INTEGRATION OF INFORMATION FOR RESEARCH AND EDUCATION: CHANGES IN THE VALUE CHAIN?

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Changes in the value chain induced by the use of information and communication technology (ICT) are discussed. ICT will lead to innovation not only in the research information system but also in the educational information system or even in the education system at large. Widespread use of ICT allows universities to change from supply-push to demand-pull education. Universities will create their own publishing and archiving environments.

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1 Introduction

Authors want to publish more, readers want to read less

This law states that wide exposure is paramount to the author and (pre)selection to the reader.

It largely determines the value chain in scientific information. Any force like the use of information and communication technology (ICT) by the actors involved (authors, readers and scientific publishers) that allows better fulfilling of this law is an engine for change in the value chain. And this will prompt changes in the roles of the players in scientific communication.

What makes ICT such a powerful engine? The main reason is not that it empowers the author to increase the visibility of his/her work or that it helps the reader in digital searching of the information base. ICT is foremost a powerful engine for change in the value chain because it allows the transition from a low volume/high margin business, as is the current mode in the research information industry, to a high volume/low margin business. ICT has clear potential to lead to innovation in the research information system, but, even more important, ICT provides a powerful tool for innovation in our higher education system from the usual supply-push system characterised by massification to an increasingly sophisticated demand-pull system characterised by customisation. This in turn furthers the globalisation of the higher education system, leading to mergers between institutes of higher education (IHEs). This strategic development drives IHEs to introduce ICT-supported education widely. For the IHE this development towards widely applying ICT in education seems an autonomous development. The changes in the value chain of scientific information will be discussed within the context sketched above[1].

2 Functions in scientific communication

2.1 General description

Following earlier work,[2, 3, 4] there are four main functions of scientific communication: the *registration, awareness, certification* and *archive* functions (see Figure 1). Figure 1 shows the overall communication process, as it is part of the research and education process. It also shows which parts of the communication process can be externalised out of the research and education system.

   Following the familiar classification of the functions into author and reader functions[5, 6] we see that registration and certification are direct, author functions and archiving and awareness are indirect, reader functions. Functions can be considered internal or external to the research and education process. By their nature, registration and archiving are external to the research and education process and can be easily outsourced to external stakeholders, viz. the publisher and the library. The internal functions are an integral part of the research and education process.

   For a comprehensive discussion of these functions and the methodological choices and consequences the reader is referred to references[2, 3, 4]. In this paper, it suffices to conclude that the use of the four functions provides a consistent analysis of formal and informal scientific communication.

Figure 1: Functions in scientific communication
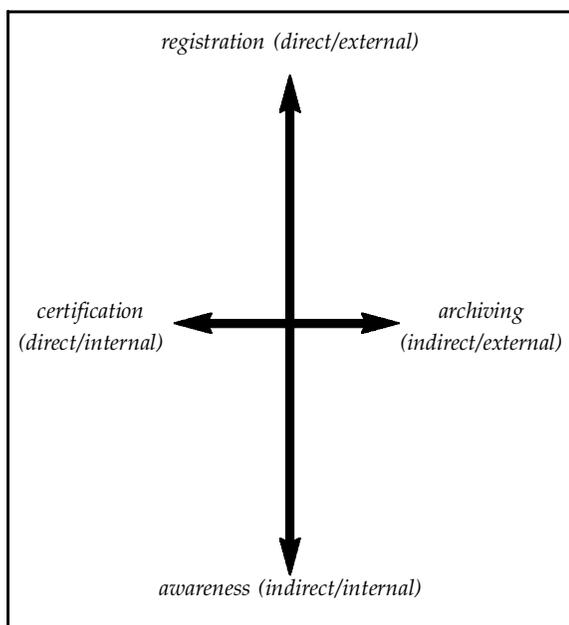
2.2 Influence of a digital publishing environment on the communication functions

Analysing the logistics of the publishing process we see that the waiting times are rather long. One added value of the digital publishing environment is facilitating shorter throughput time of information. Just to give an example: it will not be necessary to bundle publications or data collections with other publications any more, to make wide dissemination economically remunerative. Publications can be disseminated one by one to a highly segmented target group.

   This shortening of the throughput time in turn puts pressure on the certification process. This may weaken this process and leads inevitably to higher pressures for registering. Consequently, pressure to publish without certification will increase and this will weaken the quality of certification even more. At the same time in a digital environment it will be relatively simple to publish the underlying raw results and data in a discussion list or public databank. This constitutes a necessary condition for the reuse of information and is, in turn, a requirement for increasing the efficiency of the scientific process. This deposition of the underlying raw results and data leads to a deepening of the certification function.

   The certification function is shown to be of crucial relevance to the positions of the key actors, the authors and the readers, in the value chain and thereby for the value chain as a whole.

2.3 The certification function

As concluded in the previous section, the certification function will be of particular influence to the value chain due to developments triggered by the opportunities in a digital publishing and archiving environment. Merton[7] stresses in particular the strong relationship between intellectual property and the review system. The review system provides a clear authoritative system for the research enterprise and its rules of conduct are being discussed within the wider context of the goals and applicability of research[(see also 8, 9)]. Gross[10] describes peer review as a negotiation on the level of claims permissible in a scientific article: 'The higher the level, the higher the article's status; the

higher the status, the more difficult the negotiations'.

In this process of negotiation a crucial factor is the reputation of the scientific journal or discussion list. It is a negotiation on the acceptance of a scientific claim or a scientific statement. According to Popper11 a scientific statement means that it is regarded as being worthy of being subjected to further criticism. It does certainly not carry the guarantee of being a true statement, not for the short term nor for the long term. This implies that certification is a process that cannot be considered independently from a scientific frame of reference. It is the journal with its reputation that provides such a frame of reference. The negotiation process is a relative process under control of a self-judging community. For a negotiation two parties are needed: in this case the author with an affiliation and the scientific community represented by the editorial board.

In certification we can discern two systems: the author and the reader system. In the author system it is the author who takes the initiative towards certification by submitting his contribution to a refereed publication medium. In the reader system this initiative towards certification is with the reader.

It is a characteristic of the author system that acceptance by the scientific community is a priori, i.e. it precedes publication. By virtue of this acceptance the value of the publication is implicitly known to the readers who might then be inclined to pay for the publication. In the reader system, acceptance is a posteriori in an open system by the readers. In the reader system the scientific quality of the publication in the Popperian sense cannot be guaranteed which makes up front payment by the reader or library or institution risky. This implies that the authors or their institutions will have to pick up the bill. This will lead to an expansion of costs that can only be contained through the introduction of new filters not based on certification under control of an editorial board. Some proponents of the reader system claim that filters will not be required as adequate searching systems will take over that role. Then,

however, redundancy may well be introduced into the system leading to a much higher number of publications of lower scientific quality. Another important issue is that authors may feel they will run too large a risk of being openly rejected. This could well be a good reason for the author not to submit the publication to such an open system.

3 Value chain

The value chain is defined as the chain of values added by each stakeholder in the entire process of scientific information. The value chain defines their mutual roles and responsibilities.

We start with the creation of the work by the author who then, in the traditional value chain (see figure 2), submits it to a journal or other publication outlet provided by a publisher. Whether the publisher is 'for profit' or 'not for profit' is irrelevant. The publisher sends it out for review, for certification. Possibly after some rounds of revisions, the publication will be published resulting in the registration of the work. The publication will be distributed. The publication finally lands in the IHE's library and on the desk of the reader.

Figure 2: Traditional value chain

author ☞ publisher ☞ reviewer ☞ publisher ☞ agent ☞ univ ☞ reader
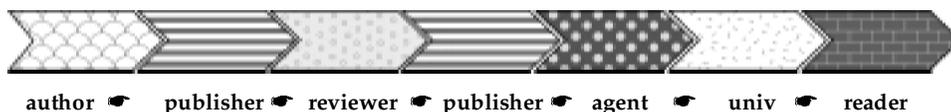
What changes do we expect in the digital environment?

It has been advocated that the value chain can be reduced to the author, reviewer and reader only, i.e. essentially without intermediaries from outside the research process. The author will distribute the work via the web and any reviewer can pick it up to add comments. Or perhaps even the reviewer can be missed out entirely, as the readers may well be qualified to judge the work by themselves. However, there are a number of issues at stake: how is the marketing of the work done, how will the reader find the publication, and as we saw in the previous section, how can publications be filtered? And there is the problem of certification: who will select the reviewer? Evidently the author should not and the reader cannot do this.

Another possibility would be to take the IHE out of the chain. In a digital environment it may well be feasible that the publisher is responsible for the entire communication between author and reader. The only problem is that the publisher will be responsible for the archive. It is not in the publishers' interest to take this economic risk and it is a responsibility that will not be entrusted to them. Alternatively, we can replace the publishers entirely by the IHE at both ends of the chain, at the author end and the reader end. But, who will select the referee? This cannot be the task of the IHE where the author is employed.

In the previous section we have argued that the certification process is a relative process. It is often argued that we should separate certification from the scientific journal9, 12. The objective is to separate the negotiation on certification from the negotiation on the transfer of copyright. This is a further argument that certification is one of the key issues in the discussion on the value chain. Indeed, if certification can be separated from the publication process, this will have severe consequences for the value chain. The premise in such proposals is that scientific information can be judged by an independent institution. This, however, means an absolute process and does not do justice to the scientific method as described by Popper. On the other hand, it may well be feasible that in new business models the author or his employer will, at least partially, retain copyright to a publication whereas the publisher will be granted appropriate exploitation rights to provide access to a specific manifestation of the work.

However, the need for certification requires a partner independent of the institutions. This is a for a publisher. This may lead to the following value chain: both the IHE and the publisher will have a symmetrical position with respect to the key actors in the chain, the author and the reader. The IHE is in direct contact with the author and the reader and will take responsibility for the necessary disclosure of the information and the

required technology. The publisher is responsible for the dissemination and branding and assists editorial boards in organising the certification process. As we have stated, the IHE are in the position to take up this role as they will be required to create an ICT supported publishing and archiving environment for the educational process. This will be further elaborated in the next section.

4   Strategic considerations

Distance learning and continuing professional development will open IHEs to new types of students. This means effectively expanding the time for which students will be associaited with the IHE by an estimated factor of two, from 4-7 years to twice as much per student-lifetime. No doubt, this will impact on the economic conditions under which IHEs will have to operate in future and this new economic regime will crucially depend on the investments that IHEs make in a publishing and archiving environment. This is the very reason for a fundamental change in the value chain as it represents a substantial change in the position of the IHE in supporting and representing the main actors in the value chain: the authors and the readers, now including students and teachers as well as researchers. Scientific information, both for research and education, turns out to be a key for the integration of research and education, a universal goal of all times. The application of ICT makes this goal attainable.

The above leads to a suggestion of an IHE-supported mode of 'self publishing and archiving' (see also Harnad[13]) for research and education. To establish such an environment requires the application of the same technologies as are used for research information only. A quick estimate shows that the total volume of production of educational information per IHE would surpass its required production of research information only by about one order of magnitude. This means that the IHEs are in the position to piggy-back the production of research information on the production

Figure 3: Emerging value chain

author   ☞   **univ**   ☞   **publisher** ☞ **reviewer**   ☞ **publisher**   ☞   **univ**   ☞   **reader**

of their educational information. The demands on archiving for education are, however, of somewhat shorter term than for research.

The integration of scientific information will lead to new roles for the actors in the value chain, the authors and readers, the IHE (possibly with new structures for the provision of scientific information and for educational innovation) and the publishers. It seems realistic to bring production as close to the source as possible, i.e. at the IHE, in particular as production facilities have to be in place for educational purposes. This was not the case with typesetting, printing, bundling in issues, distribution by mail, and displaying them in the library. We are witnessing a clear shift in added value from the intermediaries to the key actors, which will increase the stakes IHEs will have in the chain. At the same time, the development outlined will provide publishers with new and interesting opportunities for forward and backward integration in this much larger and profitable market. It may lead to an innovative industry primarily focused on the acquisition of information by the user. The system will become much more of a distributed system with clearly discerned roles for the IHEs, the publishers and other intermediaries. Sound business models will be required, with the aim of giving proper rewards for the value added by each of the partners in the chain. Publishers may become the facilitators and aggregators in such a system, facilitating the independent, and therefore internationally organised, added value in the system. A clear focus is the certification of information, which must be independent of the IHEs, and should be handled in a way that is differentiated so as to be commensurate with the needs of the stratified target groups of students, teachers and researchers. In the current system, publishers are the primary facilitators of this process. The new system should probably allow aggregation at both disciplinary and multidisciplinary levels, while at the same time retaining the benefits of the branding embedded in the present system of journals and discussion lists. As a consequence, the new value chain will have a number of characteristics of an organisational type known in the literature as a 'virtual' organisation.

5 Concluding remarks

The integration of information for education and research has been seen to be the key in the development of the value chain. In view of the overall globalisation of IHEs and the subsequent and inevitable process of mergers between such institutions, this development will need to take place within a time window of approximately five to ten years. IHEs will need to develop comprehensive publishing and archiving activities, to serve their authors and readers: students, teachers and researchers. An international network of institution-independent entities, such as required for (e.g.) certification, will have to be created. Here there is an obvious role for the publishers who would then act as facilitators and aggregators in this network. They will be responsible for high quality access and linking of certified material from distributed sources and for proper branding of this material. Such a development will necessarily lead to a distributed archive and consequentially distributed ownership. This is the true nature of the change in the value chain. Such a value chain will demand more symmetrical business models and new distribution arrangements and models.

This inevitably leads to a change in the positions of the players and provides an opportunity for new entrants leading to a new value chain for research and educational information.

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