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Electronic Publishing for Engineering Education

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Abstract

Electronic transmission of text is a revolution in progress with a profound effect on engineering education. As with all revolutions, the result is both a threat and a promise. The promise is the ease and speed of dissemination of text. The threat involves serious difficulties that arise in efforts to protect the intellectual property rights of the authors and publishers of the technical information. In this paper, we discuss both the threat and the promise. We highlight the differences in dealing with books and with journals. We give a wide range of examples from both inside of and outside of the scientific and engineering fields.

Key Words: *Publishing, electronic publishing, copyright, intellectual property, cyber security*

1. Introduction

We better all get used to the fact that we are in the midst of a revolution. The electronic transmission of text threatens to rival the invention of the printing press in the effect on dissemination of the written word. The issues involved have become the concern of an unusual variety of people, ranging from the individual desktop publisher up to policy makers at the highest levels of governments. The players include lawmakers, publishers, authors, professors, students, lawyers, giants of the entertainment industry, computer scientists, hackers, anti-hackers, engineers, software designers/distributors, book thieves, distance educators, and professional society officers. In science and technology, the American Statistical Association [1] has sounded the following alarm:[1]

> The making of books did not pass from the hands of monks to the printing press without some dislocations and even regrettable losses along with the enormous benefits. Books became much cheaper and much more widely distributed. Books on revolutionary, heretical, and (gasp!) even purely pleasurable ideas were rampant. Some in the centers of ecclesiastical and political power were mightily annoyed that they were losing control over who had access to what ideas, and the results of their discomfort were not pretty. Concurrently, in the main, books ceased to be individual, magnificent works of art with illuminated capitals, elaborate calligraphy, and original illustrations. Somewhat analogous issues will have to be faced as statistical ideas are flung into the worldwide nets. Who will profit financially and who will control the flow of information (commercial publishers, professional societies, governments, new entities

[1] This quote is attributed to Professor Bruce Trumbo, University of California, Hayward.

> not yet invented; anarchy)? Whose cherished values of scientific discourse will (or should) be preserved, extended, or demolished (quality, prestige, criticism, openness, access)? Will the Internet become the next and all-encompassing "vast wasteland" or a new medium to foster unforeseen advancements in science?

The questions raised by the American Statistical Association are not confined to science and technology. In an essay in the *New York Times Book Review*, Bayles [2], in discussing literature, raises the following concern:

> Is it awash in an unchartered sea of text...

The real question concerning electronic publishing is what is the threat and what is the promise? Should we go with the flow or should we resist? If we resist, will we dodge the bullet or miss the boat? In either case, borrowing from Bayles' description, will we find ourselves "awash?"

2. Periodicals and Books

We shall focus our attention specifically on electrical and computer engineering (ECE). The Institute of Electrical and Electronics Engineers (IEEE) has long been an international source of periodicals concerned with all phases of electrical and, more recently, computer engineering. These publications account for a significant percentage of the world's literature on the subject. In addition, income from these periodicals represents a large portion of IEEE revenue. Beginning in the mid-1980's, the IEEE has also become an important and viable source of technical books, including textbooks, handbooks, and monographs. We include a brief history.

There has been a dramatic change in engineering book publication. Prior to the mid-1980's, representatives of the traditional scientific and engineering publishing houses (Prentice-Hall, Wiley, McGraw-Hill,...) haunted the halls of academe searching for the next professor to write the next book on..., well, whatever. Those primarily involved in education at the graduate level were usually honest enough to point out to the book-reps that our potential graduate textbook would never become a technical-list best-seller. The principal reason is clearly correlated to the fact that the further one goes up the academic degree ladder, the smaller becomes the cadre of interested (or, in the case of course adoption, required) buyers. The book-reps were all quick to reply that they understood and appreciated that graduate texts and monographs were an essential part of the market, even though the prospects were seldom brighter than a modest bit above break-even. Some publishing houses appeared willing to underwrite modest losses on graduate texts and make up the difference in the undergraduate market; they did so principally for the prestige.

All of this changed dramatically with the new wave of down-sizing and attention to the so-called "bottom line." The traditional scientific publishers, with scarcely a farewell, abdicated their position in the graduate textbook and monograph market, leaving a void that has only recently begun to be filled by the small presses and, in particular, those attached to the professional societies, such as the IEEE Press.

There is a striking parallel to be drawn with the situation in literature involving mass-market books versus the "midlist." In the essay by Bayles referenced above, she makes remarks that are both interesting and a sad commentary. She writes that literary pessimists believe that [2]

> ...an increasingly conglomerated publishing industry pursues mass market success to the detriment of the so-called midlist books that are often the lifeblood of the culture.

It could not have been said better. The traditional publishers simply left the marketplace.

In the publishing of electrical and computer engineering books, the IEEE Press has demonstrated that a small press under the umbrella of a professional society can and will replace the traditional publishing houses in performing a service for the society's members, as well as a wider class of people interested in all aspects of ECE. The IEEE Press is not alone. Vibrant organizations such as the Society of Industrial and Applied Mathematics (SIAM) have demonstrated that they can produce books, handbooks, and monographs that fill the gap left in the wake of the departing traditional publishers.

We now find that filling the gap is not enough. The IEEE, for example, is faced with crucial decisions regarding electronic publishing of every type of intellectual property produced by the IEEE. Indeed, there is something quite radical going on here, for better and/or for worse. The editors of *IEEE Spectrum* have weighed in with the following question [3]:

> For centuries, the biggest and best ideas have found their way out into the world through books. But now that we can put not only words and images but also video and sound in our pockets, or send them anywhere in the world in an instant, is the quaint practice of printing and binding pages poised for a slow but sure decline?

3. IEEE

We shall use the IEEE as an example of a professional society engaged in electronic publishing. The IEEE is a principal professional society for electrical and computer engineers. The protection of the rights of its members and, in particular, its authors is an important and legitimate concern for the IEEE. In addition, the maintaining of the financial health of the IEEE is a huge consideration when we realize that the IEEE derives a large share of its revenue from its periodicals. Given these considerations, electronic publishing poses both a threat and a promise. To understand both, let us first examine the mission of the IEEE and the IEEE Press. The IEEE

> ...promotes the engineering process of creating, developing, integrating, sharing, and applying knowledge about electro- and information technologies and sciences for the benefit of humanity and the profession...The IEEE has more than 360,000 members in over 150 countries. (It) produces over 30 percent of the world's published literature in electrical engineering, computers, and control technology.

Within the IEEE, the IEEE Press has the mission of publishing

> ...texts, references, handbooks, and monographs to meet the present and future needs of IEEE members, potential members, and others in the fields of interest to IEEE.

There is nothing in these mission statements to prevent the IEEE from becoming a major player in the electronic publication market. The question is: Should it and, by inference, should other technical publishers do so?

4. The Promise

The promise of electronic publishing applied to scientific information is, quite simply, the ease and the speed of dissemination. The Web provides the means and Adobe Acrobat pdf-formatted files (there are others) provide a popular mechanism. Toss in ease of entry, methods for browsing, laser printers, and credit card payment, and we have a clear, viable prescription for a wide range of beneficial uses. The IEEE is already immersed in making available issues of many periodicals in electronic form. The IEEE Press is considering

offering some of its books and, possibly, an entire book series on-line. Other professional societies are producing electronic journals and are in some cases making journal articles universally available at no cost, after a certain period of time has elapsed since publication date. To add to this rush to electronic publication, there are now appearing organizations on the Web entering the business. An example is CrossRef, which advertises on the Web as follows:[2]

> As technology transforms the flow of information and ideas everywhere, publishers who participate in CroosRef are pleased to offer the scholarly community a milestone for electronic publishing – a collaborative, cross-publisher reference linking service that turns citations into hyperlinks, allowing researchers to navigate online literature at the article level.

The lure of electronic books and journals in academic education is particularly seductive. There has long been a need for making passages available to students from a variety of textbooks and journal articles. In the past, access has been afforded in a number of ways. A popular method has been to put a list of books "on reserve" at the university library and to make available to the students a list of journal articles to be referenced in the course. Students can then read sections of the books, as assigned by the professor, and photocopy the required journal articles. All of this becomes much easier if the books and journals in question are available in electronic form on the Web. The professor can extract the portions of each text, download the journal articles, collate, and produce a set of notes that presumably can be accessed by students who, somehow, should pay a fee for the service. One would suppose that a method could be developed where each publisher is paid royalties for the portions of the books and journal articles accessed, weighted by the number of students involved. The publishers would then compensate the authors, where appropriate.

5. The Threat

The threat inherent in electronic publishing is in protection, or lack thereof. In a 1999 report from the U.S. Register of Copyrights, the Register states [4, pg.67]

> Sophisticated technologies to prevent post-access uses of material are also a reality, although few are widely available.

and, [4, pg.141],

> Sophisticated technologies capable of protecting content against unauthorized post-access use are just now in development or coming to market, and may become widely available in the near future.

In subsequent testimony before the Subcommittee on Courts and Intellectual Property, Committee on the Judiciary, U.S. House of Representatives, the CEO of the Association of American Publishers, Patricia Schroeder, took the following position on the report from the Register [5]:

> ...in light of the Report's recognition that developments in technologies for protecting content "are harder to predict" than developments regarding licensing mechanisms and delivery systems for digital distance education (p.67), we see no sense in urging Congress to quickly enact a broadened exemption that will either be inapplicable to most digital distance education providers or improperly invoked by them, due to their inability to meet the essential condition precedent of having effective post-access technological controls "in place". (p.151)

[2] On the web at www.crossref.com

(The page references in her statement refer to pages in the report from the Register [4].) Ms. Schroeder is quite right in urging caution in enacting legislation in an environment where protection against unauthorized access is still a developing engineering area. In addition, the Register has been seriously misled in speculating that adequate protection measures "may become widely available."

As evidence of the frailty of encryption systems, consider the case of digital video discs (DVD). In a piece datelined November 5, 1999, Schwartz reports [6]

> After the motion picture industry spent years negotiating the encryption standard for digital video discs (DVD), a small group of Norwegian hackers recently released a program, called DeCSS, that can break the encryption on almost any DVD disk.

This was a serious setback to companies with huge amounts of money at stake. It also represented a direct challenge to the stance of the Register of Copyrights.

There are an increasing number of professors actively involved in the concept of digital distance education where protection of intellectual property is an issue. It is becoming apparent that we simply cannot invent a protection system that cannot be hacked. Under such a scenario, the best copyright protection may simply be low price so that it becomes economically infeasible for the hacker to ply his/her trade.

Consider comments by David Ignatius. In an Op-Ed piece in the *Washington Post*, he writes [7]

> So you think your computer communications are safe and secure? Hah! You poor, deluded, vulnerable fool. Experts in the security business confide that most computer networks are wide open to attack by dedicated hackers. Indeed, they describe some real-world electronic assaults that would make your bytes turn to bits. Want to break into one of Switzerland's most famous private banks and look at its accounts? Not a problem.

The key word here is "vulnerable." Ignatius reports on widely available sophisticated hacking tools invented and perfected by the government security and intelligence communities. He comments,

> What's happening, in effect, is the privatization of some of the most powerful tools used by intelligence agencies.

Organizations are beginning to fight back. But, are their efforts effective? Ignatius explains,

> An example of what's available comes from Michael L. Puldy, who heads IBM's Emergency Response Service. He runs a group of about 100 people worldwide, who help IBM clients clean up the damage from electronic break-ins and try to prevent them from happening in the first place.

However, Ignatius cautions us when he quotes Puldy as saying "Given enough time and effort, you can break into anything you want to..." Puldy is certainly in a position to know.

Governments are also beginning to fight back. Pete McArthur [8] comments as follows:

> Paul Kurtz, executive director of the Cyber Security Industry Alliance, Wakefield, Mass., which represents the CEOs of U.S. security companies, is pressing the Bush administration to kick cyber security a rung higher by giving it a department and an assistant secretary of its own within the Homeland Security Department.

The threat has gotten the attention of some very powerful people. Mike Snider writing in *USA Today* [9] reports,

> An unprecedented coalition of TV networks, movie studios, media conglomerates and sports and news organizations has formed to seek protection from what it calls digital piracy in cyberspace. Creation of the so-called Copyright Assembly was announced Wednesday at a congressional hearing. It includes a who's who of modern media. Among them: CBS, NBC, ABC/Disney, MGM, Paramount, Sony, Time Warner, Universal, the Directors Guild of America, the Writers Guild of America and all major sports leagues, including the NBA, NFL, NHL, Major League Baseball, the NCAA and NASCAR. "We are deeply concerned about the future of creative works," said Jack Valenti, president of the Motion Picture Association of America. He pointed to "illegitimate intruders" on the Internet who "steal copyrighted works."

In a crucial statement, Snider [9] quotes Brian McCarthy, a representative of the National Football League at the same congressional hearing,

> New technologies provide the impetus for greater potential of signal piracy...

We emphasize that, whereas the Register of Copyrights considered new coding technology a *promise*, McCarthy considered it a *threat*.

Suppose an author's and publisher's hard-earned copyright is compromised. Can the author sue? Tad Friend, for one, thinks that it is a tough proposition. Writing in the *New Yorker*, he discussed a suit brought by Mark Dunn and Carl Person against Paramount Studios. He wrote [10],

> But the reason that Dunn and Person will probably lose their suit has less to do with the perceived integrity of the plaintiffs and the ostensible skullduggery of the defendants than with the fact that most copyright plaintiffs overestimate how much protection they have under the law...Most copyright lawyers believe that if Shakespeare were alive today and had preserved his copyright on "Romeo and Juliet" he would find it difficult to win a case against "West Side Story." Leonard Bernstein and Stephen Sondheim would testify that they'd vaguely heard of Mr. Shakespeare and his Italy-based twist on the star-crossed-lovers scenario, but they'd certainly never read it. The defense would parade experts to testify that Mr. Shakespeare's melodrama was utterly different, since it contained few, if any, Puerto Rican seamstresses and ballet-dancing street gangs. And they would also make the legally weighty argument that because Mr. Shakespeare had himself, as usual, stolen his plot - in this case, from Arthur Brooke's tedious epic poem "The Tragicall Historye of Romeus and Juliet" - he had no basis for a lawsuit.

Given the persistent uncertainty of electronic protection and the difficulties in redress for copyright infringement, the following conclusions seem inevitable:

1. The threat is real.
2. It is not going away any time soon.

6. The Electronic Book (Hacker Version)

As if inadequate electronic protection were not serious enough, the world-wide book knock-off business is alive and well. U.S. copyright, for example, means nothing in many countries. Since the invention and dissemination of the Canon print engine, there has been a brisk market in illegal copying and selling of scientific and engineering books. This process becomes ever so much easier for the book-hacker if he/she has access to the book electronically. An enterprising professional book thief no longer requires the assistance of goods-and-services providers to produce a product equal to, and sometimes superior to, the original book. An individual hacker-to-be can amass all the necessary tools in a home-based book knock-off operation. All

that is needed is a computer, a color laser printer, and a book binder (device, not person). The cost of putting together a professional-quality operation of this sort decreases every year. At present, $5000US is a viable estimate. The hacker will take into account the costs, the time, and effort to create and bind. It then becomes a simple question of economics: Given the cost of the legitimate book, is the knock-off worth the investment? We should note with some alarm that all of this illegal activity can begin with the hacker's legitimate access to the electronic book.

What is potentially really scary is that there is no valid reason for limiting this knock-off discussion to books. The concept of knock-off periodicals goes to the very lifeblood of organizations such as the IEEE.

7. The Bottom Line

There is much at stake here; and we are at the mercy of hackers with extremely sophisticated hacking methods. Matters are getting worse. Indeed, CNN reported that in 1999 the FBI had a backlog of over 800 cases of computer hacking pending, double their total in 1998. At the University of Arizona, computer systems technicians in our Electrical and Computer Engineering Department spend an inordinate portion of their work-month parrying the thrusts of very intelligent people bent on hacking into our computer systems. Some do it for access to "secure" information; some do it for fun.

The challenge for any organization contemplating electronic publishing is threefold. First, those who guide the organization must understand the risks involved (the threat) and the possible rewards (the promise), both intellectual and economic. Second, they must make the tough decisions concerning the electronic market. Third, if the organization chooses to enter the market, it should do so with a viable business plan that takes into account the crucial economic factors. In essence, the challenge can be summed up in the following question: Does the promise sufficiently exceed the threat?

Books and periodicals clearly present different problems. Books involve royalties to authors; journals, transactions, and magazines do not. Engineers who write books have a right to expect that their intellectual property will be protected and that they will receive a return on their often substantial writing investment. Engineers who write in periodicals are more interested in the wide dissemination of their product. Book authors do not want to "give it away." Periodical authors are not so sure. In both cases, however, the publishing organization has the right to receive a return on its considerable investment. Indeed, losing money is clearly not a valid proposition.

If we are willing to give away what we create on the Internet, there are no insurmountable problems. For example, Web design has forever altered the ways in which professors interact with students. Web pages now contain class organization material, assignments for the semester, class notes, and access to very professional videos. As an example, some professors reproduce themselves as virtual professors on the World Wide Web. But, it is important to realize that most do so as a personal time saver in digital distance education, not as a money maker. If we are not willing to give it away, the whole scenario changes. If it can be hacked and if it is worth hacking, the hackers can and will hack it. The entire scene then becomes a matter of economics. This is the bottom line; and it is unlikely to change in the foreseeable future.

As a final note, it seems certain that books are here to stay. They will, however, likely evolve into something quite different. The editors of *IEEE Spectrum* write as follows:

> Books will evolve away from the things we know and love today: static objects that somebody writes, someone else prints, and someone else reads. They'll increasingly be bundles of data that are networked, and whose authors and readers are joined perennially in ongoing discussions within the context of specific published documents. Such a revolutionary intellectual infrastructure awaits the solution of

a few fundamental problems. First, of course, there are the copyright and business issues. Then there are the hardware challenges - we don't have anything like the right devices to access the books of the future.

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