Linköping Electronic Articles on
Academic Policies and Trends
Vol. 2(1997): nr 1

A Neo-Classical Structure for Scientific Publication and Reviewing

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Linköping University Electronic Press
Linköping, Sweden

http://www.ep.liu.se/ea/apt/1997/001/

Published on January 15, 1997 by
Linköping University Electronic Press
581 83 Linköping, Sweden

Linköping Electronic Articles on
Academic Policies and Trends
ISSN 1402-0319
Series editor: Anders Flodström

Typeset by the author using LaTeX *and*
formatted using étendu *style for A4 paper size*

Recommended citation:
<Author>. <Title>. Linköping electronic articles
on academic policies and trends, Vol. 2(1997): nr 1.
http://www.ep.liu.se/ea/apt/1997/001/.

This URL will also contain a link to the author's home page.

Abstract

I propose a *neo-classical* structure for publishing and reviewing of scientific works. This proposal has the following characteristic components:

- Electronic "preprint archives" and other similar mechanisms where research articles are made publicly available without prior formal review are considered as true and full-fledged *publication* of research from the point of view of priority of results.
- Large parts of the reviewing process is done publicly and in the form of published review letters and other contributions to the scientific debate, rather than through anonymous and confidential review statements which dominate today. There is a switch from anonymous "pass-fail" reviewing towards *open reviewing*.
- Since open reviewing happens *after* publication, rather than before, there is a second step where articles are promoted to "recommended" or "certified" status through the decision of a review committee, using criteria corresponding to those required for journal publication.
- Several techniques are foreseen for facilitating the selection process of the individual reader as well as for improving communication as such between researchers.
- One should accept that there are good reasons why there may be several articles (from the same author) presenting the same result. This suggests the introduction of a formal concept of a "result" which is represented by several publications, and to allow citations to refer to results rather than to some specific publication of the result.

I refer to this system as *neo-classical* because it assumes that peer review is done *openly* and *after* an article has been published. It is of course only proposed as a complement which can easily co-exist with the modern system, allowing each author to choose which of the two systems he or she wishes to use for a particular article.

1 Introduction and summary

The primary purpose of scientific publication is for communication between researchers: allowing the researcher-reader to find previous work that is relevant to his or her present effort; and allowing the researcher-author to make her or his work available and to get proper credit for it. The system of scientific publication is also used for a number of other purposes which I will here consider as secondary, such as to evaluate a researcher when a promotion is being considered, to evaluate the success of research projects, to make a business out of publishing, or (occasionally) by an author to earn money from royalties. These other goals will not be considered in the present discussion.

Because of the enormous volume of articles and monographs describing research results, this communication between researchers is not merely a question of transmission of the articles across space and time and of making them available. The receiver-reader has an absolute need for selection mechanisms whereby he or she can find the relevant ones among the articles being offered. Conversely, the sender-author is well advised to think in terms of a promotion strategy, if this commercial-sounding word is allowed, that is, to think of how the work is brought to the attention of readers given the selection mechanisms that are in use.

The main topic of the present article is how the technical possibility and practical emergence of electronic document handling, including the use of the Internet, can be used to improve the communication of research results in all these three major aspects: *transmission*, *selection*, and *promotion* of the articles. Two concrete issues are crucial in this regard. One is the issue of *copyrights*, and in particular the increasingly clear conflicts of interest between authors and publishers concerning the right of electronic distribution of the article. The other issue is the procedure for *reviewing* of scientific results. In brief, I propose a *neo-classical* structure for publishing and reviewing which has the following characteristic components:

- Electronic "preprint archives" and other similar mechanisms where research articles are made publicly available without prior formal review are considered as true and full-fledged *publication* of research from the point of view of priority of results.

- Large parts of the reviewing process is done publicly and in the form of published review letters and other contributions to the scientific debate, rather than through anonymous and confidential review statements which dominate today. There is a switch from anonymous "pass-fail" reviewing towards *open reviewing* where the identity and the comments of the reviewers are made public.

- Since open reviewing happens *after* publication, rather than before, there is a second step where articles are promoted to "recommended" or "certified" status through the decision of a review committee. The requirements for certification are set at least as high as for the formally published journal articles of today, so that it counts like journal publication in a CV.

- Several techniques are foreseen for facilitating the selection process of the individual reader as well as for improving communication as such between researchers, including:
  - The use of electronic or paper-based *news journals* which list all recently published articles (prior to refereeing) in a specific and narrowly defined area of research.
  - The use of *electronic colloquia* which extend an electronic news journal with commentary, debate, and posting of calendar information. Such electronic colloquia serve both the selection and the promotion activity.
  - The use of *summaries* of research articles, that is, condensed accounts of their contents which are longer than abstracts but significantly shorter than the full article.
- Rather than clinging to the formula that each scientific article shall report a "new" and "previously unpublished" scientific result, one should accept that there are good reasons why there may be several articles (from the same author) presenting the same result: successive versions due to feedback from others; the need to present it in different words or different level of detail to different audiences; and so on. This suggests the introduction of a formal concept of a "result" which is represented by several publications, and to allow citations to refer to results rather than to some specific publication of the result.

I refer to this system as *neo-classical* because it assumes that peer review is done *openly* and *after* an article has been published. This is how things were done before the advent of the "modern" publication system that dominates at present, and where anonymous peer review is applied as a filter before publication.

The neo-classical system is of course only proposed as a complement which can easily co-exist with the modern system, allowing each author to choose which of the two systems he or she wishes to use for a particular article.

Several aspects of the proposed neo-classical system are made possible through the use of the new electronic publishing technology, and would have been impossible or very unwieldy in paper-publishing frameworks. However, since the use of electronic publishing is a means rather than an end, I shall start with a discussion of the selection and promotion mechanisms that are used and taken for granted today, and then propose how they can be improved.

2 Current selection methods: scanning, reference, and exhaustive search

How does the active researcher select what to read? Many readers may find the question so trivial as not to be worth considering, but even a superficial comparison of the style of work in different disciplines shows that there is no obvious and universal answer. Consider, for example, the use of information retrieval systems which search a large database of research articles using keyword-based queries: such IR systems are an absolute necessity in some disciplines, and are considered as quite useless in others.

For the purpose of the argument, we identify the following three major selection methods:

- **Scanning:** The researcher subscribes to or has access to a certain number of journals, and checks each issue as it comes out. Some of the articles are of particular interest; she reads them in detail, and makes sure that she can refer back to them when she needs them (for herself or for referring a colleague or a student to them).

  When the researcher addresses a new problem, that is, a problem which he has not had in mind during his earlier reading, then he has to re-scan the possibly relevant journals, or at least their list of contents, looking for articles that may be relevant for the new problem.

- **Reference:** The researcher uses lists of articles which may be relevant for the topic she is addressing. These lists may be obtained from colleagues who are experts on the topic in question, including but not only from colleagues who are already working on that problem. They may also be obtained from the list of references of articles that she has found already (allowing to trace back through the literature in question), or from published bibliographies.

- **Information Retrieval (IR):** The researcher uses a computational tool which searches through a database of articles in a sufficiently broad domain, and which returns a list of those matching the present query.

None of these three methods is intrinsically dependent on the existence of formal peer review, but the fact of peer review does affect them although in different ways. *Selection-by-scanning* is affected very strongly: the scanning reader will only get to see those articles that have passed the review filter, and other articles will not be candidates for reading in any sense. Conversely, if the audience can be assumed to rely on selection-by-scanning, then the author does not need to do any promotion besides making sure that his paper is easily readable and convincing, and getting it published in a journal which is widely read. The rest will follow automatically.

In a pure *selection-by-reference* practice, the key consideration of the reader is to find the important lists, and one key consideration of the author is to get into those lists. In addition, the transmission of the article obtains a separate importance. If a journal issue is considered as a combination of a reading list (the table of contents) and the full text of the papers appearing in that list, then the general case of the list of articles has separated the two, forcing the reader to retrieve the full text of those articles which sound promising from their title (and their abstract, if available). This may be very easily and rapidly done, in particular if the reading-list is stored on-line and the full text is obtained by a click of the mouse. It may be very cumbersome and require a considerable time delay, namely if a paper copy of the article has to be ordered from a library in another country.

Is it the author or the reader that suffers if it is inconvenient to access the full text of the article? This depends on who is punished if the reader fails to obtain it. In the case of a pure consumer of the research result, such as an industrial developer who wants to use previous work but does not do any academic research herself, the application project is the potential loser. In the intra-research case, which is the one I am mostly concerned with, it depends on the culture in the research field in question. If the field punishes an author who fails to refer to some relevant previous work, for example by not accepting this author's new article for publication, then the onus is on the reader side. On the other hand, if the field is lax about that and uses a buddy system for citation to previous work, then it is important for each author to make his or her articles as easily available as possible, in order to maximize the chances that prospective readers will access the full article.

The distinctions that are being made here are not absolute in practice, of course: researchers use both selection-by-scanning and selection-by-reference; citation is done partly on objective grounds and partly on a buddy basis, and so on. I do this analysis in order to prepare the ground for identifying, in a fairly complex and many-faceted system, what it is that does not function well at present, and which properties of the system can and should be supported if things are done in a new way.

What role does formal, "pass-fail" refereeing play in a pure selection-by-reference practice? Not much in principle, since reference can go anywhere: if an author publishes her results as a departmental technical report, makes sure that that report is easily available, and gets it into a few key reference lists, then nothing more is needed. In practice, the formal refereeing is relevant anyway in the following senses:

- Since it is a prerequisite for getting into a journal, it contributes towards the widespread distribution of the article. However, now that electronic distribution is possible, journal publication may be irrelevant for this purpose, and often counterproductive, namely if the journal is not very widely circulated and its publisher does not allow the author to keep the article on-line. Also, the distribution of journals is likely to decrease due to their increasing prices and the budget crunch on libraries.

- If a reader does not read all the items on the reading list, but only those that seem the most promising, then the fact that the article has been accepted for journal publication serves as a recommendation, and may increase its promise level in the view of the prospective reader.
- If the buddy factor is strong but not total in the research field in question, and the author is not part of a major buddy circle, then the fact that the article has been published in a journal may make it much more difficult for competing authors to ignore it.

We observe, therefore, that apart from the quite practical issue of how the full text of the article can be transmitted to the reader, formal reviewing functions in an almost social way: it is one method of recommendation (complementing other methods including open reviewing), and it works only relative to a system of respect for previous work.

The case of selection-by-I.R., finally, can be understood in this context as a generalization of selection-by-reference where the list of references has been constructed automatically from the query to the database, instead of having been composed manually by peers. The resulting list will hopefully be more inclusive in the sense that fewer relevant articles are missed; it is also likely to be more inclusive in the sense of containing a much larger number of irrelevant articles.

In this case, formal review may be as decisive as in the case of selection-by-scanning, namely if the database only contains articles from peer-reviewed journals. Then, assuming that the resulting reference lists tend to be fairly long, one obtains the same considerations as for selection-by-reference: it becomes important for the author and/or the prospective reader that the article is easily available.

3 On-line publication: technical possibilities and commercial obstacles

The contemporary information technology, represented by document preparation systems, the Internet, and the World-Wide Web system, makes it straightforward for an author, a university, or a publisher to keep the full texts of research articles on-line so that anyone, anywhere, can obtain a copy of them and print them out on paper. It also makes it possible to put *meta-information* on-line, that is, information about the published articles. Such meta-information includes reference lists, reviews, rebuttals, inverse reference lists, and so on.

3.1 The advantages of full-text access to research articles

In the context of the functionalities that were described in the previous section, on-line access makes a lot of sense. Let us discuss its convenience and economy, while keeping in mind that there are two variants of the electronic alternative:

- *author-provided:* The effort and cost of storing the article and keeping it on the net is carried by the institution of each respective author. It is free of charge for the reader, except for the cost of the Internet connection itself and the computer equipment on the reader side. It is a plausible assumption that most authors' institutions are willing to accept this cost.

- *publisher-provided:* A commercial publisher has replaced or complemented the conventional journal issue with an electronic version which is made available, in the server of the publisher, to researchers at those universities who subscribe.

3.1.1 Selection by scanning

Let us first consider how full-text electronic access comes out in the case of selection by scanning new journal issues, where the electronic counterpart of the journal is an electronic list of contents containing links to the full texts of the respective articles. I make the following assumptions about the typical reader of a scientific journal issue:

- She is likely to look very rapidly at most of its articles, and will wish to have her private copy of the few relevant ones. Unless she has a personal subscription of the journal as a whole, this involves obtaining a separate copy using a copying machine or printer.

- She has uninterrupted access to a PC or workstation in her office. The cost of this is there anyway, regardless of whether journals arrive on paper or electronically.

- In order to access a paper-based journal, she either obtains it on circulation, with a requirement to pass it on quickly, or she has to go to the library to read it.

The convenience tradeoff comes out as follows: it is somewhat more convenient to glance through a paper issue than an electronic issue, but it is significantly more convenient to print out an electronic article than to copy an article from a journal issue at a copier. Having to wait for a journal issue that is on circulation is a nuisance. Whether it is an advantage or a disadvantage to do the reading in the library is a matter of taste, and local conditions.

The major difference is in cost: the author-provided electronic alternative makes it possible for the selection-by-scanning reader to cover many more journals than a typical department or university can afford to subscribe to at present.

This reasoning suggests that paper-based journals will be intrinsically more attractive than electronic ones, from the point of view of selection-by-scanning, in those cases where a personal subscription is affordable for the researcher and the value obtained from it motivates the cost. It also suggests that library subscriptions of paper-based journals will not be attractive from the same point of view.

3.1.2 Selection by reference

In the context of selection by reference, the electronic variant is very attractive, since a major consideration in that case is how to get from the reference towards an article to its full text. The electronic reference list can be made to contain direct links to the full text of each article. Moreover, since the essence of selection-by-reference is to rely on the preferences and judgements of known colleagues, it is striking how electronic reference lists can be augmented with commentary, links to reviews and debate about the article in question, and so on. Concisely speaking, just as selection-by-scanning goes with pass/fail reviewing whereby articles are accepted to journals, so selection-by-reference combines naturally with open reviewing where each reader is provided with nuanced meta-information about candidate articles.

The formation of lists of articles *other than* the list of contents in a journal issue is likely to meet with a technical difficulty in the case of publisher-provided full texts. For author-provided full texts, one can take for granted that each article has its individual URL ("address on the network"), so that clicking the reference list will take one directly to that article. For publisher-provided full texts in electronic journal issues, on the other hand, the necessity to make the customer *pay* for access to the article means, in current systems, that the researcher-reader has to browse through a chain of pages, where she first visits that publisher's entry page, passes the access control, and then proceeds via menue or search mechanisms to the desired journal issue and article. This is less of a nuisance in the case of selection-by-scanning, since one makes the access once for reading a whole journal issue, but it is much more annoying if it has to be repeated for each article one looks at.

It is likely that this problem can and will be solved when so-called micro-payments are introduced on the net, but then one may begin to wonder what is the utility, for the scientific community, of all the toll-booths that we have to pass when we read each others' works.

3.1.3 Selection by I.R.

For selection using IR systems, finally, there are the same considerations as for selection-by-reference: one would expect that the IR database contains the information about the URL of each listed article, and that it will generate lists of articles in clickable electronic form, so that direct reference becomes possible. A possible concern may be that if users are made to pay for each time they look at an article, then this may further increase the premium for providing articles with titles that "sound interesting". Such attempts are more easily filtered out when reference lists are composed by peers.

3.2 The trend towards open reviewing and selection by reference

To summarize the present section and the previous one, we have a triangle drama involving (1) formal peer review, (2) the selection and promotion mechanisms in the communication of scientific results, and (3) the possibilities of electronic publication of the articles themselves as well as of reference lists, reviews and commentary, etc. We have observed that the formal reviewing mechanism affects the selection/promotion methods in two ways: as a pass/fail access filter (some of the selection techniques are defined so that they will not give any chance to articles that have not passed the review filter) and in a "soft" way as one of several recommendation mechanisms.

The soft aspect of formal review is further enhanced by the differences in prestige which are often associated with different journals. I shall return to that topic in the next subsection.

The possibility of electronic publication of articles and meta-information changes this picture in two important ways. First, it reduces the need for the pass/fail access filter, since one major reason for that filter was that conventional journals must restrict the number of pages they print, for pure cost reasons. Particularly in the case of author-provided electronic publication, that is not a consideration, or more precisely, it is the author's own problem.

Furthermore, the electronic medium makes it possible to improve open reviewing considerably. Reference lists which serve as reading recommendations can be updated continuously, they can attach reviews (both anonymous and signed ones) as well as rebuttals to those reviews, etc, and they can of course be clickable and contain direct links to the full text of the articles.

All of this suggests a shift of emphasis, in our system for publication, selection, and promotion of research publications, with less reliance on confidential pass/fail reviews, and more reliance on open reviews (those which are made available to readers and where the reviewer is known). At the same time, it suggests a shift towards more reliance on selection-by-reference, and less reliance on selection-by-browsing in packaged journal issues. Rather than glancing through the list of all articles that have been accepted for a certain journal issue, the researcher would perhaps be better advised, and better served, by glancing through the list of *all* recent articles which have been published in his area, weighing together the apparent relevance (as judged from the title of the paper and the possible knowledge of the author) and the displayed review information towards a decision about whether to begin reading or not to read the article.

3.3 Hard vs. soft reviews and the prestige factor of journals

Different scientific journals are supposed to have different "prestige", based on the perceived level of quality that is required for an article to be accepted to the journal in question. This is a topic which often comes up in the context of electronic publication: it is argued that it will be difficult to establish new electronic journals, because since they do not have the prestige of established journals they will not attract good contributions, which in turn prevents them from receiving good contributions, thereby establishing a vicious circle. Therefore, it may be useful to analyze the topic of journal prestige.

Two years ago, the office of the Swedish TFR (Research Council for Engineering Sciences) requested its council members to submit short lists of what are the highest-ranked journals in their respective fields. More recently, the council members have also been presented with numerically calculated journal rankings, where the rank of each journal is defined in terms of the average number of incoming references to each article in the journal in question, which presumably could be used as an indicator of the quality of an arbitrary article in that journal.

These suggestions have led to strong opposition from researchers in some of the participating fields, and in particular from computer science. Several of my colleagues have argued that apart from filtering out certain journals as below standards, the whole concept of rank ordering articles on the basis of which journal they are in is (1) ridiculous and (2) harmful. It is ridiculous, it is argued, because the current strategies of researchers in the field is to select, for each article, the journal where it is maximally exposed to readers who are likely to use it actively and to reference its results. This selection of journal depends on the topic, and there is no fixed pecking order of the kind that is presumed by the council's requests. Furthermore, the idea is harmful because the present system of communication works fine, and if the council's criteria were to be applied, then it would force our researchers into a non-optimal publication behavior. It would be a case where one inadvertently influences the system that one is trying to observe.

Representatives of some other disciplines were less critical, and it seems that this is one of the ways how publication habits differ between different sciences. In an analysis of why these differences occur, it is possible that they are due to pure accidence, since the concept of a high-prestige journal is in itself a self-sustaining one. One may also point at some other possible reasons. Computer science is characterized by relatively long articles and relatively few articles per author per year, compared to the natural sciences or to medicine. This may be one of the factors that lead to long review times per article. If an author has few articles and faces long review times, then he or she is less likely to gamble by sending a good article to a journal which might reject it, either because it takes pride in being even more demanding, or because of uneven reviewing standards. It may "cost" too much to have to make a second try later on. In an area where one typically publishes many short articles based on rapid reviewing, authors may be much more likely to try their luck.

Conversely, if the rank-ordering of journals is weak, one may speculate that selection-by-reference tends to become well developed, since selection by scanning of recent journals issues only captures a limited part of the relevant new results. This is also consistent with another observation about computer science, namely the strong position that is attributed to quality conferences (conferences with strict review requirements and acceptance rates which are often between 20 and 25 percent; sometimes even lower). Publication in these conferences is generally considered as comparable with journal publication. It is possible that to the extent that researchers in computer science do selection by scanning, they tend to use quality conference proceedings rather than journals for this purpose.

Finally, these choices interact with each discipline's culture for promotion decisions. If the merits of an author are calculated on the basis of the number of publications, weighted by the prestige factor of the journal where each of them appeared, then of course this will influence the researchers' publications habits very strongly. On the other hand, if faculty search committees request each applicant to submit his or her three best papers, and the committee forms its own opinions about the quality of those articles regardless of where they were published, then people will behave accordingly. It seems to me that computer science, as a field, tends to assign less relevance than many other fields to exactly where each particular article was published.

My conclusion from all this is that computer science, as well as any other discipline which has similar publication patterns, *can be expected to be particularly open to the emergence of electronic publishing:* the prestige barrier against start-up electronic journals is relatively low, and the fact that selection-by-reference is relatively strong (compared to selection by scanning journal issues) means that the field can easily appreciate the further improvements to selection-by-reference which are made possible through electronically published meta-information.

The strong position of conferences as publication media is yet another factor that speaks in the same direction. In most conferences that I am aware of (I am mostly familiar with the A.I. part of computer science) almost all the work of preparing articles resulting in a conference proceedings is done by the conference organizers, including the program committee and the local staff of the program chair, besides the authors themselves of course. It is increasingly the case that the complete masters for printing the proceedings are delivered directly from the program chair to the bookprinter. This means that unless electronic publishing is provided in a competitive way by conventional publishers, the researchers in the area know that they can easily do it themselves.

3.4 Commercial publishers against electronic publication

It is evident that each author of a scientific article may benefit considerably from having the article on-line and free of charge on the Internet. It is also clear that he or she may benefit considerably from having had it accepted for an established scientific journal.

Since commercial publishers either do not put articles on-line at all, or do so in ways which are not very convenient, especially in the context of selection by reference and selection through information retrieval systems, the obvious way out is that the author keeps or puts the article on-line even in those cases where it is published in a conventional journal. He or she may do that by keeping it in his own filemass in the local computer system, but it may also happen as a university department puts its "internal" technical reports on-line, or the work is presented at a scientific workshop "with limited attendance" which puts the articles presented there on-line, presumably for the benefits of those colleagues who were not able to attend, or the work is included in an electronic so-called *preprint archive*. Such stores of essentially unrefereed research reports are now emerging as on-line services for whole fields of research.

This recent development is just a continuation of the earlier development, a few decades ago, where duplication and offset printing technology made it possible for university departments to produce "preprints" of articles that were later to be published formally. Throughout this development, most scientific journals have continued to profess a principle that they only accept "not previously published" work, or work that has only been published "with limited circulation". This doctrine presumably dates from the time when regular printing, which involved typesetting and proofreading, was the *only* way of distributing a research result. It has become increasingly disconnected from reality: how can you claim that something has not been published, or that it has limited availability when it has been available for everyone, worldwide, at the click of a mouse?

Given the present doctrine, however, there is an explicit or implicit clash between the interests of the journals and those of the researchers. The publishing agreements of many journals require the author to transfer most rights to the article, and in particular the rights of electronic distribution, to the publisher. This means that the author is expected not to put the article on-line, and to remove it if it is already on-line. The clash e.g. with the preprint archives is obvious: the mere term "preprint archive" implies that what is put in the archive can not be removed.

The situation is fuzzy, and we all know that scientific publishers have not (yet) taken any action to defend their formal rights in those cases where they are violated, or it can be argued that they have been violated. However, this is no guarantee that it can not happen in the future.

In summary: every researcher who *both* wishes to have his or her work published in a traditional journal, *and* wishes it to be available electronically for the benefit of readers, is caught in a conflict of interest. This implies that the research communities in varius disciplines have very good reasons to rethink their systems of publication, review, selection and promotion of research articles in their entirety.

4 Quality in reviewing

In previous sections, I have attempted to characterize the balance between confidential pass/fail reviewing that precedes publication in conventional journals, and open reviewing which may better be done after publication. I also mentioned, in the introductory section, the possibility of a posteriori reviewing scheme where an article is first *published* in the technical sense of being made public and citable for the future, then subject to *open review* in the sense of public scientific debate, and finally *certified* through the pass/fail decision of a review board which corresponds to a contemporary editorial board or program committee.

Such a scheme would fit quite nicely into a general framework of electronic publication. A possible objection against it would be that it is difficult to establish any alternatives to the modern system of anonymous peer review, particularly since it works quite well. In the present section I wish to argue that it *does not* work very well, and that it can evolve into and co-exist with a system which uses electronic publication and which is much superior to it for authors and readers alike.

4.1 Functions of reviewing

The concept of a scientific journal and the concept of a reviewing organization are interdependent. One may think of the journal as the primary phenomenon and the editorial board as an auxiliary system which is required in order to select the journal's contents, but one may equally well think of the reviewing organization as the primary thing, and the journal as the way of distributing what has been selected. In the latter perspective, the reviewing organization serves several very important functions:

- Providing *feedback* to the authors, telling them what has to be improved in the presentation of their results.
- Performing a *filtering* task, in order to provide the readership (and thereby the scientific community) with a list of possibly relevant reading. This ties in with the method of selection by scanning which was discussed above.
- Performing a *quality control* task, assuring the readership and the scientific community that the published results are correct.
- Helping the author with the *promotion* of his or her results: the author has interest in getting colleagues to read the article, and acceptance to a journal is one way (although not the only way) of getting that to happen. This ties in with the discussion of selection by reference and by I.R. as discussed above.
- Performing an *evaluation* task, since the acceptance of papers to scientific journals are major items in the credentials of a researcher (when applying for a position) and for a research group (when applying for a grant).
- Supervising the mechanism of *proper assignment of credit* to earlier work. If an author fails to make reference to the original source of a previous result that is relevant for the new article, or makes reference to a non-original source, then the reviewers should observe and correct this.

All these functions are very important ones in the total research system of today. It is therefore striking, first of all, that almost all of this reviewing work is done so to say "in the dark", that is, without explicit recognition. One might have thought that the participation in the review process could be an officially specified activity, towards university administrations or towards the sponsors of research grants, but this is not the case. Senior researchers spend a considerable amount of time for this activity, but since the reviews are supposed to be anonymous, no one can claim any credit for it. (The mere membership in editorial boards and program committees can be used in the CV, of course, but the credit obtained from this is not very strongly correlated to the quantity or the quality of the review work that is actually performed. Some people can be for years on an editorial board without ever getting to review a single paper).

4.2 How well does the reviewing process perform its functions?

How well does this machinery function at present? It is difficult to obtain systematic information on that question, but a few observations can be made. They refer to my own experience, and are by necessity specific to the field that I am in, namely to artificial intellligence. I believe that they generalize at least to most parts of computer science, and that some aspects of it generalize much more broadly, but I leave it to each reader to decide how well this agrees with his or her experience.

The *long review times*, which are sometimes *extremely long* in our discipline, have already been mentioned. This is a twofold problem: it causes difficulties for the researcher who is dependent on the review decision for his or her career. It hurts even more if the author loses the priority to the result because someone else is able to publish the same result in the meantime. It becomes really maddening if there is a suspicion (rightly or wrongly) that the result has "leaked" during the reviewing process. This can happen since the result is not considered to be formally published while it is still in the review stage.

The feedback to the author holds very varying quality. I speak now of the reviews that I have seen as program chair or area chair in quite a number of program committees. Some reviews are brief and uninformative. When reviews are long and detailed, they often provide good feedback to the author, and writing such reviews is a considerable service to the author and to the research community. One would like to have better ways of rewarding these conscientious reviewers.

The accomplishment of the filtering task leaves much to be desired. Short reviews may sometimes be haphazard, and one is inclined to question how reliable they are. There are also many cases where a more detailed, critical review reflects genuine scientific disagreements rather than lack of quality in the paper. In such cases, one would have wished that the reviewer could say "I do not agree with this author, but I still think that he/she should be allowed to express his/her point of view". Such a generous but natural attitude is sometimes notably absent even in reviews for workshops. Arguably, it would be much better, in such cases, that the paper were published and the review (and a subsequent discussion) was brought into the open. It becomes baroque when anonymous peer reviews are used for censoring research results belonging to another direction or "school" than one's own.

The quality control task is a sore point. Some neighboring, theoretical disciplines take for granted that a reviewer checks the correctness of proofs in the article. This does not necessarily happen in our field: one can regularly see reviewers who say that "I have not been able to check the proofs completely, but it looks convincing." This need not be as bad as it sounds, in those cases where the theorems and proofs have the character of an annex for verifying that a proposed system, besides it major properties described in other parts of the article, also satisfies certain basic formal requirements. Sometimes, proofs are very complicated and it may take a lot of time to penetrate them; the reviewer may be unwilling to do that, particularly since there is absolutely no reward for it, but anyway one would prefer that there were *some* systematic procedure in this research whereby proofs were checked.

The quality control of proposed software results is an even bigger problem. If an author proposes a particular way of organizing a software system, with respect to program structure and/or data structure, how is the quality of that result to be verified? Only by listening to how well the author explains the approach? This is the usual method today. One would probably demand too much from the reviewer if he or she were requested to test-run the program and to analyze it in sufficient depth to be able to comment on it, much less to evaluate it with confidence.

In practice, there is of course a quality control of software which happens when the program is exported and others get to use it. However, that kind of verification and the subsequent reporting of the outcome happens largely outside the research publication system.

The *promotion* aspect of journals is important, but sometimes overrated. In a naive theory, all that a researcher needs to do is to get his or her results published, and then the world will eagerly read the article and take notice. This theory is sometimes true, but not always. In particular, European researchers are often likely to misjudge the situation, and are surprised when their work is not properly observed by American colleagues although it has been properly published. This serves as a reminder of the importance of other selection schemes, and in particular selection by reference.

The *evaluation* aspect of the work, for the benefit of universities and research grant agencies, has already been touched upon. The long delay times and the various marginal factors that influence review decisions have already been mentioned.

If the evaluation aspect is taken seriously, then journal editorial boards and conference program committees do not only have a responsibility towards the readers or attendants for protecting them against papers they do not want want to be bothered with. They also have a responsibility towards authors for not rejecting papers which properly ought to have been published. One can frequently hear about cases where papers have been rejected which obviously should have been accepted.

Such evaluation errors can cause considerable pain for the author in question, particularly if he or she is at the beginning of his/her career. It may be argued that mistakes are unavoidable in any human activity, including reviewing, and that the only thing one can do is to appeal to the reviewer's conscience and good will. However, I would argue that an additional requirement on *the evaluation system* must be that it allows mistakes to be corrected. If it is later discovered that the rejected paper was a good one, then the author should obtain the full credit for the work, *including recognition of the original date of presentation of the result.* This is important, particularly in view of the long review times, and in view of the possibility that someone else has presented a similar result in the meantime.

From this point of view I question the wisdom, and indeed the sanity of the present pattern where many of our conferences take pride in having as low acceptance rates as possible.

Finally, when it comes to the function of *supervising proper assignment of credit*, the field of A.I. has unfortunately much to be ashamed of. In a field such as physics, according to colleagues there which I have interviewed, authors are strictly required to refer to first the published source of previous results that they build on, and if they fail to do so the reviewer will correct them. In A.I., the practice of buddy citation is much stronger. Our publications abound with expressions such as "in this respect we were inspired by N.N. [reference]" (although some other researcher may have described the same method earlier, and the current author knows it; he just reports in which order he did his reading, and not who was the originator of the result), or "some of the previous results in this area are..." (no attempt to identify first results; often a highly partial list, for example only selecting American authors).

4.3 Dangers when an article in under review

Besides the six functions that reviewing is supposed to perform, there is also the overriding question whether the combination of reviewing and publishing or, more precisely, the system of anonymous peer review *preceding* publication works as intended.

One striking aspect of this system is that it leaves an article in a peculiar state while it is under review: the article has not been officially published, which means that the result is not citable and the author can not yet claim priority to it, but at the same time it is circulated to a number of persons, and in particular to some who are active in the same research area and who therefore compete with the present author about the same kinds of results.

It is obvious that this can only work if people are honest. It is also well known that most people *are* honest, even in situations where they are anonymous, but that some are not. One would therefore like to know how often it happens that a research result is "stolen" while it is in the grey state defined by the review process.

It is difficult to get a measure of this phenomenon. In order to get some feeling for it, at least, I have asked a number of colleagues whether it has happened to them, or someone they know. Almost everyone has answered with a resigned smile that yes, of course, they have been the victims or know victims of such incidents. I have asked colleagues in several other disciplines besides computer science, and the situation seems to be similar everywhere.

This in itself does not prove anything, both because my sample is of limited size, and because I do not have the full story for any of the cases. However, I do think my sample indicates that this is *perceived* as a problem, regardless of what is the actual frequency of such malpractice. This already should be a good reason for considering whether something can be done about it, and whether one can find a system which does not inspire misuse or suspicion of misuse.

5 The proposed Neo-Classical System for Publication and Reviewing

The obvious retort to the problem descriptions in the previous section will be: "so the present system is not perfect, but can you come up with something better?" The present section is dedicated to that challenge, presenting a proposal for a system which becomes possible only through the use of electronic publication.

I shall first state my proposal itself with very little argumentation, and then discuss the ramifications of the proposed scheme in the following section. The proposal is divided into a number of parts represented by subsections. Throughout, I use the present tense, such as in "we create a new journal" while the modality of "I propose that..." is to be understood as context.

5.1 Conceptual proposal: Separation of publication list from archive

An issue of a conventional journal is both a selection of articles which one hopes will be of interest for the reader, and the carrier and container of those articles. In the electronic world, there is no reason to maintain that coupling. One obvious function is *archive*, that is, the reliable storage of articles so that they are preserved for posterity. This is not only a service to that posterity; it is also significant now, since if one is going to include a reference to one article in the bibliography of another, later article, then one must suppose that the first article will be persistently available. Furthermore, one must have a guarantee that the article can not be manipulated or "improved" by its author, or by anyone else, at any time.

Regardless of where an article has been archived, it may be entered into one or more *publication lists*. One obvious case is the *recommended publication list*, that is, the list which fills the same function as the list of contents of a journal: it lists articles which have been certified by a review board. However, unlike the case of conventional journals, a review board (corresponding to an editorial board or a conference program committee) no longer needs to have its own archive. It may work against a single, world-wide, universal archive where it only considers a miniscule part, or it may work against a network of local archives (university-wide or country-wide) as long as the latter live up to certain safety standards.

Besides recommended publication lists, there is also a need for submitted publication lists, that is, lists of recent work which has not yet passed full review. I will return to this below. For continuity, the term *electronic journal* will be used for any structure which regularly publishes lists of articles including electronic links to them. If the articles themselves are stored at other servers than the list itself, and in particular if they are stored in various archives, then the journal will be referred to as a *distributed* one.

5.2 Proposal for First Publication Archives

The conceptual separation of archives from publication lists opens many new possibilities, but concretely speaking it means that one does not make sense without the other. The first part of the concrete proposal is therefore the creation and accreditation of *First Publication Archives*. By this I mean the same as is often called a "preprint archive"; I object to the latter phrase because it is a contradiction in terms.

The basic function of a First Publication Archive, FPA, is that it receives scientific articles in electronic form, preserves them, and makes them available over the Internet on a permanent basis and at a fixed URL. This URL becomes the well-defined identifier for the article in question.

The entry of an article into an FPA should not be conditional on formal pass/fail review in the sense of contemporary journals. A reasonable criterion might be that every senior researcher (full professor, etc) should have the authority to decide about entry of articles from his/her department or research group.

With respect to my own discipline and the European scene, there is presently a proposal within the AAAI (American Association for Artificial Intelligence) about setting up a preprint archive for the the AAAI as a whole. This is probably not possible in Europe, but it is also not necessary. One could foresee having a network of more local FPA:s, which may be operated within each country, or even within each university. In the latter case, it should preferably be done on the common university level, such as under the auspices of the computing center or the university library, rather than within the participating department.

5.3 Proposal for Electronic News Journals

An Electronic News Journal (ENJ) is a distributed journal whose primary contents are links to recent entries in the First Publication Archives, thereby making them known to the world. It focuses on a well defined and specialized research area, such as (in the case of A.I. research) "terminological languages", "reasoning about actions and change", or "qualitative reasoning", and provides the active researcher in that specialized area a steady flow of the latest news. Of course, the ideal ENJ covers *all* recent work in its area, unlike a conventional journal, and with direct links to the full text of each of them. Also, if one and the same article is relevant for several of these specialized research areas, then it is perfectly appropriate to include it in the electronic news journals for each of them, again unlike what happens in conventional journals.

For the typical active researcher, it will be natural to scan the electronic news journal for work within his or her own specialized area, in order to be up-to-date about what happens there, but to limit oneself to the recommended publication list for neighboring specialities.

Running an electronic news journal is therefore an activity that is comparable to the organization of a workshop or small conference. The acceptance criteria for an ENJ should be very straightforward: it receives articles which are stored in one of the accredited First Publication Archives (which means that the article has been submitted by a senior researcher), and the submissions are only subjected to a few simple checks:

- The article shall contain a summary that states some kind of result. (The question whether the result in question is correct, worthwhile, etc. is not to be a criterium for acceptance; it is a matter for the subsequent debate). The concept of a "long abstract" will be further described below.
- The article and, in particular, the stated result shall be arguably relevant for the area of the electronic news journal in question.
- The topic of the article shall be made further precise using, for example, a set of keywords.
- The natural restrictions on size, not containing illegal or indecent materials, etc.

This means effectively that the selection process for electronic news journals is based on self-control, in particular by the research group leaders (often a chaired professor). It will of course be possible, although uncommon, that a paper by a junior researcher is submitted by the leader of some other groups and not the one where he or she is working.

The requirement that the submitter must be a senior researcher is not intended to imply that the submitter must be one of the authors. If a young group member did all the work, then he should be the single author, but his professor will have to sign the paper saying that the article is submitted.

A possible objection against this scheme is that it gives undue power to senior researchers. However, if a young researcher has a result which his group leader doesn't approve of, then there are certainly other publication outlets, so it will not be a problem.

Another consideration is how to accomodate researchers who work individually in odd places. This may be handled by having a separate scheme for such contributions, which would then be reviewed by a journal editor to the same level of standards as for the other contributions.

From a *merit* point of view, publication in an electronic news journal ought not to count for very much: it would be considered as equivalent to publication at a workshop (in computer science) or a conference (in disciplines where conferences count considerably less than journals). From the point of view of *priority of research results*, on the other hand, publication in a First Publication Archive combined with appearance in an electronic news journal is to count; *it defines the date when the authors presented the result.*

5.4 Proposal for Peer Reviewed Electronic Transactions

The idea with the electronic news journal is to advertise research results as soon as they hit the first publication archive, but only in a very targeted fashion. The complementary need for publication lists of *refereed* publications is achieved by defining the truly electronic counterpart of the journal, namely the *Peer Reviewed Electronic Transactions.*

The normal procedure for a paper is that it is first sent to a First Publication Archive and listed in the appropriate electronic news journal. Then follows a period of time when the paper is under *open review*, that is, other researchers in the same discipline are encouraged to write their comments, either by private communication with the author, or publicly via a mailgroup or an electronic colloquium (more about this below). This means that those aspects of reviewing which have a general interest and which for example reflect differences of opinion regarding research goals or methodology are brought out into the open.

The proposed scheme also means that *the activity of reviewing*, which is of course a very important one in science, can be given independent credit. One of the reasons why the present scheme of anonymous peer review doesn't work well may be that exactly because it is anonymous, reviewers are not given any academic credit for their work.

After such a review period, the paper may be submitted to the review board of the Electronic Transactions for possible certification. At this point the public reviewing debate is complemented with a confidential review and a decision by the editorial board or main editor, like in the present, modern system. However, it is assumed that this part of the reviewing will be much easier and more rapid than at present, because the substantial part of it has been done publicly.

By way of difference from a conventional journal, the electronic transactions renounces the use of the mantra "previously unpublished results". Of course the results have been previously published; they count as published (in the sense of unrefereed publication) as soon as they get into the First Publication Archive. More often than not they have been so in current journals as well; it's just that we pretend not to see this completely obvious fact.

5.5 Local self-control of quality

One frequent objection against the proposed scheme is that it will lead to an inundation of research papers: "who will read all the trash that is going to be published?" Such an argument assumes that all material which is now being sent for review will be published in first publication archives under the proposed neo-classical system. This is by no means certain. The present system licenses authors not to take full responsibility for what they send to journals, since there is a peer review between the author and actual publication. In the neo-classical system, authors have to take more responsibility, because once an article has been published, it is not possible to retract it. If you publish something stupid, it will be with you for life.

In particular, academic promotion committees would be well advised to consider what proportion of a candidate's published articles have *failed* to reach certification within a reasonable time, since this is an excellent measure of this researcher's sense of judgement. Once this realization has become widespread, one can expect that the amount of so-called trash that gets published does not increase very much – and that the amount of trash that needs to be reviewed will go down considerably.

On the other hand, if a researcher or a group of researchers feel that the reason why many of their articles have failed to reach certification is that reviewers have not understood the value of their results, and not that they do not have a good case, then they are invited to write a debate article and argue their point. In this situation the world can decide whether the journal has made a mistake. This is one more example of how the neo-classical system, although it can not of course *prevent* reviewing mistakes, anyway is better able to *correct* such mistakes.

5.6 Dual citations

In my mind, one important goal for an improved publication and review system should be to create a more stringent atmosphere with respect to first publication of results. This may not be a concern in all fields, but it is in the field that I am in; readers who do not think of it as an issue may skip the present subsection.

A first step towards a change in this respect would be the introduction of *dual citations*, where a research result is referenced in the running text as e.g. [Smith 1987a/1989b]. In this case, the bibliography at the end of the article should contain one entry for [Smith 1987a] containing the *first publication in any form of the result in question*, and [Smith 1989b] shall be the *most appropriate source for reading about it* from the point of view of legibility and availability. Possibly there can be more than one citation after the slash, for example [Smith 1987a/1989b,1990a] if, let us say, 1989b is more technical and 1990a is more easily readable.

For the first publication part of a dual citation, it is obvious that publication in an approved First Publication Archive will count, provided that it has been properly followed up by being included in an electronic news journal. Publication at workshops and as departmental technical reports shall also count, as long as these have been reasonably publicly available.

It may not always be easy for an author to determine the correct contents of such dual citations. Therefore, one of the functions of the open review period, when an article has been published in a news journal but has not yet been certified, is to make sure that the citations are complete and correct. Researchers are encouraged to check all articles that appear in the same speciality as they are working, also from the point of view of citations, and to write the author with proposals for corrections to them. This is a concrete example of a promotion activity that every researcher can engage in.

It is to be foreseen that there can be a certain amount of disagreement with respect to what are correct citations. Although such disagreement can be painful, I think that it a vital part of the total publication and review activity.

For future articles which are associated with long abstracts, as will be proposed below, the rule should be that an article is considered to contain a result only if the result is stated in the long abstract. More about this later.

5.7 Criteria for certification in electronic transactions

It was stated above that certification in peer reviewed electronic transactions ought to require the same high quality standards as for acceptance in existing quality journals. In fact, the electronic transactions should be able to achieve a considerably *higher* standard than conventional journals since the public reviewing scheme can be expected to provide more feedback to the authors and more information to the concluding, confidential review and publication decision.

Normally, an article will be changed and improved from the news journal version before it is certified for the transactions. If the changes are significant, then a second round of news journal publication may be used, so that the changes can also be subject to feedback.

If the revised article is rejected for the transactions, then the author shall of course always get an explanation for that decision. If the author is not satisfied with the outcome, then he shall always be offered the possibility of re-publishing the revised article in the news journal, *together with the reviewing comments of the transactions*, and the rebuttal of the author. (However, this option may be restricted in numbers, for example to one article per author per year). In this way, an author always has a possibility to appeal to the world for justice.

5.8 The long abstract page

The customary size of abstracts in journal and conference articles is often limited to 100 or 150 words. The abstracts that are written within this framework are not very adequate, at least not in the research areas that I am familiar with, from the following point of view. Suppose that you have developed a new technical result, and you wish to check back in the current literature to see whether someone else has already published the same result or a similar result which you do not already know about. Ideally, you should be able to inspect the abstracts of earlier articles in the field in order to determine whether the result described there coincides or not. In practice, this does not work at all, for the simple reason that abstracts are too brief and too vague. They only serve to whet the reader's appetite and get her or him to read the whole article, and as a help for program committees to sort the article to the right reviewers.

I propose that this problem could be tackled in the following manner: Every article is associated with a *long abstract*, consisting of one page in the two-column format of current conference proceedings (A4 size or 8.5 * 11 inches), or the corresponding amount of text in book format. The long abstract consists of the following parts: description of the problem (10 lines), the results (most of the text), what are the previous results on the same problem and in what ways is this an advancement over them (10-15 lines), and why is this research important (10 lines).

Such long abstracts should be required both for the news journals and for the peer-reviewed transactions. They would serve several important purposes. Besides facilitating the search for earlier occurrences of a particular result, they would also facilitate the reading of new appearing articles. Therefore, they would serve as one other measure in response to the argument "who would read everything that gets published under the proposed neo-classical system?" – maybe it would be good if people got to read a larger number of results than they do today, provided that the results are presented in a sufficiently concise way. (This argument is possibly specific to AI and other parts of computer science, where articles are by tradition relatively long).

The term "summary" may be appropriate in place of "long abstract", as long as one keeps in mind that something more concrete than the traditional abstract is intended.

5.9 Who suffers if a researcher misses an earlier reference

One important effect of the proposed neo-classical scheme is that the disadvantage if a researcher misses an earlier reference is moved from the earlier author and towards the later author. In the contemporary "modern" system, if a researcher misses an earlier reference and the reviewers do not observe it, that's just too bad for the author whose earlier work did not get to be cited. In the proposed neo-classical scheme, the author of the earlier work has a chance to complain openly during the open review period, and the later author can not avoid (or finds it more difficult to avoid) including the missing reference.

In the even more salient situation where the same result had been published before, the later author will of course suffer in the sense that his article never reaches certification at all. This is tough, in the case where he really discovered the result independently, but it is also tough for the earlier researcher if her results are not properly recognized. By moving the risk-taking in favor of the earlier author, we increase the incentives for researchers to keep track of newly published as well as earlier results.

In this context, it may be reasonable to have a rule to the effect that a result shall be considered as published in an article only if it is stated in the long abstract of that article. If it is hidden somewhere in the details of the text part, presumably the author did not understand at the time of writing that the result in question was important, and then it should not count.

If an author realizes later on that something which had a disguised position in a paper was in fact important, then he or she can always submit a new article to a news journal, containing only an abstract, a reference to the previous article, and possibly a nominal body of text.

6 Electronic vs. paper publication

We proceed now to the question of electronic versus paper-based publication. This is an important issue which has many ramifications, including economy, convenience, availability of research results for researchers in less endowed countries, and the persistence of the literature over time. My proposal is as follows; it will be stated in concise, itemized form and the reasons for the various items are fairly self-evident.

6.1 Article structure and the availability of articles

- Each article is considered to consist of four parts, namely the *summary* or long abstract page, the *contribution* part describing the new results, the *context* part describing relationship to other work, with correct and complete references, and (optionally) *multimedia* part. The contribution part is immediately suitable for paper publication; normally it is written in Latex. The context part will typically consist only of text, and it may be appropriate to express it in HTML rather than Latex/postscript/PDF, since it will probably be dominated by text and by links to other articles; formulae are likely to be scarce there. The multimedia part, finally, may contain interactive presentations, movies, color pictures, and other features which are impossible or expensive to print.

- The contribution part shall remain constant over time, but authors are encouraged to update and improve the context part, even to the point of updating it so that it discusses the relationship to other work which appears later than the present result.

- Whenever there is a multimedia part to an article, the contribution part shall contain an explanation of what is presented in the media part.

- All three or four parts of all articles shall be made electronically available on the date of publication.

- Electronic News Journals are published continuously: each article in an ENJ has its individual publication date.

- The electronic transactions will follow the pattern of conventional journals. Thus, it appears regularly at intervals of 1, 2, or 3 months, and each article belongs to a particular issue. Each issue has a particular publication date, and on that date, a web page containing a list of the contents of the issue is made available, with electronic links to the articles in question. However, each article in the issue lists the date when that result appeared in the First Publication Archive; this is considered as the important date from the point of view of priority.

- Both ENJ:s and peer-reviewed electronic transactions will be printed on paper once per year for library use. Thus, libraries can buy a nicely bound volume of the periodical in question. The printed volume for the electronic transactions contains both the long abstract, the contribution part, and the current version of the context part. For the ENJ:s, it only contains the long abstracts, together with the publication status list of all articles that have been published in that ENJ during the same and three previous years.

- For the benefit of scientists who do not have access to electronic communication, a limited number of copies are printed on paper. This is done each time an issue of the electronic transactions appears, and contains the long abstract, contribution, and context parts of certified articles, together with the long abstracts which have appeared during the last two months in the ENJ. These copies are not bound; they are printed on ordinary paper and not even glued together, in order to facilitate subsequent copying. Departments and research institutes doing active research in the area, and who qualify, are offered one copy each of such paper issues. Independent funding should be sought from suitable sources for defraying the cost of these paper issues.

6.2 Graphical appearance

- With respect to formating, the ENJ:s will use the same two-column format as in ordinary conference proceedings, whereas the electronic transactions should use the smaller, conventional journal format. Care will be taken that the formatting style of the transactions resembles as much as possible the "look and feel" of printed journals, and Latex-quality formatting with a uniform style will be absolutely required.

6.3 Copyright

- The electronic periodicals should be based on a principle of non-exclusive copyright, which means that they obtain the right to publish the article on paper and electronically, but the author retains the same right. Also, it shall be agreed that additional copying on paper of electronic versions is allowed for any non-commercial purpose. (This means in particular that articles may be copied and used in university classes without hassle with page charges etc).

- Further copying is of course only allowed if the article is unmutilated; it is not permitted to change an existing article before distributing it. Also, the author must agree in writing not to change his on-line version of the article after it has been published in the journal.

- Decisions about the inclusion of an article in other printed volumes ("Papers in the theory of X", etc) are taken by the author; the electronic periodicals do not care.

7 Recruitment of editors

An obvious question in this context is also "who will do the work?" Editing and reviewing take considerable effort; it is not obvious that one will find people who do it.

In the short-range perspective, this has to be done by volunteers and enthusiasts, which is possible for small-scale periodicals but not in the case where the number of contributions becomes very large. It can be done more easily in computer science and A.I., where we are used to working with a large number of relatively small journals, and is not likely to be working in the case of really large journals which dominate in some other fields. However, the concept of organizing the electronic transactions in terms of specialized research areas which are held together also by electronic colloquia, works also in the direction of small entities. Within each of them it should be possible to find researchers who are interested in doing this job, particularly in the early period when these enterprises are new.

In the longer range, I think these questions must be answered along the following lines. Quality control and evaluation of research results is of great importance for the research community. In particular, it is of great importance for research funding agencies, including both universities and separate agencies (research councils, etc), since they are the ones who need these evaluations in order to make their decisions on recruitment and on allocation of resources.

Similarly, of course, the efficient distribution of research results is of importance for same research funding agencies.

In our current system, the costs of these important functions in the research system are largely speaking hidden. One part of it is actually done through the anonymous peer review system, which is not recognized and accounted for anywhere exactly because it is anonymous.

Another part of these costs are via the payment of journals and conference registration fees, which also help defray some of the costs of the machineries for evaluation and dissemination. These resources are paid by the university system via the subscriptions which are paid by its libraries and by the individual researchers.

Both of these payment methods are very roundabout. The non-accounting of reviewing work has already been discussed. The subscriptions tie the payments to the existence of paper copies; the conference registration fees to actual participation at the conference in question.

In the long run, therefore, I believe that the academic system should recognize that it is much more rational to pay for these functions directly.

It is obvious that reviewing and publishing of research results are better done on a European level than locally in each country. Hopefully, there will soon be a time when those responsible for EU research policies will see the necessity of engaging at least a little bit in the issues of basic research, and not only in subventions to industry for technology development. It will be very reasonable and natural, at that time, to consider union-level support for review and publication of research results by electronic means as a priority area, in particular since the costs involved are very moderate ones.

Also, in considering promotion of faculty members and other researchers, it would be in the interest of good science if universities would count the writing of publicly recognized reviews as a credential on a par with writing original articles, although of course with a weight factor reflecting the difference in the amount of work. A public recommendation to this effect by the university authorities in our respective countries would be very valuable.

Once these matters have been settled, so that the editor and review functions are financed appropriately, the electronic distribution of the articles themselves will be straightforward. The costs at the reader's end can be dealt with locally according to wish. This includes both the obvious local costs (computer equipment, etc) and the arrangements for printing paper copies whenever needed, possibly involving the use of licensed, small-scale print shops.

8 Summary

In summary, I argue that the scheme proposed here would have the following advantages for the research community:

- It provides more serious treatment of the researcher as an author of research results. The introduction of First Publication Archives and Electronic News Journals, whereby the result counts as published, as well as the dual citation scheme, provide her or him with a better guarantee of obtaining correct credit for her/his results.

- The use of the long abstract page encourages authors to summarize more concisely what their results are, so that readers can identify the essence of results without plowing through long articles.

- The proposed ground rule for the future, to the effect that a result will only "count" for the purpose of precedence if it is clearly stated in the long abstract, provides further encouragement to write informative, concise long abstracts.

- The existence of the well-defined public review period between publication in an ENJ and in electronic transactions (or other archival journals) provides an opportunity for feedback to the author, which will improve the quality of all articles.

- The public character of the review process (except for the final decision of acceptance based also on a confidential consideration) provides many safeguards against inappropriate rejection of good research results.

- The economical and recruitment aspects of the scheme can be solved.