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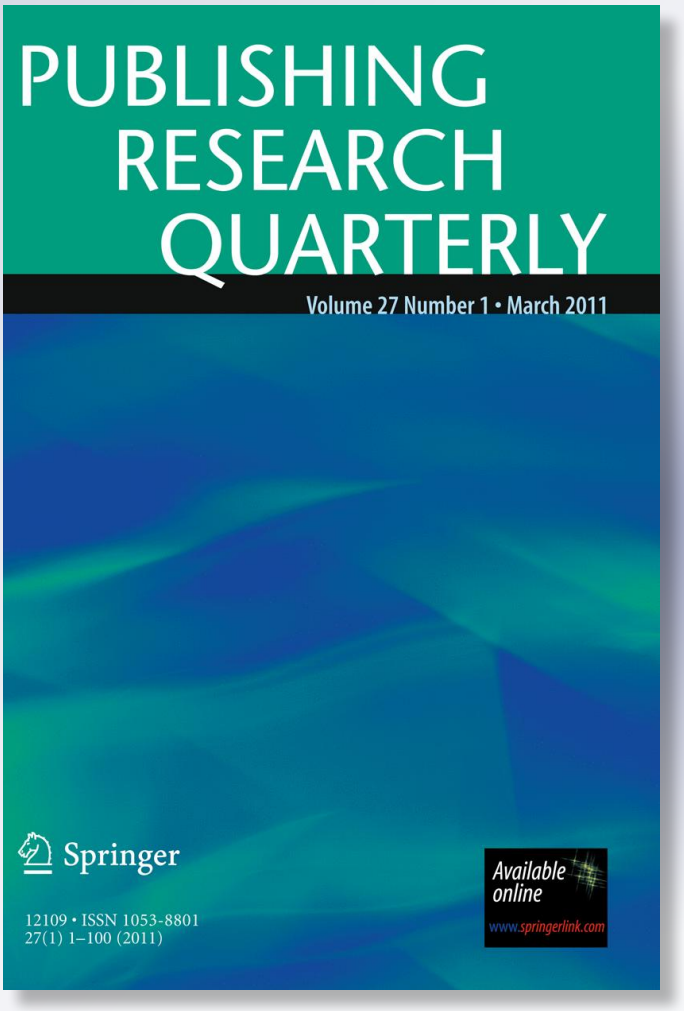
Publishing Research Quarterly

ISSN 1053-8801
Volume 27
Number 1

Pub Res Q (2011) 27:1-12
DOI 10.1007/s12109-011-9202-y



Springer

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The Scholarly Communication of the Future: From Book Information to Problem Solving

Rafael Ball

Published online: 3 February 2011

Abstract As long as scientists discuss scientific problems and communicate with each other, scholarly communication is an essential part of scientific activities. In the very ancient time the scholarly communication was only an oral tradition, a face to face communication. Later on, the written form of communication has taken place. Since the invention of movable printing types by Gutenberg the scholarly communication was preferable in written and printed form. Since 15 years the revolution has taken place with the digital information, which is now available for scholarly communication. There was a paradigm shift from the printed and oral tradition to a new digital electronic science communication. In the future the traditional printed book information for scientific communication will be replaced by problem solving portals with all electronic and digital tools.

Keywords Digital era · Digital scientific information · Electronic information environment · Electronic information · e-sciences · Scholarly communication future · Scholarly communication history · Science communication · Scientific platforms

Introduction

Within living memory, scientists have always been communicating and exchanging ideas, thoughts and hypotheses as well as their scientific results. In antiquity,

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scholarly communication[1] was synchronous, and manifested itself as human-to-human (face-to-face) interaction.[2]

However, already more than 2,000 years ago in ancient Greece, the first fundamental dispute about the most desirable form of scholarly communication took place. While Plato, as an advocate of synchronous communication, strictly opposed to written forms of scholarly discourse, Aristotle expected considerable benefits from the textualization of science.

Language, as the necessary basis of scholarly communication, always depends on a medium for its realization. The paradigm shift from oral to written forms of communication that has taken place in antiquity,[3] illustrates the very basic problem of the relation of content and form, which has also led to intense debates in the Age of Enlightenment.[4] The need for written forms of knowledge is shared by all elaborate social structures and societies.[5] However, it was no accident that it was in ancient Greece, with its comparatively high percentage of literacy, where the discussion about the best form of scholarly communication first came up.[6]

It was the regular, written fixation of scholarly communication that made a systematic collection of scientific knowledge in libraries possible. This paradigm shift was a prerequisite for the sophisticated system of libraries that have now been preserving and making accessible information for more than 2,000 years. For all this time, Libraries have primarily been concerned with the safety and integrity of scientific documents: Up to the present, attributes like accessibility, durability and completeness of their collections have been the trademarks of librarians.

Scholarly communication and libraries are mutually dependent. That is why the new, emerging paradigm shift from the communication via books to communicating digitally is of fundamental importance for both science and libraries. We are now only beginning to understand and to model the consequences of this development. Today, dynamic documents are being created in the process of scholarly knowledge production, and these documents have a great impact on the way knowledge is produced, stored, and made accessible.

[1] 'Scholarly communication is here understood as communication in (between members of) the scientific community, and not in the sense of communicating science to the general public.

[2] Hermann Rösch, "Wissenschaftliche Kommunikation und Bibliotheken im Wandel," *B.I.T.-Online* 2 [12]: 113–124.

[3] Gabriele Kalmbach, *Der Dialog im Spannungsfeld von Schriftlichkeit und Mündlichkeit* (Tübingen: Niemeyer, [9].

[4] Michael Cahn, "Die Medien des Wissens. Sprache, Schrift und Druck," in *Der Druck des Wissens. Geschichte und Medium der wissenschaftlichen Publikation*, ed. Michael Cahn (Wiesbaden: Reichert, [2], 31–64.

[5] Ernesto Hofmann, "Wort, Schrift, Druck: Kommunikation im Wandel," accessed Dezember 10, [7], http://www.ejournal.at/buecher/erhomedia/index.html.

[6] Rafael Capurro, "Medien (R-)Evolutionen: Platon, Kant und der Cyberspace," last modified January 22, [3], http://www.capurro.de/leipzig.htm.

We have only just begun to understand how dynamic documents may revolutionize scientific results and their concretion in the form of scholarly publications, e.g. by allowing the simultaneous creation, distribution and discussion of ideas in 'real-time'. This is a dramatic change that also entails consequences for libraries: The acquisition, preservation and content analysis of our scientific heritage can no longer be modelled on the attributes of static documents. We need new concepts for a new scientific reality.

The Development of Scientific Communication Up to the Present

Raffaelo Sanzio (1509): The School of Athens

Source: http://en.wikipedia.org

The development of scholarly communication is closely connected to the history of academies in Europe since antiquity. The very first of these is thought to be the academy founded by Plato, 385 BC.[7] It served the sole purpose of educating

[7] Hans Krämer, "Die Ältere Akademie," in *Die Philosophie der Antike: Ältere Akademie, Aristoteles und Peripatos*, vol. 3. Basel: Schwabe, [10]. Also see Microsoft, *Microsoft Encarta Enzyklopädie,* Microsoft Corporation, [5].

philosophers. Oral (Socratic) dialogues were the dominant form of scholarly communication, alongside with disputations, lectures and exercises of a more interactive nature.[8]

The antique academies supposedly existed until 529 AD, when emperor Justinian had the Platonic academy closed.[9] It took 1,000 years until the antique culture of academies was being revived: in 1426, Marcilio Viccino founded the first occidental academy, which was modelled on its antique predecessors ('Academica Platonica'). At the beginning of the 17th century, about 400 academies had been founded; however, not all of them lasted very long.

It was only then that scholars turned away from the Platonic ideal of scholarship, and concentrated on the natural sciences alongside purely philosophical problems. Leibniz' maxim, „science in the service of progress",[10] was a defining element for the academies of the 17th and 18th century. Among the most important academies in Europe in this age were the Royal Society in London (founded 1662), the Académie des Sciences in Paris (founded 1666), and the Kurfürstlich Brandenburgische Societät der Sciencien in Berlin (founded 1700).

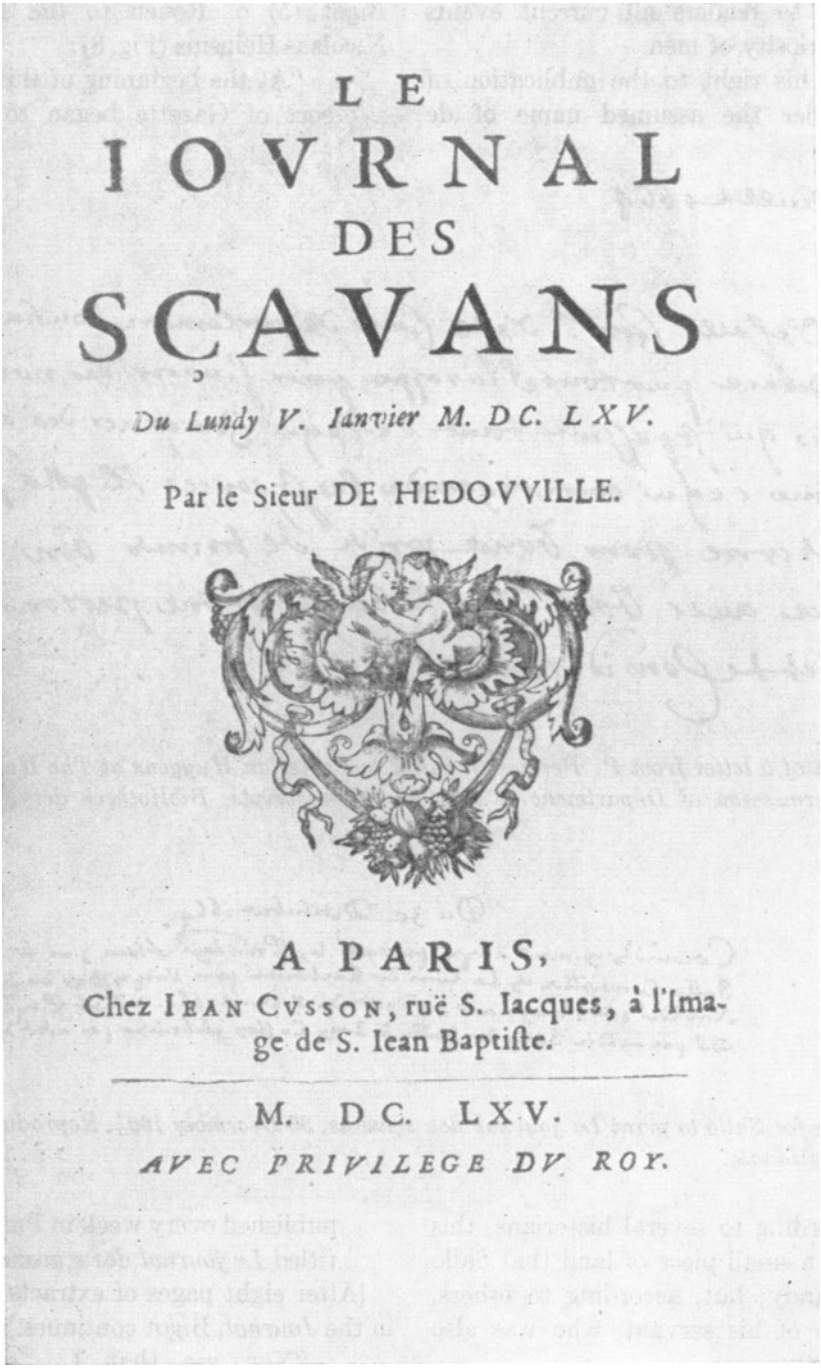
The academies were not only promoting and furthering science and education, but also served as a focus for scholarly communication. While the development of the letterpress had already allowed to create voluminous scientific works, indices and catalogues (e.g. Konrad Gessner's Biblioteca Universalis, 1545), it was still an intricate and rather long-winded process to communicate via printed books. The 'small form' of scholarly communication, e.g. contributions to discussions, reports about experiments, reviews or notes, was not yet institutionalized, and scholarly periodicals had not yet been invented. However, there was a predecessor to today's scholarly journals (which are of paramount importance for the natural sciences, technological disciplines, and medicine): the minutes and records of the academies of the 17th century. Lectures, notes and reports about results and discussions were sent to the members of the academy. From there, it was only a small step to collecting, editing and publishing these protocols in form of a scholarly periodical.

[8] Barbara Janßen, "Medienkritik bei Platon und heute," accessed July 15, [8], http://www.linse.uni-essen.de/linse/esel/arbeiten/medienkritik.html.

[9] Hubert Cancik et al., *Der Neue Pauly: Enzyklopädie der Antike (DNP)* (Weimar: Metzler, [4].

[10] Hubert Cancik et al., *Pauly.*

Title Page of Journal Des Sçavans, No. 1 (1665)



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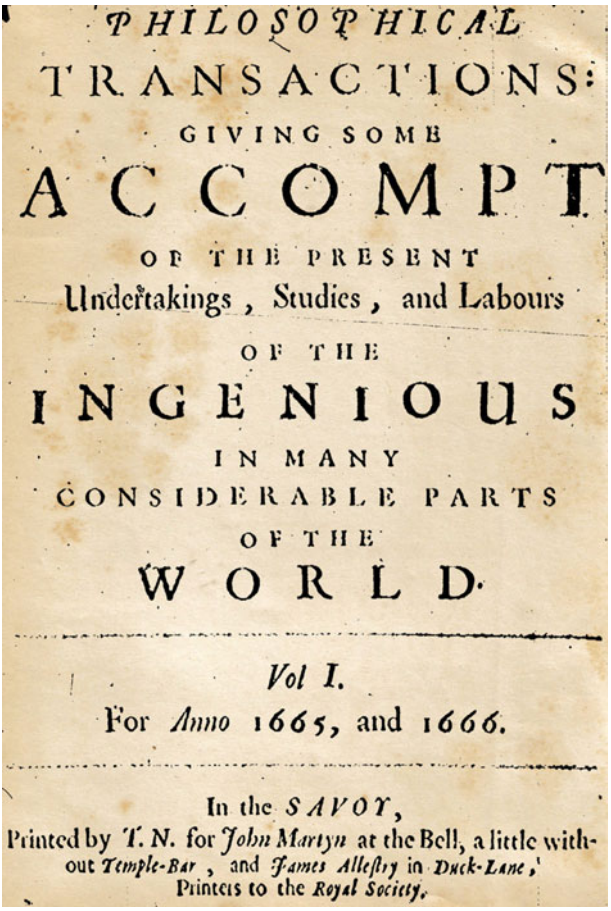
Cover of the First Volume of Phil. Trans., Covering the Years 1665 and 1666


PHILOSOPHICAL
TRANSACTIONS:
GIVING SOME
ACCOMPT
OF THE PRESENT
Undertakings, Studies, and Labours
OF THE
INGENIOUS
IN MANY
CONSIDERABLE PARTS
OF THE
WORLD.
Vol I.
For Anno 1665, and 1666.
In the SAVOY,
Printed by T. N. for John Martyn at the Bell, a little without Temple-Bar, and James Allestry in Duck-Lane,
Printers to the Royal Society.

Source: http://en.wikipedia.org

The first scholarly periodical was the "Journal des Scavants", which was first published in 1665. The "Philosophical Transactions", published by the Royal Society, followed shortly after. Incidentally, both periodicals are still being published today.

The evolution of scientific journals revolutionized scholarly communication. It became possible to report about a variety of topics in a focused, concise, periodical and frequent way, without taking recourse to the long-winded process of creating a book. However, the scholarly periodical did not really begin its triumphal course until the middle of the 19th century, when the number of periodicals virtually exploded. Today, there are more than 160,000 scholarly periodicals worldwide.

The Generation of Knowledge and Science Communication

Scholarly communication can be understood to consist of three distinct phases:

1. the development and scientific flow of ideas (informal communication among colleagues),
2. further processing, concretion, and ongoing communication with colleagues,
3. the formal, publicly available end product in form of an article in a journal or conference proceedings, a monograph etc.[11]

The Generation of Knowledge: Formally and Today

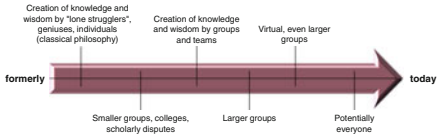


Diagram: Rafael Ball

These three phases also mirror a (generalized) process of how knowledge is gained by doing science. Along this 'chain of knowledge creation', the process of scholarly communication develops.

The 'Chain of Knowledge Creation'

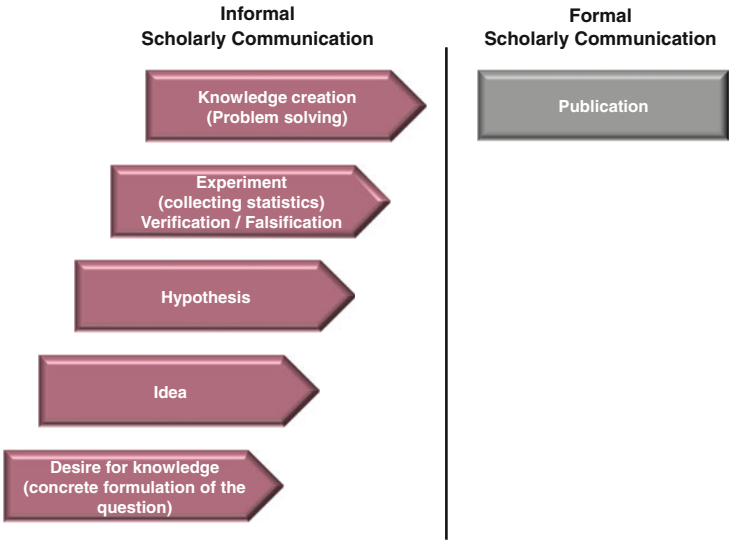


Diagram: Rafael Ball

[11] Suzanne E. Thorin, "Global Changes in Scholarly Communication" (paper presented at the e-Workshops on Scholarly Communication in the Digital Era, Feng Chia University, Taichung, Taiwan, August 11–24, [13], accessed April 11, 2010. http://www.arl.org/bm~doc/thorin.pdf.

At the starting point of this process, we can always find the wish to gain knowledge or insight. On the basis of an idea, a hypothesis is being developed, which is then verified or falsified according to the methods of the respective discipline. Only then, knowledge is gained, or the solution to a problem is proven to be correct. At this point, the new knowledge can be fitted into the structure of formal scholarly communication. Up to the present, science has always known this qualitative difference between informal and formal scholarly communication.

Traditionally, only the formal end product (a monograph, a scientific article, etc.) has been considered as the proper outcome of the process of creating knowledge. Significantly, only this part of the scientific process with its formalized products was of interest to the librarian. Libraries neither have extensive collections of primary data (laboratory journals, drafts or outlines, preliminary considerations etc.), nor were these products of informal scholarly communication ever being accessed to a great extent.

However, during the last decade, new technological developments have been changing our idea of scholarly communication.[12] It is hardly exaggerated to call these recent developments a paradigm shift. The existence of a clear qualitative gap between informal scholarly communication and the finished, formal products of scientific work has been cast into doubt. Gradual shades have been replacing what once was a steep divide.

Furthermore, for some scientific disciplines, finding scientific ideas does no longer take place among an inner circle of colleagues in a laboratory or institute, but will increasingly be negotiated in public 'marketplaces'. In the hypermedium internet, almost the whole chain of knowledge creation can be discussed in a great number of delimited, but very often freely accessible communities, and on a variety of platforms; 'publishing' thus obtains a new meaning. It has now become reality that scientific knowledge is being developed cooperatively, in public communities, and independently from time and space. This forces us to reconsider our definitions of scholarly communication, and, in consequence, libraries too have to think about their self-conception, their function as collectors of documents, and the types of media they hold.

Today, scientific communication is characterized by an increasing dissolution of the hitherto well-defined boundaries between informal and formal communication, and by a considerable heterogeneity and complexity of media used by formal scholarly communication.[13] In the age of printed media, there was a clear division between the world of informal scholarly communication (which was not relevant to libraries), and the world of formal scholarly communication (collected by libraries). The rapid changes that have taken place over the last 15 years have almost nullified this distinct divide, and created a continuity between informal and formal scholarly communication.

[12] S. Hagenhoff et al., "Neue Formen der Wissenschaftskommunikation: eine Fallstudienuntersuchung," in Göttinger Schriften zur Internetforschung (Universitätsverlag Göttingen: Göttingen, [6].

[13] Wolfgang Riepl, *Das Nachrichtenwesen des Altertums mit besonderer Rücksicht auf die Römer* (Leipzig: Berlin, [11].

Today, already in the early phases of the 'knowledge chain', the scientific community is being integrated into the discussion and evaluation of first results. Communication software makes it possible to integrate locally disperse researchers and research groups. Ideas are being generated in chat rooms via virtual discourse. Scientific preprints are being reviewed publicly, thus narrowing the qualitative gap that formerly existed between a preprint and the final publication. For libraries, but also for the hitherto dominant idea of individual authorship, all this has dramatic consequences. As there is no longer a clear definition of when and by whom a scholarly work has been published (with all entailed consequences for the citability of a work) the traditional and up to now absolutely sufficient understanding of what a library should collect becomes obsolete. Irritating is not so much the great variety of media and technological means that are being employed, but the loss of well defined boundaries between informal and formal scholarly communication, and the emergence of a new form of collective authorship, which accentuates individual contributions to a final knowledge product to lesser degree than we are used to. Authorship may become less visible—up to the point where individual contributions are not even meant to be relatable to specific persons. For quite some time, libraries have been collecting and archiving preprints, discussion papers and other preliminary publications, and have been making them available to scientists and students. Generally, citability has become a touchstone of this system. It allows finding a publication in digital or printed space. This is why libraries are increasingly forced to draw the boundaries between formal and informal scholarly communication arbitrarily.

For a very long time, the typical result of scientific work has been an article or a monograph; it documented the integrity and wholeness of the results, and the finiteness of the process of knowledge that has taken place; it could not be altered, and its authors and editors were well-defined. Finally, it could be archived for virtually unlimited time. The age of electronic, dynamic and collectively generated scientific documents has only just begun, and it cannot be understood or even described in these terms. To describe modern scholarly communication, both researchers and librarians have to part with these dated categories. It is only in this way that they can participate in the ongoing discussion, and maybe have some impact on the future shape of science.

Scholarly Communication, E-Science and Primary Data

A further topic of potentially great future relevance in the field of scholarly communication is primary data. Already today, a variety of disciplines are providing access to primary scientific data, e.g. series of measurements, data from satellites, weather data, or empirical data from socio-scientific surveys, not only as a point of reference, but also to facilitate the further use of this data in other research projects.

As already discussed, scholarly communication today is characterized by an increasing dissolution of the hitherto well-defined boundaries between informal and formal communication. This has also sparked a dispute about the status of (formal or informal) primary data. For those disciplines willing to share their primary data,

libraries can provide valuable services. While for some disciplines, archiving and making accessible primary data has proven to be very rewarding, other fields of research like molecular biology and genetics are guarding their primary data jealously in a relentless struggle for research money and patents. Freely accessible DNA databases in the Public Domain provide a playground for scientists; the really critical data, however, is carefully protected until the moment for its publication has come.

Not only the life sciences, but also the humanities are usually reluctant when it comes to publishing primary data, as even the very concept of this type of data is not totally clear in these disciplines. With an informal understanding of scholarly communication, however, the output of intellectual discussion circles that are at work before the actual scholarly hypotheses are formed, could be understood as a form of primary data, and thus be published and archived.

E-science is short for 'Enhanced Science' (and not, as commonly mistaken, for 'Electronic Science'), and denotes a new form of network-based, cooperative scientific work. On the basis of the newest networking technologies and by using information and knowledge technology, research processes are facilitated, improved and intensified. With local computers, virtual collaboration and Open Access, a new method of scientific work has become available for scientists.

The Dialectics of Scholarly Communication

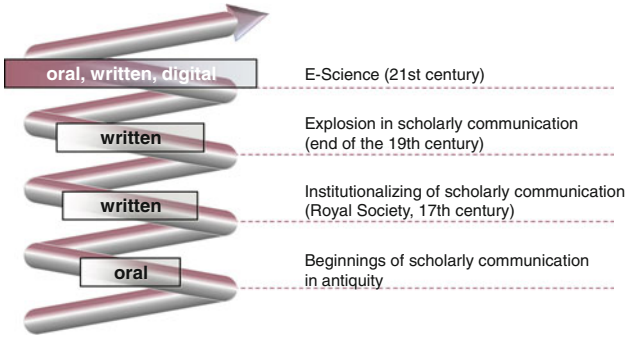


Diagram: Rafael Ball

While scholarly communication in antiquity was oral and synchronic, its textualization, especially after Gutenberg, and with the institutionalization of scientific communication after the foundation of the academies in the 17th century and the explosion of scientific output since the end of the 19th century, has now reached an absolute peak. The oral tradition has long since transformed into written, asynchronous scholarly communication.

The scholarly communication of the near future, however, will be integrating these opposites dialectically. It will be characterized by the simultaneity of oral, written, and digital scholarly communication, and it combines synchronous and asynchronous forms of communication.

At the same time, E-science (probably the new shape of science for the 21st century), is beginning to nullify the strict division of informal and formal scholarly communication. In an almost continuous process of developing ideas and hypotheses, of falsification and verification until publication, the creation and distribution of knowledge takes place in a vast, virtual space that comprises the whole scientific community.[14]

Summary and Future Prospects

For almost 500 years, the printed book has been the dominant medium of science and scholarly communication. Saying goodbye to this medium might give rise to many potential concerns. However, we will not lose our cultural heritage, nor the scientific contents or our knowledge. We only have to let go of a specific medium, which we have learned to treasure: paper in form of a book, and books in form of paper.

The media of the scholarly communication of the future will be different. There will be no more separate contents and objects that need to be assembled physically and intellectually, but complex electronic platforms that allow using both primary and secondary sources. These platforms will also offer effective communication software that interconnects the scientific community, and professional systems for the collaborative production and publication of scientific research products. Integrated additional tools, e.g. data sheets, calculation and drawing programs or Yellow Pages, will be specifically adapted to the needs of individual disciplines, thus completing these elaborated research platforms.

Libraries of the future will not provide books, periodicals and databases for its customers, but integrated portals geared towards the needs of individual research disciplines.

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