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Do We Need Alternative Forms of Publishing or Only NewTechnologies? Some Personal Reflections

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This paper considers the incredible changes in the journal publishing industry that have taken place during the last quarter century from the perspective of someone who has been closely involved with major publishing firms in the U.K. It speaks primarily of the changes in scientific publishing. It treats not only the publishing of journals but also the development of the journal publishing industry. The author looks at these changes from an economic, technical and behavioural standpoint. In the final section, the author looks to the future of scientific journal publishing in the world of Internet. He concludes that the need for high-quality, organised information will be as great in the future as it was in the past, but the containers for this information might well look different.

Introduction

Do we need alternative forms of publishing, or only new technologies? The answer is probably yes to the first part and no to the second, and having said that, I am strongly tempted to sit down. But like everything else, it is not as simple as that! In the remarks that follow, I am restricting myself to talking about the publication of science research, rather than covering the wider world of text publication, let alone the even wider world of multimedia.

First, a word or two about myself.

Until very recently, I was Director of Business Development at the British Medical Journal (BMJ) Publishing Group. Since 1 October 1999, I have undertaken a new role as a consultant in various aspects of publishing, although my major client is still the BMJ, with whom I have spent the last eighteen years. I doubt if there has been a more exciting place to work in medical publishing. For the first eight years, I worked with one of the legendary, great medical editors, Stephen Lock, from whom I learnt much. The last eleven years have been equally interesting, working with the extraordinary visionary, Richard Smith who, I am glad to say, was recently awarded by the British government with one of the senior honours in our country for services to medical journalism.

My career in publishing began in much less exalted areas, starting in 1969 on a range of magazines covering factory and office equipment – heating and vending machines, photocopiers and various pieces of office equipment. From there, I moved into consumer magazines, mainly sports and health. Not as a journalist – I have always fought shy of writing. My interest in publishing has always been in the mechanics of communications. In those early years, my work ranged from driving fork lift trucks to selling advertising space; from organising health and fitness conferences to judging beauty contests!

In 1975, I was offered a job at Oxford University Press (OUP) in the Journals Department. My

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friends all said I was crazy to take the new job – moving from the fast action, glamorous world of consumer magazine publishing to the deadly dull world of academic publishing. However, I had just married, and the salary was considerably higher. I needed the money. Stimulus enough to make the change.

As soon as I arrived at OUP, people there asked me why I had bothered to come. There was not much future in journals. By 1980, paper journals would give way to electronic journals. Science research would be published on huge computers to which other researchers would somehow connect, although in 1975 I got the impression that no one knew quite how this would actually work.

In 1982, I moved to the British Medical Journal, primarily to run the journal fulfilment and distribution section. The BMJ is probably a unique publishing company, at least in one respect. The Editor of the BMJ is actually the CEO of the publishing operation. At the American Medical Association (AMA), which publishes *JAMA (Journal of the American Medical Association)*, the Massachusetts Medical Society, which publishes the *New England Journal of Medicine*, the American College of Physicians which publishes the *Annals of Internal Medicine*, and even at *The Lancet*, published by Reed Elsevier, editors wield huge influence and power. However, only at the BMA is the editor responsible for the commercial profitability of the publishing operation.

In spite of the fact that I came from a background of commercial publishing, I believe this editorially led scenario can work, not only for the profitability of the company, (often only marginal, it must be said) but for the benefit of readers and the wider community.

Over the years, my work at the BMJ has led me into many national and international medical and scientific publishing fora, and I have been able to gain an outsider's view of what happens in other medical publishing houses, both learned, not-for-profit society publishers as well as some of the key commercial houses. I am involved in a number of publishing bodies and institutions, both in the U.K. and internationally, and I currently chair the Copyright Licensing Agency in Britain, the equivalent of CopyDan (Denmark), Kopinor (Norway), the Copyright Clearance Center (USA) and so on.

With more than thirty years experience, and significant current involvement in some of the key issues in science publishing, you might think I would have some expert analysis of the state of science publishing and, perhaps, a reasonable understanding of its immediate or near future. A couple of years ago, I thought I did. Here, in January 2000, I have to confess that I do not.

Where we are now

I think I have a fairly good understanding of what many of the questions are, but an increasingly hazy appreciation of what just a few of the answers might be. I am also finding it increasingly difficult to see some kind of pattern in what is going on in the world of science publishing.

For a long time now, I have tended to analyse things in terms of economic, technical and behavioural imperatives. A troika, just like faith, hope and charity and, like charity, I believe the behavioural imperative is by far the greatest.

Economic

Let's look first at the economic situation. Although most western economies are experiencing a period of almost unparalleled economic growth, there are continuing pressures on publicly funded ventures such as education and healthcare. This is probably not due to scarcity of wealth in our nations, but the almost universal drift in the 1980s to market-led economics. So academic institutions continue to be pressed into taking ever more students at ever decreasing subsidies from national funds. This is certainly true in Britain.

Indeed, in our country there is strong pressure from central government for universities to see themselves as commercial ventures, and to form alliances with for profit corporations to exploit what the universities increasingly sees as its intellectual property rights, not its researchers. More of this later.

Another pressure on research, and consequently on its publication, is the actual cost of the communications infrastructure: networks, hardware, software and so on. I do not know what it is like [here] in Denmark, but in the United Kingdom the cost of managing information and knowledge within the institution is often paid from the same

funds as buying the reference information in the first place.

It is indeed a wonderful and increasingly rare thing to celebrate the opening of a new medical library. As recently as last December, at an international conference for publishers in London, Professor Christopher Higgins of the Imperial College School of Medicine advocated the closure of all institutional research libraries, and a scaling back of academic, educational libraries. The rationale for such a radical attempt at saving scarce resources was that everything of importance is already available on the Internet. The interesting thing was that although there were gasps of shock, few people in the audience questioned his analysis.

Technical

Back in 1975, when I said that my new-found colleagues at Oxford University Press were telling me everything would be online by 1980, computers were hugely expensive things, housed in cavernous air conditioned rooms with strengthened floors, tended by strange people who, thankfully for the rest of us, understood the inner workings of the silent monsters they tended. It was possible for a few academics that knew what they were doing to access the databases stored on the machines using terminals attached by wires. Only a visionary could have foreseen that future computers would house information that practically anyone could access.

It took the introduction of the Personal Computer by IBM, driven by operating software developed by the young Bill Gates' Microsoft company, to make computers accessible to the non computer specialist. The corporate wise men at IBM did not think there was much long-term future in PCs or any real money to be made from easy to use, standardised software. Oh dear – I guess most of us make huge errors of judgement once or twice in our lives, but IBM have never really recovered from that one, and Bill Gates has never looked back!

The next big change in the way scientific information is moved around was the invention of the CD-ROM, itself almost an accident or at least the outcome of the failure by Philips and Sony to win the video-recorders war, although both had better technical products than Matsushita, the eventual winners with VHS. Remember what I said about behaviour being the main driver of change? Did you know that homemade pornographic videos greatly influenced the outcome of the video recorder wars? Maybe you also know that the time it took for the average orchestra to play Beethoven's Ninth Symphony determined the 120mm diameter of a CD-ROM?

In the mid-1980s, it seemed that the CD-ROM was the answer to all the questions about science publishing. Databases such as *Medline*, *Biosis*, *Excerpta Medica* were compacted onto CDs and distributed by competing publishers, each with its own proprietary access software. CD-ROMs were horrendously expensive too. In 1986 and 1987, I well remember working with colleagues at the *New England Journal of Medicine* to produce a CD-ROM containing AIDS research papers published in each of the main journals. It was a heady period, and the first time that journals such as the *NEJM*, *Lancet*, *Annals of Internal Medicine*, *Nature* and ourselves [*BMJ*] had ever worked together. Looking back, it was one of the most enjoyable periods in my career, and we made friendships in each other's companies that survive to this day. We already had the material, and we were even granted free use of the old BRS database software to marshal the material and make it accessible. Our ambition was to keep the selling price under $2000. We struggled to do this, and I can tell you now that the Massachusetts Medical Society lost quite an investment by the time the product was sold to the late Robert Maxwell in 1988. Yesterday, in a shop in London, I saw a computer magazine with no less than three free CD-ROMs attached to the front cover, one of which was an entire encyclopaedia, selling for something like US$4.00.

Just as the real future lay with software not hardware, so it turned out that remote storage of information rather than local on CD or hard disk would be the future. This was not easy to see in the early 1990s, and quite a few fortunes were lost in developing expensive CD-ROM science information products. What decided the issue was when the information scientists at CERN in Geneva wrote software by which data stored on various servers linked by the Internet could be accessed. Overlaid with the original Mosaic browser, and subsequently with Netscape Navigator and Microsoft Internet Explorer, the World

Wide Web came to life almost as suddenly as the charge of electricity that brought Frankenstein's monster to life.

Few inventions are ever entirely original – perhaps only the wheel and axle is the single non-derivative brainwave. If the U.S. Defense Department had not been worried about a Russian nuclear missile destroying its cable linked network of communications computers, we would maybe never have had the Internet, and if the Internet had ever been easy to use, we would probably never had had the World Wide Web, and so on.

But sometimes, an invention – the wheel, for instance – changes forever the way we live. I am sure most have us have played the game of naming the top ten most important inventions or discoveries in history. Even though it is early days, I would expect many if not all of you would include the Web in the top ten. Early days indeed. What the Web means for science publishing we can only guess at. But I believe that things will never be the same again.

Apart from universal ease of access, the Web is altering science publishing in at least three very significant ways.

Interactive

First, it is enabling researchers and authors to interact with their audiences, in all stages of what up till now we have called publication. We will address issues of copyright and intellectual property rights later, but for the moment, let us note that the audience can download all or part of the published research, and manipulate it either for their own benefit or as part of a return communication to the original author. This is especially true for statistical data, and it is a very profound innovation. Note too that obtaining the information to be manipulated is an extremely easy process, costing almost nothing in either time or money, at least in terms of access and transmission.

Multimedia

On the Web, researchers can very easily incorporate spreadsheet, diagrammatic, video and audio "clips" into their papers. Not as bells or whistles, which is how multimedia has often been used up till now, but as truly integrated illustrative data. In medicine, this will be particularly valuable in articles intended for practitioners and students. Not every medium will necessarily be appropriate for all scientific or academic disciplines, but many will be.

Dynamic

Science papers on the Web will inevitably be dynamic. Those of you who are familiar with the BMJ's Web site will know that we link all letters received in response to a paper to that paper, almost as an integrated piece of work. It might still be possible for a researcher to do as Luther did – nail his thesis to the digital wall and say – Here I stand, I can do no other. The thing is – he doesn't have to. He can go back and amend it after publication, after his work has undergone the much wider peer review that publication brings. This is raising all sorts of ethical and philosophical questions at the moment, and indeed, the act of publication needs a completely new definition, and bodies such is the International Council of Scientific Unions are engaged in working with publishers to arrive at such a definition.

The digital hurricane that is sweeping through the entire world of communication, from music, to video, to text, is having a truly profound effect on science publication, and is surely changing the whole process for ever.

The old remains

Having said all that, there is one phenomenon about the emergence of new technologies that always amazes me. I read somewhere recently that effluent gases from ocean-going liners are adding considerably to atmospheric pollution, particularly in the Atlantic and North Pacific. What was that? I thought the Boeing 707 was supposed to have dealt a fatal blow to such ships. There are more horses grazing in southern England today than there ever were in the Middle Ages. There are five or six times as many radio stations to tune into in London today than there were before television became universally available, and television was bound to close the radio stations down. Why would anyone want to just listen when through television they could watch as well as listen? Why, too, would anyone want

to bother going to the movies when they could watch a video in the comfort of their own home? And yet, there has been a massive increase in the building of multiplex movie theatres in our towns and city centres.

It is conceivable that the Internet could stop the printing presses turning, and that we would no longer be chopping trees down. But do you really think this will happen? I do not. I am intrigued by the operation of the principle of paradox in behavioural development, and I would be willing to bet that not only will the Web NOT stop the presses turning, it will stimulate a huge growth in the amount of material printed. We have already witnessed the phenomenon of huge amounts of paper being literally wasted as people print off two or three line email messages. If horses, and ocean liners, and radios, and cinemas are anything to go by, you might want to consider seriously investing in paper mills and printing companies.

Archiving

There is one other technological implication I would like to touch on. That is the whole question of archiving digital material. When a journal or book is printed, there are many copies. Even the low circulation journals will print sufficient numbers to send one to the national library for depositing in the archive. With CD-ROMs, it is not difficult to send a copy to the archive, though where the number of copies pressed is tiny and the selling cost is very high, publishers are fearful of the commercial implications of uncontrolled access to the deposit copy. Incidentally, what does present a challenge to the archiving library is not so much storing the CD-ROM itself, but maintaining machinery and access software that can read the CD in years to come. Already, there are deposits of scientific material, usually in tape or diskette form that can no longer be read.

When the term "electronic journal" simply meant the electronic replication of the printed page, as in Adobe Acrobat PDF (portable document format), it would be possible to send a copy of the PDF to the national library, although there would not be much point, since the hard printed copy is likely to be far more durable, and accessible in the future. Indeed, the British Library has already said that it would prefer to receive the printed publication if the electronic version is simply a digital replication of the printed page.

What presents a perhaps-insoluble problem is the question of archiving dynamic and multimedia scientific publications. Over the last few years, we at the BMJ have been wrestling with endless proposals from various vendors to host our papers, and you can find our material in different guises on HighWire Press at Stanford University, OCLC in Dublin, Ohio, Ingenta in Bath, England, or on Ovid – either on their server in Salt Lake City or, if your library prefers it, downloaded onto your institution's server. This did not matter much where we are talking about a PDF of even straight HTML version of the text.

But it gets very complicated when you start adding text and forward and backward links. It is extremely expensive and perhaps impossible for all these versions of a journal article to be updated simultaneously, and we soon encounter version control problems. This disadvantages both the author and reader, and such diffuse depositing of the research material is ultimately not viable.

If you then imagine the scenario when video and audio clips, integral to the research, might be stored on different servers from where the text is housed, you quickly add a layer of complexity that makes storing the data on multiple sites practically impossible. Realistically, there can only be one version, stored on one server. We can no longer speak of multiple copies.

This, then, presents perhaps impossible challenges to the concept of depositing a copy in an archive, even the national library archive. Perhaps we might have to abandon the idea of a permanent archive of science research publications, at least in its multimedia, dynamically updated digital format? A printed volume is a finite entity. A digital object is at once potentially unique and infinite. There are already those who say that the only sure way to permanently archive research is to print it, however incomplete and inadequate this archive version might be. Who knows? I honestly do not know!

Behavioural

If the economic and technical implications of the change in science publication are difficult to comprehend, the cultural or behavioural ones might be impossible.

The science author

Authors publish for a variety of reasons, but in science, it is generally in order to secure continued research funding, to gain academic or other advance, and to achieve recognition by their peers. Over the last two or three years in the United States and in the United Kingdom, there has been considerable debate about the rights and expectations of science research authors. In the UK, at one stage this became particularly heated. One of the leading British authors representation bodies, the Authors Licensing and Collecting Society (ALCS), mounted a campaign in which they tried to persuade academic authors to grant to journal publishers only the most limited distribution rights. In particular, they were advising authors to withhold electronic publication rights.

The campaign failed because of two quite profound misunderstandings about the science publication process. The first was about so called secondary rights. For professional authors and journalists, the group of writers the ALCS best represents, there is considerable money to be made from selling the work on to a second publisher. This has always been true of syndicated journalists.

The amount of money made by a scientific publisher from photocopying of journal articles spread across the number of articles published in a year is very small indeed, and divided amongst authors or journal articles would amount to pennies.

Secondly, in spite of the fact that the journal articles have been available for some time on hosted proprietary text services such as Ovid, and more recently on the publishers own Web servers, the amount of revenue gained has been fairly insignificant compared with the investment publishers have had to make and are continuing to make in preparing text for digital usage. If there is a pot of gold at the end of the digital rainbow in science publishing, I have yet to meet a publisher who has found it.

What is bothering science authors might not be any change in expectation for financial reward, but rather how the concept of claiming authorship can endure in the new instant digital age.

The institution

Academic and research institutions, on the other hand, might be taking a very different attitude. Apart from a few obvious exceptions, such as the University of Chicago, Harvard University, MIT, Oxford University and Cambridge, universities have not traditionally made good publishers. In England, for instance, while the law implies that the copyright of all work conducted while in the employment of an institution is held by that institution, by custom and practice, universities have been happy for faculty members to claim copyright, and for them in turn to assign the copyright to the publisher of the journal in which they publish their articles. Except for the presses mentioned above, the universities have not been in the business of publishing research.

This is changing. First, as I alluded earlier, academic centres are coming under increasing pressure to become more commercially aware of the value of the research conducted under their auspices. Secondly, the press is flooded with stories of entrepreneurs making untold fortunes from seizing the opportunities presented by the World Wide Web. Over the last few years, a very small number of publishers have made large profits from publishing scientific journals. In the United Kingdom, in the United States and in Germany, almost all the original medical journal publishers – the great houses of Churchill Livingstone, Butterworths, Williams and Wilkins, Lippincott, W B Saunders, Springer Verlag to name but a few – have all either been bought by or merged with larger houses, faced with the unprofitability of publishing journals and the heavy investment required to develop digital publishing and distribution techniques. I do not know of a single publisher who has had anything like a reasonable return on the investment so far made.

Nevertheless, more and more institutions are trying to claim the copyright on the publication of all research conducted under their auspices. There might be good reason for this, especially if the institution wishes to reinforce its reputation for a excellence in a particular field of research in order to gain increased funding, although I think it would take more than an attractive or even a comprehensive web site to achieve this.

Corporate influence

It is not only scientists and their learned institutions that have a stake in the ownership of published research. Perhaps in medicine and the life

sciences more than any other area, we are witnessing a monumental change in the way issues of who owns what are being discussed. There is much money to be made in the cure and even in the prevention of disease, and many Internet entrepreneurs are predicting that supplying healthcare information is the biggest single earnings potential in the entire world of Web commerce. Until the last fifteen or twenty years, the hard money in medicine was in pharmaceuticals. Now, in addition to the unique growth in genetics and biotechnology, there is a whole new market in health information, not only for the researcher and practitioner, but for the patient and his family as well.

It is impossible to predict what will happen in this regard, but the very recent purchase by America Online of the vast Time-Warner media content company might be indicative. If McLuhan is right after all, that the medium is more important than the message, those of us in this room who have spent much of our lives working on some aspect or other of information content rather than its transmission, as authors, librarians and publishers, are probably facing a very uncertain future. There is an old English proverb, which we were all taught as children: "Look after the pence and the pounds will look after themselves". In Alice in Wonderland, Lewis Carroll converted this advice to "Look after the sense, and the sounds will look after themselves". Over the years, this has been a sort of guiding principle for me, and I have probably bored my colleagues by quoting it often. I have always felt the academic author and publisher should concentrate on the quality of the information we are supplying, and worry a little less about the way it is presented. It might be that for the next period of development, the sounds might be seen as being more commercially valuable than the sense.

Where we might be going

The same night I heard the news about AOL buying Time-Warner, I saw a programme on the History Channel about the gold rush in the Klondike territory of Northwest Canada. In two short years between 1897 and 1899, 30,000 prospectors sacrificed almost everything they had to get to the Klondike. The vast majority was disappointed, and most were ruined. The comparison with what is going on today with regard to people investing unreal sums in dot.com companies is hard to resist. I referred earlier to the paradox of progress. On the Web, almost anyone can do almost anything. That is the theory. The reality might be different. Is there room for more than one general online book supplier? The world's largest bookseller, Barnes and Noble, is struggling to catch up with Amazon.com, and may well not make it. Isn't funny too, that the product most bought online by consumers is the printed book!

The ongoing tussle between the US Justice Department and the Microsoft Corporation might also give us cause to think. We all hate monopolies, and all our governments have laws to prevent them forming. And yet, the software standards that Microsoft offers, especially in its word processing and spreadsheet packages are essential if we are not do operate in kind of digital tower of Babel. Another paradox.

Globalisation of business, including publishing is probably irreversible. Glaxo and Allen and Hanbury, and Wellcome, and Smith, Kline and French and Beecham have merged into one. There are few and fewer pharmaceutical companies in the world. There are also few and fewer publishing houses, and for very similar reasons – the cost of developing new products and taking advantage of new technologies is becoming so great that only mega-sized companies can afford it.

The world of publishing is in as much turmoil as most other industries, and perhaps more so. I alluded earlier to the fact that most of the big North American media companies – Thompson, Times Mirror, Time-Warner – have pulled out of primary science publication. Apart from Taylor and Francis, there are no significant British publishers left in science, technical or medical journal publishing. There is only one American company in the Big Four – Harcourt. The two biggest are Dutch, Elsevier and Wolters-Kluwer. Bertelsmann of Germany is a new entrant into the world of STM, with its purchase of Springer Verlag, one of the largest and most innovative of medical publishers.

Who is left of the traditional players? There are still the traditional university presses in America and in England, and the learned and professional societies, some of which are large publishers in their own right, particularly in the physical and

life sciences. These bodies are having to adapt to entirely new methodologies in the publication of science research.

We have already seen how the Internet grew out of the American Defense Department's concern not to rely on a single fixed network for communications. This is not the only thing science publishing owes to the US defence industry, at least indirectly. The Los Alamos National Laboratory, descendent of the facility which developed the first atomic weapons, but now the home of high energy particle physics, provides the server onto which physicists from all over the world can post drafts of their research. This serves the dual purpose of notifying fellow scientists and researchers of the work they are doing and of inviting comment from them. Particle physicists have a decades long history of circulating such drafts, previously in carbon copy or photocopy format, before offering the article for formal publication in relevant journals. The Los Alamos server makes this process vastly easier and more effective.

There are obvious differences in physics and biomedical research. For one thing, physics research is far more collaborative then in the life science. Tens of co-authors are not at all unusual in this branch of physics. For another, the basis for funding is different, and there is little patent implication in the sort of material appearing for open access on the physics server. Nor is there much likelihood that research leaking into the public arena will cause much distress or arouse any false hopes of impending miracle cures before the peer review process has had time to operate.

But already, what has happened at Los Alamos is beginning to effect the course of biomedical publishing. The initiative at the National Library of Medicine in Bethesda to act as a unique resource for the entire world's biomedical research is getting under way. The original proposal by the then Director of the National Institutes of Health, Dr Harold Varmus, in early 1999 to set up a service at the NLM where scientists could deposit drafts of their research, and on which the peered reviewed version would also be stored, has undergone considerable development. One of the key motives in setting up this service was to combat the high prices of traditional print journals, especially those published by the for profit corporations.

Not surprisingly, traditional journal publishers felt extremely threatened by the proposal, the learned societies perhaps more so than the commercial houses, since for many of them, sales of their journals to libraries and non-members is the leading source of income. The NIH has listened to these arguments, and the current proposal for PubMed Central goes some way to allaying the fears of the society publishers. Indeed, the British Medical Journal has announced that it will deposit its scientific papers on PubMed Central, and is one of the first clinical medical publishers to do so.

But it was not an easy decision for us to make, and it still presents us – and our readers – with problems. Biomedical publishing is no longer a static process. If you have seen the on line version of our journals recently, you will see that there are all sorts of links we embed in a science paper, of which the most significant are subsequent letters and editorial comments. While the article housed in PubMed Central will be able to link to other cited articles via *Medline*, they will not contain the dynamic additions. These are stored on Stanford University's HighWire Press server in California, and we might reluctantly be facing the problem of version control, referred to earlier.

Some of us also wonder whether there are not some risks in devolving to an agency funded by the United States Federal Government, or indeed, any other national government or agency, the responsibility of being the guardian repository of the entire output of biomedical research. Some wonder whether it is even a practical proposition. My own personal view is that it probably is not, but we live in exciting times, and it just might work.

So where does all this leave the poor librarian and the hard-pressed publisher?

Was Professor Higgins right when he advocated the immediate closure of biomedical research libraries and the trimming back of university and teaching libraries? Two or three years ago, I would have said the whole idea was crazy. Whether they remain as physical institutions or not, and I expect they will, libraries are bound to change very substantially over the next few years. I have fought all my life against jargon, but for once, I cannot think of a better way to describe the new library than as the information resource and knowledge management centre.

And as regards us, the publisher, it is hard to predict precisely what our future will be. The way authors write up their research, the way their institutions view the intellectual property rights contained in that research, the belief that institutions themselves could become publishers are already having a profound effect on the way we operate. And it has only just begun.

Here is what I think.

I believe some things will not change. Authors will still want their research to be published in the best medium, with the highest impact factor: not just for the prestige value, with the continued funding and promotion that that such publication brings, but so that their research will be visible in an ocean of undifferentiated material. Apart from turning research words into something approaching literature, publishers might continue to provide much better and more independent peer review than that originally envisaged by Dr. Varmus. He thought it could be done adequately either by volunteers or by the researcher's learned society. So we might continue to play a major part in the refinement process of science publication.

I think we also continue to supply one other key service. The emergence of new technologies rarely destroys the older ones, it simply changes them to provide different functionality: liners going from Los Angeles to Alaska, not from New York to Southampton; horses being ridden for pleasure not work; movie theatres seating people comfortably in groups of three hundred, not three thousand in discomfort; radio stations catering for 50,000 country music fans not a whole city of a million with every possible music taste, and so on.

I predict that that the sheer volume of information available to researchers and clinicians on the Web, likened by some to drinking at a fire hydrant, will lead to a demand of periodically delivered printed copies of the information they know they have to read – in good old ink on paper format, selected by peer colleagues they trust, once a month or so. New printing technologies, where there has been a digital revolution every bit as radical as in other industries, will enable companies like ours to provide readers with precisely the full printed version of papers they need to read, together with summaries other papers which have some tangential interest. These printed publications, tailored for perhaps only groups of ten or more, and sometimes purely for individuals, might actually add real value to on line information. The may not be journals as we know them, but I am willing to predict a proliferation of tailored publications, that look an awful lot like that traditional journal, just changed to meet new user needs. All driven by the explosion of information available on the Web.

I said at the beginning of this presentation that I have been working in publishing for more than thirty years. I don't ever recall a time when it has been as exciting as it is now.