



# On the Net or invisible: The evolution of mathematics and Science

Andrew Odlyzko  
Digital Technology Center  
University of Minnesota  
<http://www.dtc.umn.edu/~odlyzko>



## Key points:

- Scholarly communication is changing rapidly
- Available information drives patterns of usage
- Journals are not where the interesting action is
- Competition for attention is key to the future



Why do we have to have change?  
Why isn't change faster?

Complicated world with many poorly understood feedback loops.

STM publishing:

- ◆ approx. 2 million articles per year
- ◆ approx. \$8 billion in revenues for publishers

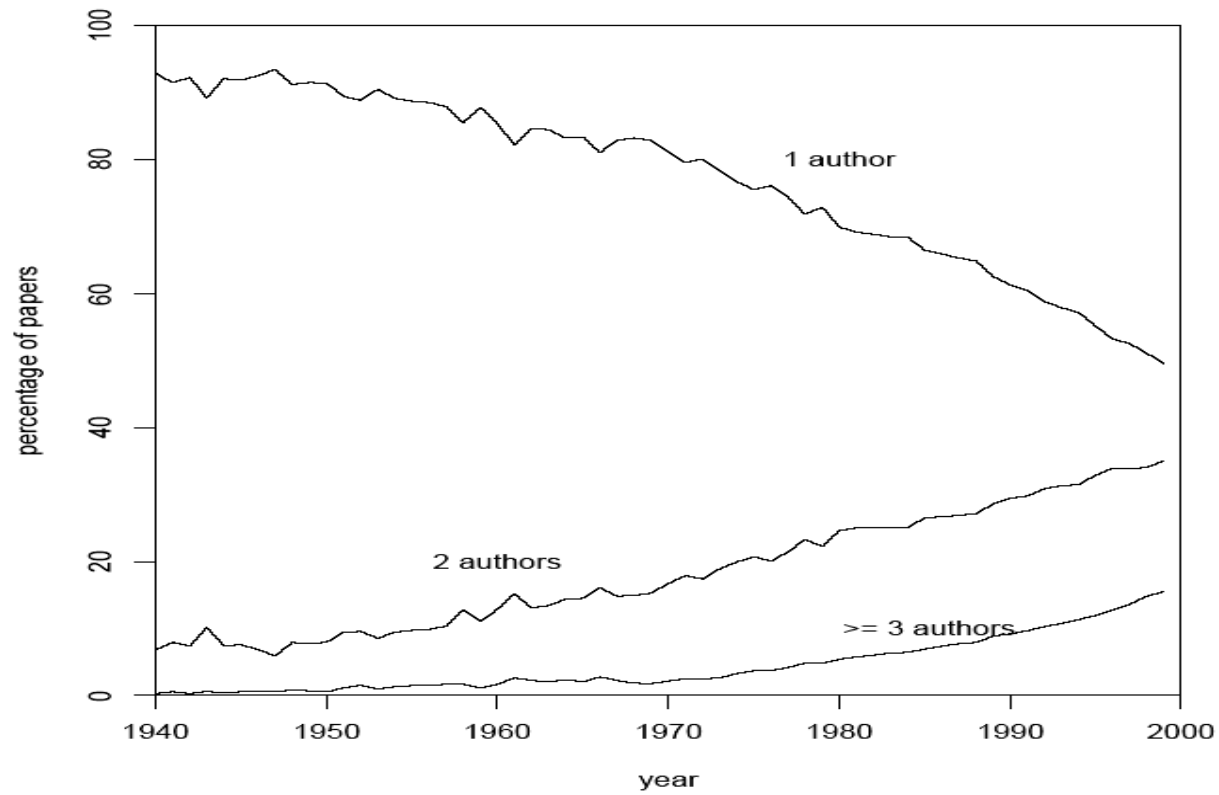
Total spending on R&D is 100 times larger!

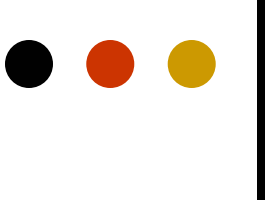
Pressure for change is increasing rapidly.



# Some changes are extremely slow

collaboration among mathematicians





# Some changes are faster, but Internet time is a myth!

A modern maxim says.

People tend to overestimate what can be done in one year and underestimate what can be done in five or ten years.

J. C. R. Licklider, "Libraries of the Future" 1965

Except for the browser, a decade is still the typical time for a new technology to be widely accepted.



## Cautionary notes.

- Encyclopaedia Britannica
- mainframe computers



# Library statistics, 1996-97 academic year

	circulation	staff	acquisition	total budget
Brown	0.3M	240	\$5.0M	\$14.8M
Harvard	1.4M	1182	\$17.5M	\$70.9M
Ohio State	1.5M	423	\$8.6M	\$22.1M
Princeton	0.6M	384	\$9.2M	\$24.9M

The journal crisis is a library cost crisis more than a publisher pricing crisis!

In the meantime, online usage is increasing rapidly!



# AT&T Labs-Research external Web server statistics.

Month	“hits”	hosts
Jan 1997	542, 644	17, 886
Jan 1998	754, 477	35, 943
Jan 1999	1, 204, 664	67, 191
Jan 2000	1, 843, 319	100, 077
Jan 2001	4, 190, 362	178, 923



# Library of Congress electronic services

month	GB	requests (millions)
Feb 1995	14.0	1.1
Feb 1996	31.2	3.9
Feb 1997	109.4	15.1
Feb 1998	282.0	36.0
Feb 1999	535.0	48.6
Feb 2000	741.1	61.3
Feb 2001	1202.6	86.7
Feb 2002	2043.6	138.6
Feb 2003	2890.3	182.0



# First Monday access statistics

Month	Hosts	Articles	MB
Feb 1999	16, 780	63, 722	1, 607
Feb 2000	22, 839	122, 983	2, 995
Feb 2001	48, 478	210, 269	5, 938
Feb 2002	58, 309	299, 273	8, 913
Feb 2003	83, 580	356, 628	11, 713



**Neil Sloane's sequence server.**

**<http://www.research.att.com/~njas/sequences/>**

**What is the next term in the sequence**

**1, 2, 3, 6, 11, 23, 47, 106, 235, ?**

Requests to Neil Sloane's sequence server.

Month	Requests	Hosts
Jan 1997	6, 646	550
Jan 1998	33, 508	2, 294
Jan 1999	58, 655	3, 996
Jan 2000	135, 843	7, 851
Jan 2001	222, 795	11, 105



This discovery of yours will create forgetfulness in the minds of those who learn to use it; they will not exercise their memories, but, trusting in external, foreign marks, they will not bring things to remembrance from within themselves. You have discovered a remedy not for memory, but for reminding. You offer your students the appearance of wisdom, not true wisdom. They will be hearers of many things and will have learned nothing; they will appear to be omniscient and will generally know nothing; they will be tiresome company, having the show of wisdom without the reality.

Plato, "Phaedrus"

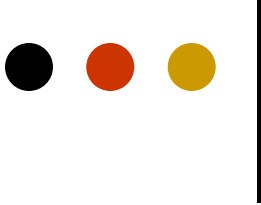


# Even small barriers reduce usage

Easy Web access reduces barriers, and stimulates usage:

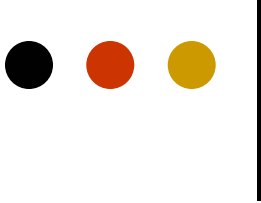
Penn State University.

- in math, pre-1973 material in off-site storage
- math research community: about 200 people
- number of items requested from off-site storage per year: 850



... there's a sense in which the journal articles prior to the inception of that electronic abstracting and indexing database may as well not exist, because they are so difficult to find. Now that we are starting to see, in libraries, full-text showing up online, I think we are very shortly going to cross a sort of critical mass boundary where those publications that are not instantly available in full-text will become kind of second-rate in a sense, not because their quality is low, but just because people will prefer the accessibility of things they can get right away.

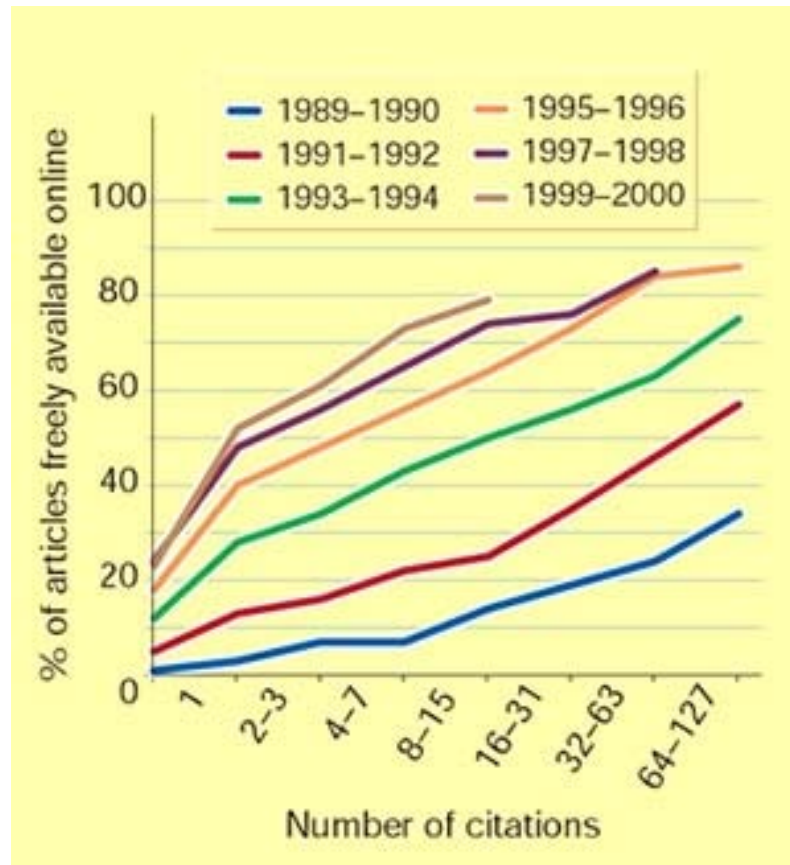
Clifford Lynch, 1997



AO, "Tragic loss or good riddance. The impending demise of traditional scholarly journals," 1994. predicted that pay-per-view in scholarly communication doomed to fail because of the deterrent effects of usage charges

[Elsevier's] goal is to give people access to as much information as possible on a flat fee, unlimited use basis. [Elsevier's] experience has been that as soon as the usage is metered on a per-article basis, there is an inhibition on use or a concern about exceeding some budget allocation.

K. Hunter of Elsevier, 2000



S. Lawrence, [www.nature.com/nature/debates/e-access/](http://www.nature.com/nature/debates/e-access/) and (extended version) at [www.neci.nec.com/~lawrence/papers/online-nature01/](http://www.neci.nec.com/~lawrence/papers/online-nature01/) online articles are cited 4.5 times as often as those available exclusively in print.

Such data produces strong incentives for authors to make their articles freely available.

Appeals to altruism will no longer be the primary motivation!



Digitization of print literature is not a huge task from financial and technical standpoint (but economics and copyrights are a different story).

Total mathematical literature:

On the order of 30,000,000 pages

Digitization (including some OCR, but not rekeying) costs from 20 cents to 2 dollars per page (depending on how much skilled labor is involved in the preparation of final output) hence total costs of digitizing the literature are in the range of \$6 M to \$60 M

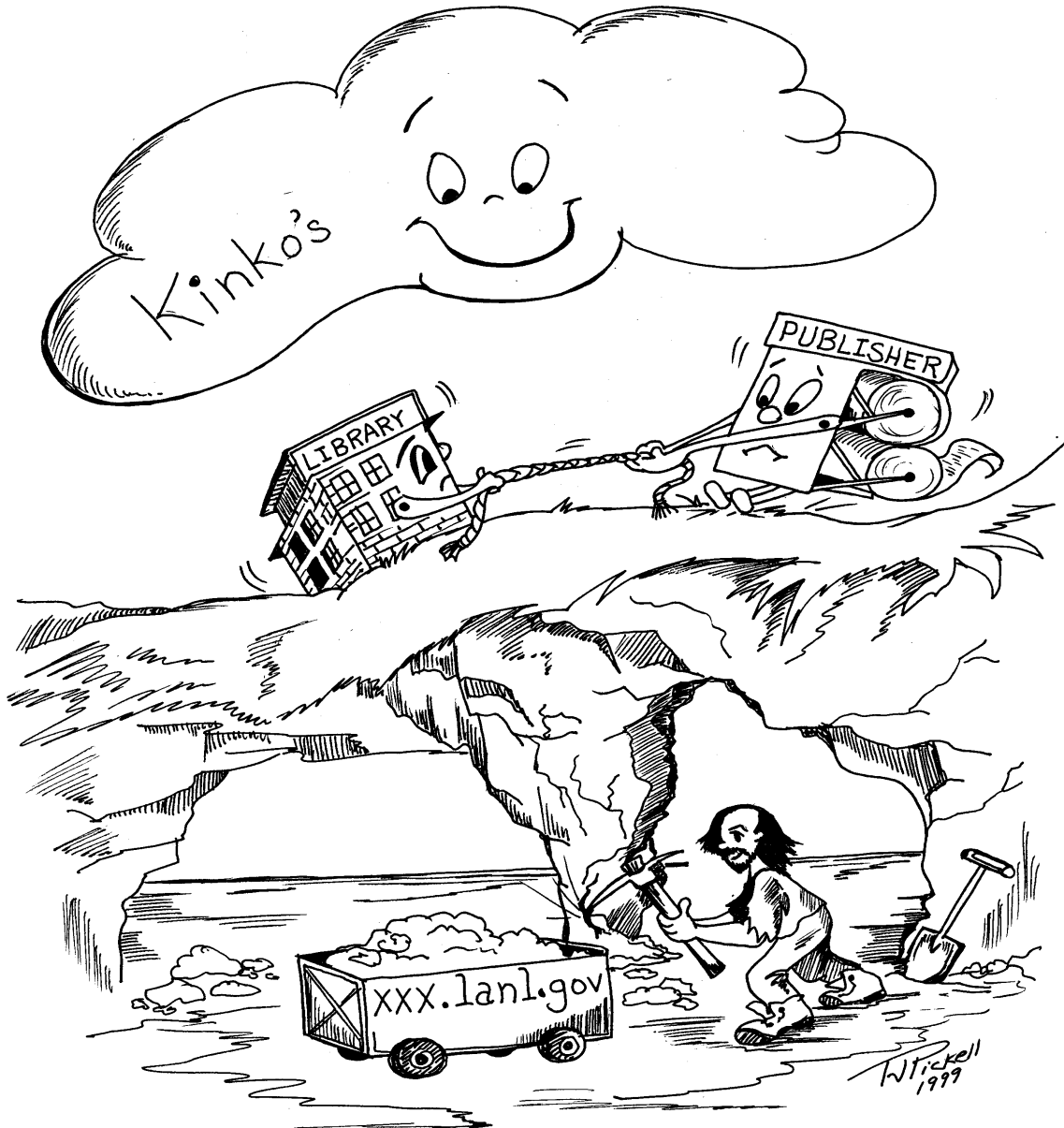
By comparison, all math journals have annual revenues of over \$200 M



Spending on information in an  
Information Age can only increase!

But where will this spending take place?

Most functions (peer review, distribution,  
preservation, ...) can migrate.





# Conclusions.

- **ease of access and use is paramount**
- **the most interesting developments are outside the formal library/publishing format**
- **it's a “war for the eyeballs” in scholarly communication as well as in commerce**

More details in papers at

[www.dtc.umn.edu/~odlyzko/doc/eworld.html](http://www.dtc.umn.edu/~odlyzko/doc/eworld.html)