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The Evolution of Scientific Publishing and the *JHEP* Model

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Scientific information at the beginning of the third millennium

Some recent events have brought to the attention of the general public the issue of free access to scientific information. On many occasions basic scientific information has been said to be constantly available to scientists. In truth, a group of scientists (those who live in the developing countries) have long remained on the fringes of the international research community and in part still are, mainly because of the existing difficulties in accessing scientific publications. However, this fact has never been as blatant as it was with the Human Genome Project. Indeed, the project saw an attempt to conceal and privatize the results of advanced basic research. On that occasion, the fear of a private exploitation of scientific results became a real threat.

On the other hand, we are also witnessing opposite signs. The birth of open archives, the free software movement and the Linux phenomenon, have highlighted the benefits of free circulation of information and of co-operation among scientists. Another significant factor is the introduction of the Internet as a revolutionary means of sharing information.

At the beginning of the 21st century, the general situation is quite heterogeneous, but scientific information has clearly gained fundamental importance. The state of

things was rather different at the beginning of the last century, in spite of the importance of the social and economic role of science. Everything changed after World War II. The past few decades have seen a dramatic increase in the number of scientists and the same applies to the quantity of research and discoveries and their applications. Scientific activity is nowadays carried out by a large portion of the working population - 1% in some of the most advanced countries. Allegedly, in the years to come a considerable part of the working population will be involved in scientific research.

These deep and radical transformations have altered the very nature of research. The way in which science is conceived has changed and therefore scientific information has taken on a different role. At the time of Galilei and Newton the production of scientific information was a secondary aspect of the scientist's work and data were seldom circulated, also due to difficulties in distributing them. Nowadays the situation has changed and scientific information is no longer kept unshared; on the contrary, as soon as scientific articles are released by the authors, they seem to become autonomous and gain a life of their own.

For some time now scientific information has lost its original innocence and its value as pure knowledge of nature. It can no longer wander around the scientists' Garden of Eden but it is forced to venture into the real world invested with values that are quite different from those originally intended. Out of metaphor, scientific information can be considered as merchandise and therefore be subject to the laws of the market. This transubstantiation of scientific information can happen in at least three different ways: 1) *transitive*: scientific information can appear such an immediate and crucial element for the development of new technologies and new products, that it is eventually invested with the value of these products and it ends up being considered as a product itself. This is the case with the attempt, maybe unrealistic, to privatise the results of the human genome project; 2) *media*: scientific information plays an increasingly important role in providing the show business with new ideas for general entertainment, as demonstrated by the enormous success of recent TV programs dedicated to the popularisation of science; 3) *publishing*: publishers have widely recognised the market value of specialised magazines and science books, but this exploitation of scientific information on the part of the publishing sector is jeopardised by the innovations introduced by the information revolution.

However, the previous statements must be given a neutral judgement, devoid of any deprecatory or moralizing meaning - as is sometimes the case with other issues arising within the scientific community. The fact that a result of human activity, such as

science, becomes a product to be circulated for the production of profit is something that has been occurring since the beginning of capitalism whenever an activity generates goods that can be exchanged for other goods. Indeed, this is a sign of the maturity and progress of scientific research which can finally play a leading role in global economy.

Similarly, manipulations of scientific information cannot be accepted uncritically simply because they can produce profit. It is the duty of scientists and of all those who care about the destiny of science to keep watch on the situation so that the new enclosures and the private use of science do not result in damage or obstacles to research. The evolution of specialised scientific publications is a clear example of the maze of problems arising when scientific information gets entangled into market mechanisms.

The example of scientific publishing

Each scientist shares the results of his research with his colleagues all over the world, mainly through articles published in specialised magazines (the so-called *journals* in scientific jargon). This practice dates back to the origins of the scientific revolution but gained a new significance in the second half of the past century. It is based on peer review, that is to say the author's colleagues examine his work and decide whether it should be published". It was certainly the ability of some businessmen to capture the market potentials of this kind of information exchange and embark upon the business by supplying funds and the publishing know-how. This led to the birth of specialised magazines with a neat typographical layout, guaranteeing the authoritativeness of scientific information and a widespread distribution even though, due to economic reasons, the Third World was virtually excluded.

Some of these publishers have grown so much that they eventually became multinationals. The Dutch Elsevier, for example, has conquered a dominant position thanks to its long-term takeover strategy . Unfortunately, these publishers did not want to (or did not know how to or were unable to) reject the easy mechanism of constantly raising the prices of their products. Thus, the cost of scientific magazines became a heavy burden for the restricted budgets of universities and research centres and, in the Nineties, it eventually led to the rebellion against Elsevier. Probably this would not have happened without the introduction of the Internet and the innovations it brought about, opening new paths to scientific publishing.

The advent of the Internet and the revolution of scientific publishing

The events that have occurred from the Nineties on could probably have been predicted a decade before, when the first networks began to connect remote calculators. Scientists began to exchange information by sending files via the electronic mail. Soon, even the traditional exchange of *preprints* on paper (preliminary versions of scientific articles used to share with to colleagues quick information on the most recent scientific results) was replaced by the faster and cheaper exchange of preprints on file. However, there remained a practical problem: without a filter, each scientist had to send his/her files to all recipients, which was an evident drawback both for the senders and the recipients. The problem was solved with centralisation.

Centralisation was introduced by P. Gisnparg in Los Alamos, where the first xxx archives were created in 1991 (a few months later new archives were created at the SISSA in Trieste with a complementary subject and were then merged with those in Los Alamos; these archives are currently in Cornell and have mirrors all over the world). Electronic archives are designed to collect all preprints on files, divided by subject and sector, and to make them available to the scientific community. Any researcher is free to send his files which are immediately put on the network and made available to colleagues all over the world. The information can be uploaded and downloaded for free.

The success of electronic archives has been enormous. They now store millions of documents and, thanks to their rapidity (it takes only one day from the upload to the distribution), they have become a normal work tool for all researchers. Of the utmost importance are also the time and money saved by scientific institutes and the opportunity for scientists in developing countries to have access to the same information as their colleagues in the rest of the world.

Electronic "journals"

The following step was the creation of electronic journals. Ostensibly, the archives of preprints are sufficient to cover the distribution of specialised scientific information. Although they do guarantee widespread distribution and have an undeniably democratic and egalitarian inspiration, other elements come into the picture: the evaluation of scientific results and the hierarchization of scientific knowledge. The application of naive egalitarianism (all articles have the same value) would indeed be the denial of science. The work of scientists does not stop when a result is announced by a researcher or by a group of researchers, no matter how authoritative it may be. Scientific research is based upon continuous assessments carried out in different places and, when possible, with different methods. The final scientific product is a social product, it is the result of assessments and counter assessments carried out within the scientific community.

Therefore, all research must undergo strict criticism. Only this way can the integrity of scientific research be preserved. This is why the archives are not sufficient. The scientific community has created the filter of scientific magazines to provide a preliminary evaluation and selection of the results, leaving the final evaluation to further analysis. This is why specialised scientific magazines are based on the peer review method: the article submitted by the author is then sent to one or more colleagues (anonymous) who act as referees assessing the value of the article, submitting corrections and amendments before publication. Quite naturally, this procedure is not exempt from evaluation errors and abuse, but it is a universally accepted method despite the attempts to replace it with more reliable systems.

What is still to be understood is how an electronic journal can improve the status of specialised scientific magazines. Let us now dwell on the functioning of one of the most successful electronic journals: the *Journal of High Energy Physics* (*JHEP*). *JHEP* was launched by SISSA in 1997. Nowadays it is the most important and inexpensive magazine of the sector. It is a completely computerised electronic magazine (no printed copy is published). Articles are submitted via the direct uploading of files to the magazine site. Each article submitted to *JHEP* is managed by a robot which, through a keyword-based system, assigns it to an editor who is invariably a scientist of worldwide renown. Editors then select one or more referees and their decision on whether to publish the article or not will based on the referees' evaluation report. The refereeing process is the only stage coinciding with the standard procedure in traditional

magazines. All the passages, from author to editor, from editor to referee and back to editor are computerised, as are the exchanges between the members of the editorial staff and the on-line publication of the accepted article. Of course, an electronic magazine is also economically competitive: *JHEP* is 10 to 15 times less expensive than its traditional competitors.

This is why electronic magazines enjoy a strong support in the scientific community: because they are cheaper, because they are innovative and because they provide a faster validation of scientific results. However, the number of important electronic magazines on the market is still very small: they can be counted on the fingers of one hand. Based on the *JHEP* model, in 2003 SISSA launched, through SISSA Telematica, *JCAP* (*Journal of Cosmology and Astroparticle Physics*) – an initiative that made a promising start - and other new projects are about to be launched. Another important initiative has to do with PLOS (Public Library of Science), but the rate of development of new electronic magazines is still rather low. Why?

Difficulties in the development of electronic magazines

The first reason is surely the inertia of the scientific community, still fond of printed magazines. A second reason is the inertia of the magazines' payment systems: an electronic magazine will replace or stand alongside traditional magazines. In order to pay for the new magazine (regardless of the payment system), a library will either increase the budget allocated for the purchase of magazines or simply give up the traditional magazine. The main reason is however tied to the perplexities of investors, who have to launch a magazine and trust an undefined and uncertain market. It must be remembered that virtually all articles published in magazines, both electronic and printed, are already available for free in preprint archives. Therefore, scientific institutions have no reason to squeeze their budgets in order to pay for the magazines.

The solution can be found in a mutual agreement between publishers and scientific institutions that guarantees the continuity of the service offered by the publishers. However, two requirements need to be met: 1) the scientific community must recognise that the services offered by the specialised magazines are essential for scientific research; 2) publishers must set reasonable prices for their magazines. Hence, publishers cannot freely raise the price of their products, which makes the market of

scientific magazine rather unconventional, discouraging risk capital from entering in this field.

The *JHEP* model

There is probably no universally valid solution to all these problems. Setting enjoyable utopias aside — which are far from rare even in the scientific world which believes that electronic magazines should be free (it is not as clear who should pay the people working for the magazine) -, there are signs that the above-mentioned mutual agreement can indeed work. The first sign is the rebellion against the pricing policies of Elsevier. A second sign is the presence of new investors in the sector of electronic magazines, powerful foundations such as the Soros Foundation.

Lastly, the third sign is the success of the *JHEP* model also from the point of view of sales. The investments used to launch *JHEP* were provided by various sponsors, chiefly by SISSA and by INFN. To set up a model that is economically sustainable, SISSA has reached an agreement with the IOPP (Institute of Physics Publishing), the commercial branch of the IOP (Britain's Institute of Physics and, a non-profit organisation) that markets *JHEP* and now also *JCAP*. Third world countries have free access to *JHEP*, while access for richer countries requires a moderate and affordable subscription fee which is accepted by most scientific institutions. This limitation to the access to *JHEP* is more symbolic than real: all articles published on *JHEP* are freely available in the preprint archives, and in any case, a few years after publication all *JHEP* issues become available for free. Even the denial of access for those who do not pay the subscription fee is more virtual than real: the message is that everybody should contribute to a useful service. Moreover, the IOPP supports the open archive initiative. Thanks to the *JHEP* model, the scientific world has resumed control not merely over scientific matters but also over the financial matters related to scientific journals.

Another model is that of the Public Library of Science, whose initial endowment enables it to adopt a fist-class marketing strategy. This initiative aims to set up electronic journals devoted primarily to biological sciences, providing free access to all its products. In this case publication costs are paid for by the authors themselves and no subscription charges are requested from the readers. Surely no particular solution can be singled out as the ideal formula for setting up new electronic journals. The PLOS model is scarcely applicable to physics and mathematics as it would require a considerable

shift in the budget of scientific institutes from libraries to research funds, in order to pay for the authors' publication charges. Another drawback lies in the fact that this model apparently penalises the most productive authors. Notwithstanding, we are faced with an interesting effort that deserves attention.

Conclusions

Among the contradictions characterising the distribution of scientific information at the beginning of this century, the advent of the Internet seems to provide the scientific world with an opportunity to regain control of the management of scientific information. The *JHEP* model is based on the recovery of a determining role for scientists (also from an economic point of view). Cleary this type of models, including the one developed by the PLOS, rejects the idea of indiscriminate profit, which means that the publishing activities can only be carried out by non-profit organisations. The adjective "non-profit" sounds always ambiguous. However, the case of scientific electronic publishing seems to offer an opportunity to define the real meaning of this term. Indeed, the definition of non-profit organisations cannot be absolute, but only relative to the field in which they operate. The fact that these models encompass free access to scientific information for the developing countries, that the setting of prices envisages some form of negotiation between publishers and the scientific world, and that a new tacit agreement in this sense may come true, leads us to consider what has happened so far not as a mere transition but as a realistic step towards the principle of fair exchange.

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