Scholarly Skywriting and the Prepublication Continuum of Scientific Inquiry

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William Gardner's proposal* (1990) is fine, as far as it goes (though he seems to have missed some of the relevant background literature, e.g. Engelbart 1975, 1984a, b; Schatz, 1985, 1987, 1990). The potential role of electronic networks in scientific publication, however goes far beyond providing searchable electronic archives for electronic journals. The whole process of scholarly communication currently is undergoing a revolution comparable to the one occasioned by the invention of printing. On the brink of intellectual perestroika is that vast prepublication phase of scientific inquiry in which ideas and findings are discussed informally with colleagues (in person, by phone, and by regular mail), presented more formally in seminars, conferences, and symposia, and distributed still more widely in the form of preprints and technical reports that have undergone various degrees of peer review. It has now become possible to do all of this in a remarkably new way that is not only incomparably more thorough and systematic in its distribution, potentially global in scale and almost instantaneous in speed, but so unprecedentedly interactive that it will substantially restructure the pursuit of knowledge.

The prepublication phase of scientific inquiry is, after all, the one in which most of

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the cognitive work is done. Some of this work is relatively noninteractive, to be sure (for example, actually executing experiments, running computer simulations, or proving theorems). But the rest—from the interplay of the prior ideas out of which the experiments were designed, and the theories were constructed to the analysis and interpretation of the findings and their fit to the theories—clearly consists of activities that profit from peer feedback. For most investigators the formal submission of a manuscript for refereeing is not the first stage at which it has been subjected to peer scrutiny; that is what all the prior discussions, sympo-

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*Gardner, writing in *Psychological Science*, proposed an electronic journal publishing program for psychologists, called the electronic archive. He cited three critical principles: first, electronic publishing must retain the readability of a traditional printed journal. Second, it must be both accessible and attractive to all members of the discipline, whether they use computers or not. Most importantly, it must provide improved facilities for retrieving information, while continuing to serve as a permanent archive. He argued that the primary advantage of electronic publishing is not the inexpensive delivery of text, but the use of a centralized archive to concentrate resources for discovering and utilizing information.

sia, and preprints had been intended to elicit. And all the prepublication interaction clearly is continuous with the lapidary stage at which the manuscript—usually further revised in response to peer review—is accepted and archived in print. Nor does the process really end there, for of course the literature may respond to a contribution directly or indirectly for years to come, and there are even ways of soliciting post-publication feedback in the form of "open peer commentary" (as in this case).

Not just archiving itself, but all these other stages of scientific inquiry, which are on a continuum with the archival function, must be jointly re-examined in the light of the new technology. The picture that accordingly emerges turns out to be very different from what an exclusive spotlight on electronic archiving suggests.

There now exist numerous electronic networks such as Bitnet and Internet that link academic and research institutions globally. They not only make it possible to send electronic mail (e-mail) from individual to individual almost instantaneously, but they allow individuals to send multiple e-mail to groups of individuals reciprocally—anywhere from a few collaborating colleagues, to all the experts in a given subspecialty, to an entire discipline—all just as quickly as individual e-mail, but with the emergent benefits of the interactive feedback. I have called this new medium "scholarly skywriting." In principle, all the interactions at the "pilot" stage of inquiry—from informal brainstorming, to participating in research symposia, to circulating preprints for peer criticism before formal submission to an archival journal for peer review—can now be accomplished by skywriting, not only at a great saving in travel and talking time, but with a speed, geographic scope, and scale of multiple interactiveness that no prior means of communication could even come close to providing.

The potential effects of this rapid global interactiveness on scholarly inquiry are, in my opinion, nothing short of revolutionary.

But why has the revolution not begun, and why have the fabled effects so far failed to manifest themselves? There are obstacles. (1) Old ways of thinking about scientific communication and publication (partially evident in the limited scope and relatively conventional framework of Gardner's proposal) constrain our imaginations. (2) The computer is not yet quite friendly enough to have won over the majority of scholars; many still do not even use it for word-processing, much less electronic mail. It must also be admitted that (3) the current intellectual level of discussion on electronic networks is anything but inspiring. And many scholars are reluctant to entrust serious ideas, time, and attention to the net because of prima facie worries about (4) plagiarism, (5) copyright, (6) academic credit and advancement, (7) junk mail and (8) security. All these obstacles can be overcome, and all the objections have sensible answers.

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1. Old ways of thinking will not be corrected by futuristic proposals; only convincing demonstrations of the potential power, productivity, and scope of scholarly skywriting will capture the scientific community's allegiance and participation.

2. Computers are getting friendlier every day, and the proportion of scholars with e-mail is growing; but, again, the only thing that will really draw skeptics onto the net will be dramatic demonstrations of the unprecedented potential of scholarly skywriting. Then the medium will be seen to be as unique and indispensable to serious scholars as books and journals once were.

3. The currently low intellectual level of the net is purely the result of incidental initial conditions. The medium was created by engineers and computer scientists, and they (along with students, reared on video games, with little knowledge, and a lot of time on their hands) are the ones who have been setting people's expectations and standards so far, giving the impression that the net is just a global graffiti board for trivial pursuit. But this initial con-

dition which is rather as though Guttenberg and a legion of linotype operators, instead of Shakespeare and Newton, had provided our model of what the printed page was to be used for—is surely destined to rectify itself as the net's demography changes and the serious demonstrations of its scholarly potential start to appear.

4. The best protection against plagiarism would be to set up a vertical peer hierarchy like the one described later in this commentary. That way the relevant specialists will see new ideas first and know where they originated. A soft archive for all skywriting could be used to authenticate priority where necessary. And because scientists write for their peers rather than the publication-list-padding multitudes, it is not even clear how much they are, or ought to be, worried about ideas being purloined by contributors to the unrefereed vanity press.

5. The copyright laws will no doubt have to be enlarged to take the electronic media into account, but, in principle, skywriting represents no greater or lesser threat to auctorial proprietorship than printing or photocopying.

6. Once the intellectual potential of scholarly skywriting is demonstrated, it is a foregone conclusion that contributions to the medium will be given much greater weight. Just as citation statistics have become relevant to tenure/promotion committees, so will airtime—weighted, of course, by the altitude in the peer hierarchy where it takes place. Moreover, as there is no real hermetic seal along the horizontal (archiving) continuum either, skywriting contributions will come to be cited in the "hard" archival publications with which Gardner is concerned, just as "personal communications" are now, except that, having already been jointly witnessed in the sky by the relevant peer community when they originally appeared, these "soft" citations will be increasingly seen as the locus classicus, or at least the site of origin, of new contributions.

7. The concern about being overwhelmed by junk electronic mail in an age when there is already an information glut looks reason-able on the face of it, but actually is quite wrong-headed. It is, in fact, easier to filter electronic mail than it is to filter paper mail and phone calls (yet we never considered turning our back on the latter because of potential overload). Simple computer programs can restrict one's e-mail to the individuals, groups or topics one chooses. Moreover, even unfiltered e-mail, unlike paper mail and phone calls, can be discarded with one keystroke after scanning a one-line topic header. In fact, e-mail should soon take over much of the load of regular mail and telephoning, at a much lower cost in time and resources. So the net will turn out to be the best means of rationally managing the information glut, rather than being just another polluter.

8. In this era of computer viruses and vandalism, there are still unsolved security problems, but these need not be deterrents to scholarly skywriting. Though they are not 100% secure, the currently available password and encryption systems are safe enough for scientists, if not for military analysts. Paper mail, phone calls, and even face-to-face conversations are never altogether immune from snooping. There is no reason to see this as a greater threat on the net.

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Once we recognize that the archiving of scientific ideas and findings is *already* on a continuum, with varying degrees of formality, reliability, and even of peer validation (as in the prestige hierarchy among journals, from the most rigorously reviewed ones at the top to what is virtually a vanity press at the bottom), it is natural to transpose all of this into the electronic dimension as well. I have proposed that two dimensions should be implemented in the archival continuum that begins with an inchoate thought and ends in a lapidary entry in the literature:

> The idea is to have a vertical (peer expertise) and a horizontal (temporal-archival) dimension of quality control. The vertical di-

mension would be a pyramidal hierarchy of email groups, the height of each depending on degree of expertise, whether in a subspecialty, an entire discipline, or even an interdisciplinary field. An accredited group of peers at level i would have read/write access at level i; those at level i-1 would have read-write access at level i-1 and read-only access at level i, but with the right to post to a read-write peer at level i who could in turn post their contribution for them, if it was judged good enough. An individual with an established record of valuable mediated postings could eventually be voted up a level. A single editor or an editorial board are simply special cases of this very same mechanism, where one person or only a few mediate all writing privileges through peer review.

This vertical hierarchy would be based on the contributors' degree of expertise, specialization, and their record of contributions in a given field. In principle, the hierarchy could trickle down all the way to general access groups for nonspecialists and students at the lowest read/write levels. (Such unrefereed groups would carry the equivalent of what is called "flaming" on the network today; unfortunately, this anarchic level is the only one that exists among the net's current "unmoderated" groups; in the so-called "moderated" groups all contributions are filtered through a single person, but usually one with no special qualifications or answerability. There is not yet any real peer review on the net.)

So far, even at the highest levels, this would still be just brainstorming, at the pilot stage of inquiry. The horizontal dimension would then take the surviving products of all this skywriting, referee them the usual way (by having them read, criticized and revised under peer scrutiny) and then archive them (electronically) according to the level of rigor of the referring system they have gone through (corresponding, more or less, to the current "prestige hierarchy" and levels of specialization among print journals). Again, an unrefereed "vanity press" could be the bottom of the archiving hierarchy. (Harnad, 1990).

It would be at the late horizontal stages of such a two-dimensional system that Gardner's proposal for an interactive, searchable archive would come in, although there seems to be no reason to assume that the process should end there. It may be just as important to skywrite in response to an archived contribution as to one at a softer stage of the process. Thus, the continuum would swallow its own tail.

Scholarly inquiry in this new medium will proceed much more quickly, interactively, and globally; and it is likely to become a lot more participatory, though perhaps also more depersonalized, with ideas propagating and permuting on the net in directions over which their originators would be unable (and indeed perhaps unwilling) to claim proprietorship. An individual's compensation for the diminished proprietorship, however, would be the possibility of much greater intellectual productivity in one lifetime, and this is perhaps scholarly skywriting's greatest reward.

In accordance with the Ziegarnik effect, our memory for tasks we have not yet completed is better than for tasks we are already done with. Because of the slow turnaround time of conventional publication, by the time the literature takes up a theme that we had in mind when we published something, we may no longer be actively thinking about it. Intellectual communication has its own natural pace; perhaps real-time verbal conversation is its most natural tempo. Writing, though slower, has the advantage of being more disciplined and reflective, and of preserving an archival record of what we said. Yet we all know that we can think faster than we can write; and we can certainly think faster than the time it takes for a letter to reach someone and be answered. So consider how much faster still we are able to think than the time it takes for an article to be accepted, published, read by others, and responded to? How many are the stillborn thoughts that might have survived and flourished if only they had been stimulated by peer feedback at the right time, while they were still active in one's mind?

Skywriting offers the possibility of accelerating scholarly communication to something closer to the speed of thought while

adding a globally interactive dimension that makes the medium radically different from any other. To be truly forward-looking, Gardner's proposed searchable electronic archive should be embedded in a continuous stream of electronic communication among scholars.[1]

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1. An experimental skywriting group conceived along these lines, PSYCOLOQUY, has recently been formed. The vertical hierarchy has not yet been implemented, but there is an editorial board with specialists from all fields of psychology, and all contributions are refereed. To sign on, send the one-line message Sub Psyc your Firstname Lastname to listserv@pucc.bitnet. Postings are then sent to psych@tcsvm.bitnet. PSYCOLOQUY can also be accessed from Usenet as the moderated newgroup sci.psychology.digest. For further information, send email to harnad@clarity.princeton.edu or harnad@pucc.bitnet.

Editorial Schedule Change

With the first issue of 1991, ISI ® implemented a schedule change in the front matter for *Current Contents. ® Citation Classics ®* and the *ISI ® Press Digest,* including *Hot Topics,* now appear every other week. They alternate with either an essay by Eugene Garfield, a reprint with an appropriate introduction, or an essay by an invited guest.