval

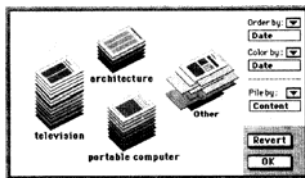
*How is it organized?*

spatial & non-hierarchical

Virtual pile cabinets for your computer files

**A 'Pile' Metaphor for Supporting Casual Organization of Information**

*Richard Mander, Gitta Salomon and Yin Yin Wong*  
Human Interface Group, Advanced Technology  
Apple Computer, Inc.



Look at each feature

*What hasn't Chris told us much about?*  
*What isn't working?*

Inbox – how to prioritise the work

	Urgent	Non-urgent
Important	1	2
Not important	3...	

my four-level cognitive tool

*What aspect of human cognition does this remind you of?*

The office as a cognitive tool



Info management trade-offs:  
ease of storage vs ease of retrieval  
task management vs distraction & information overload  
need for long term storage vs frequency of use  
(& forgetting due to disuse)

*Can we use technology to deal with these problems?*

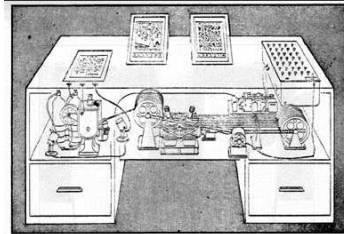
*Is there a better method for organising & storing information?*

**Memex: Non-hierarchical information system**

Vannevar Bush, "As We May Think" (1945)

**Memex system** to organise microfilmed information and retrieve it *without leaving the desk*

"...when one of these items is in view, the other can be instantly recalled merely by tapping a button"



**Key feature was "Associative Indexing"** linking information sources together and save a trail of connections: "The process of tying two items together is the important thing"

**Memex: Non-hierarchical information system**

**Vannevar Bush**

Director of the US Office of Scientific Research and Development

Director of the US National Advisory Committee for Aeronautics (pre-NASA)

"As We May Think" (1945)

"tools change our way of doing, and expand the horizons before us"

Predicted microphotography, personal computers, EFTPOS, on-line literature, hypertext & many other technology advances

**How do we computers to organise & store information?**

All of these computer systems use a desktop/office/filing cabinet metaphor as a representation (for ease of use)



As a result, they have most of the same limitations as paper-based systems (maybe more?)

**How does the information get in the computer?**

Type it in or scan it...

Don't forget to back-up your data!

Office computers have given us a new information tool:

**the Database**

"A structured collection of records or data that is stored in a computer so that a program can consult it to answer queries"

Flat file database	Hierarchical database	Network database	Relational database
Two-dimensional array of data elements; rows & columns	Tree structure efficient & flexible but little or no cross-referencing	Like hierarchical model, but each element can have multiple "parents"	Entries with attributes that can be searched & linked using relational operators

**Hierarchical database**

Organised collection of files  
Each file contains records  
Each record contains individual pieces of information (fields)



**Relational database**

Contains linked tables  
Each table contains records with several data fields  
A relational query filters information, finds ones that meet criteria or arranges them in a particular order



Provides method of cross-referencing & creates new knowledge by finding relationships

**Hypertext: another method of cross-referencing & finding relationships in data**

*Selecting a word in a piece of text and the focus immediately shifts to another document or page dealing with that word*

Vannevar Bush's original concept for the Memex

The internet is a distributed relational database connected by hyperlinks (hypertext markup language or html)

"The Internet is not a thing, a place, a single technology, or a mode of governance. It is an agreement"

John Gage, Sun Microsystems

Domains and connections of the world wide web. Colors represent .edu, .gov, .com, etc. domains

The internet (cyberspace) offers nearly unlimited size & formats for information but searching & organising results of searches can still be difficult need search engines, bots, & avatars

The surface features of the search results can affect how the information is processed

### Information Display

Map representing the losses over time of French army troops during the Russian campaign, 1812-1813. Constructed by Charles Joseph Minard, Inspector General of Public Works, retired. Paris, 20 November 1869

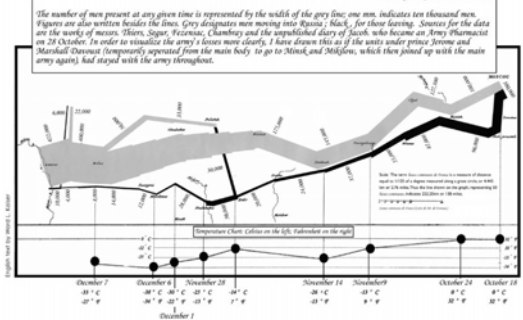


Figure 58. Minard's map of Napoleon's Russian campaign. This graphic has been translated from French to English and modified to most effectively display the temperature data.

### CBS/BBC broadcast of Kennedy assassination coverage, 1963



### MSNBC coverage of 9/11/2001



Newsmap image 17 April 2007 <http://www.marumushi.com/apps/newsmap>



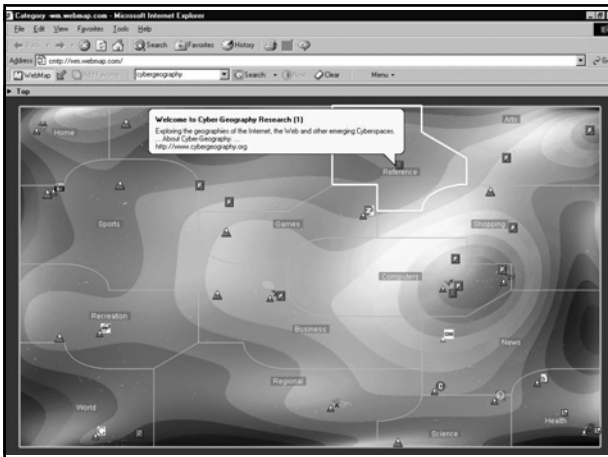
### Newsmap is a type of Treemap

Two-dimensional representation of a tree hierarchy or relational search result  
Allows simultaneous comparison across multiple levels  
Organisational structure can be changed easily



Top 100 songs in the iTunes music service. The map updates every 24 hours by reading current data from Apple's iTunes XML feed

<http://www.hivegroup.com/demos>



## Alternative Information Systems

### The Pond



*"In the Pond design we try to move away from the conventional ideas of desktop metaphors and the established notions of how information systems are accessed and manipulated. Instead, concepts from areas such as bio-ecosystems, fishing, fluid mechanics, roulette wheels and jukeboxes have been our inspiration."*

## Future Challenges

*"Today our society and our social institutions are being reshaped by the rapid advances in information technology: computers, telecommunications, and networks.... This technology allows us to form and sustain communities for work, play, and learning in ways unimaginable just a decade ago."*

James Duderstadt, President Emeritus, University of Michigan, 1999

*"I wonder at times if we are not like the dinosaurs, looking up at the sky at the approaching asteroid and wondering whether it has an implication for our future."*

Frank Rhodes, President Emeritus, Cornell University, 1998

## 3 Future Challenges For Knowledge Systems

Communications and computer technology has been increasing *one hundredfold* every decade

*What are the implications of this increase?*

*How can universities use this increase in communication and computation?*

1. Library – repository of existing knowledge
2. Scholarship – creating new knowledge
3. Teaching – transmitting knowledge

## Future Challenge #1

Library: Repository of existing knowledge

*Virtual access - do we need a physical library, or is on-line access preferable?*

*Should an on-line library be the same as a physical library (a virtual library) or can a digital library be more?*

*How do we organise & navigate all the different types of information available?*

*(spatial organisation won't work - Multimedia info ?)*

*Do we need librarians? What will they do?*

What does the Wikipedia experience tell us?

Library: Repository of existing knowledge

What does the Wikipedia experience tell us?

Nupedia –web-based encyclopedia, articles written by experts (w/ PhDs) & licenced as free content. Funded in Jimmy Wales of bomis.com. Nupedia had extensive peer review process, only 24 articles completed the process, discontinued after Sept 2003

Wikipedia started as a feeder project for Nupedia  
Goal is to produce free encyclopedias in all languages based on a neutral point of view, anyone can contribute or edit self-policed for accuracy, vandalism, etc.

By Sept 2004 Wikipedia had 1m articles in > 100 languages

By March 2006, English Wikipedia hit 1m articles

*Can a Wiki (organised & policed by users) ever be considered authoritative?*

Library: Repository of existing knowledge

*What kind of an interface do we need for a virtual library?*



Library: Repository of existing knowledge

*How do we organise & navigate all the different types of information available?*

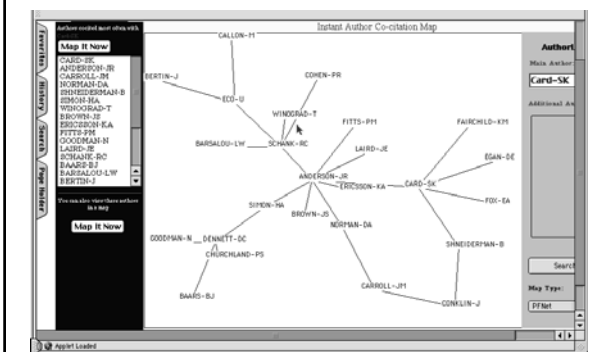
*(spatial organisation won't work - Multimedia info ?)*

*How is a digital library different from a database?*

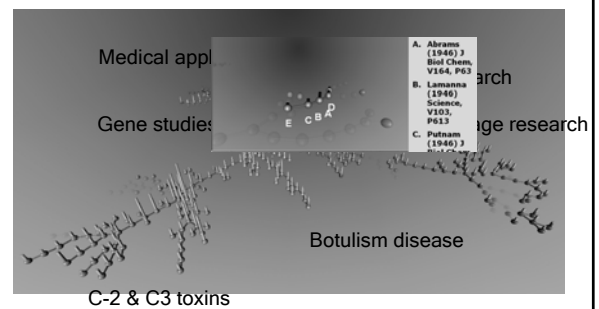
Traditional relational database searches are not probabilistic, they use specific structures, known relationships (links), or keywords (metadata)

A digital library search could use inexact matching (probabilistic, clustering, pathfinder & MDS scaling) based on contents of text

Author-link search results -- PFNet algorithm



Library search of research on botulinum toxin research between 1945 and 2002 (PFNet algorithm)



### Future Challenge #2

Scholarship: Creation of new knowledge

Data integration (data mining)

Solving complex dynamic equations (modeling weather)

Simulation of complex physical phenomenon

Collaboratories – distributed teams of researchers working on topics  
Goals are expanded access, structural transformation (multidisciplinary), new kinds of science, increased output



<http://www.scienceofcollaboratories.org/Resources/colisting.php>

### Future Challenge #3

Teaching: Transmitting knowledge

Knowledge is the medium & product of a university

E-learning, Distance learning & Virtual Universities



Teaching: Transmitting knowledge

Self-paced instruction can be very convenient

*But is learning a solitary activity?*

*Does class size matter?*

*How big is too big - how small is too small?*

*Is lecturing the best learning format?*

asynchronous vs synchronous learning

*Does synchronicity of participants matter?*

*Is video conferencing the answer?*

*Can we do better than distance education?*

*Does cyberspace offer other opportunities?*

Teaching: Transmitting knowledge

*Would you go to a school for avatars?*

*Is this better than email?*

Avatars: a representation of yourself that you can "send" anywhere to interact with others

*Better than a conference call?*

*Why not just videoconference?*

*Can we use the technology to change the quality of social interactions?*

*What are the issues?*

*Does it matter what the avatar is being used for?*

Anthony & Lawson, 2002

Avatars can do things and go places that we can't

Anyone can be rendered as an avatar

Avatars can even be who we aren't

### Massive Multiplayer Online Role Playing Games (MMORPGs)

There, Second Life, EverQuest, Guild Wars, Hattrick, Lineage, Maplestory, Runescape, Star Wars Galaxies, World of Warcraft

#### The Sims On-line (TSO)

Peter Ludlow, philosophy professor, University of Michigan entered TSO as an "investigative reporter" and published Alphaville Herald – documented "scammers" (who steal simoleans) & interviewed "Evangeline" who ran an on-line brothel in TSO.

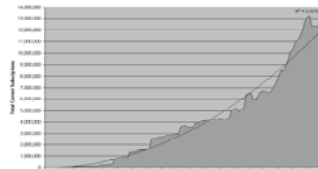
Ludlow was banned from the game "*The only thing that makes any sense to me at all is they don't care what's going on in the game...They just don't want people to know what's going on.*"

The Sim Mafia subsequently appeared inside TSO "*Our job is to basically take those complaints from the normal citizens of the game, who can't go to EA because EA won't do anything about it*" (thesimmafia.com)

### Massive Multiplayer Online Role Playing Games (MMORPGs)

number of active players

Guild Wars	– 3,000,000
Hattrick	– 934,000
Lineage	– 1,300,000
Maplestory	– 2,000,000
Runescape	– 1,000,000
World of Warcraft	– 8,500,000



8.7% of male and 23.2% of female players have had an online wedding

### Discussion: Design a better university

goals: learner-centred, affordable, lifelong learning, interactive/collaborative, diverse, intelligent & adaptive

do you agree with these goals?

are there additional goals?

how do we use the knowledge systems information we've discussed to meet these goals?