

Analysis of a Case ■

From Paper to Electron: How an STM Journal Can Survive the Disruptive Technology of the Internet

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Abstract The Internet represents a different type of technology for publishers of scientific, technical, and medical journals. It is not a technology that sustains current markets and creates new efficiencies but is, rather, a disruptive technology that could radically alter market forces, profit expectations, and business models. This paper is a translation and amplification of the research done in this area, applied to a large-circulation new science journal, *Pediatrics*. The findings suggest that the journal of the future will be electronic, have a less volatile cost structure, be supported more by services than by content, be less able to rely on subscription revenues, and abandon certain elements of current value networks. It also provides a possible framework for other publishers to use to evaluate their own journals relative to this disruptive technology.

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The technologies stemming from the Internet promise to bring tremendous and fundamental changes to scientific, technical, and medical (STM) journal publishing. Yet, contemporaneously, other technologies with similar degrees of complexity and widespread implementations have emerged in publishers' lives, but with much more welcome and well-controlled effects. The Internet represents a different type of technology. Most technologies are *sustaining* technologies, largely reinforcing the same markets, work flows, and economic assumptions that existed previously. However, the Internet is a technology of another sort, a *disruptive* technology, one that profoundly alters market assumptions, economic models, price points, and market participants.

The purpose of this paper is to outline the elements of the Internet that make it a disruptive technology for STM publishers; analyze the metrics and value networks associated with its disruptive influence; project time lines for these disruptions for one journal, *Pediatrics*; analyze the economics of migration from print to online publication; and develop a possible set

of organizational responses for publishers, including the publisher of *Pediatrics*, in response to this disruptive technology, taking into account the special nature of STM journals. It is, simultaneously, an application of the conceptual framework developed by Clayton Christensen in his 1997 book, *The Innovator's Dilemma*,¹ to test whether STM publishers are facing a disruptive technology in the Internet and, if so, whether recommendations from his research can be extended to STM journals.

About *Pediatrics*

Pediatrics is the official journal of the American Academy of Pediatrics (AAP). Published continuously since 1948, it has an ISI impact factor of 3.466 (1998) and a monthly print run (including overruns for archiving) of approximately 62,500. This large circulation increases variable costs and makes some comparisons with smaller-circulation journals difficult. In January 1997, an online-only section of complete, original, peer-reviewed research articles, *Pediatrics electronic pages*, debuted on the Web, with abstracts of these articles printed in the paper edition of the journal. Abstracts of the articles published in the paper edition were also published on line, alongside the contents of the electronic pages, creating a complementary print-and-online publishing model. On the basis of the success of this experiment,² the full text of the journal was placed on line in July 1998, with the *electronic pages* remaining as an online-only section, its

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contents abstracted in the paper version. Since the launch of the online-only section of the journal, the circulation of *Pediatrics* has increased from 57,868 to 61,110.

Organizationally, *Pediatrics* is edited by an editor-in-chief, an associate editor, two consulting editors, and an editorial board of more than 30 members. More than 2,500 peer reviewers evaluate the more than 1,500 research papers that are submitted each year. Only 23 percent of the papers submitted to *Pediatrics* are accepted. At the AAP, management oversight for *Pediatrics* resides in the Department of Education. The journal is managed primarily by staff in the Division of Medical Journals and Professional Periodicals. A managing editor provides the majority of the business oversight, with the division's director, the director of the Department of Education, and the Academy's finance staff also contributing. The same staff are responsible for the print and online versions of *Pediatrics*. Advertising, both commercial and classified, is sold by an outside firm on a commission basis. The online version (www.pediatrics.org) is published with the assistance of Stanford University's HighWire Press.

An overview of the journal's average revenues and expenses from January 1996 through July 1999 is shown in Table 1. Throughout this analysis, financial data are presented as percentages, to effectively disguise the actual figures while preserving their relative values.

Table 2 shows the change in these revenue and expense sources between 1996 and 1999.

The following points emerge from this revenue and expense analysis:

- The relatively stable (even deflationary) paper market has played a role in limiting the increase of variable costs during the period covered.
- Nonmember subscriptions have declined, and stand out as the only declining revenue source in the comparison.
- Postal increases have been significant.
- Commercial advertising has become an even more important source of revenue for the print version of *Pediatrics*.

Disruptive vs. Sustaining Technologies

In *The Innovator's Dilemma*,¹ his acclaimed analysis of technologically driven change, Clayton M. Christensen articulates the distinction between a *sustaining*

Table 1 ■

Revenues and Expenditures for *Pediatrics*, January 1996 through July 1999

Revenue Source	%	Expense Source	%
Member subscriptions	27.48	Variable costs:	49.39
Commercial advertising	31.33	Paper	37.08
Nonmember subscriptions	26.25	Postage	24.87
Article reprints	3.47	Bindery	6.15
Classified advertising	9.21	Redactory	9.13
Royalties and international editions	2.26	Press	22.74
		Fixed costs*	50.61

*Include overhead charges (salaries, travel, space charges, telephone, distributed costs) for management staff.

Table 2 ■

Changes in Revenue and Expense Levels for *Pediatrics*, 1996 to 1999

Revenue Source	% Change	Expense Source	% Change
Member subscriptions	0.76	Variable costs:	1.85
Nonmember subscriptions*	-12.46	Paper	-7.46
Article reprints	18.05	Postage	11.34
Commercial advertising	36.01	Bindery	37.80
Classified advertising	8.71	Redactory	-0.30
Total change	3.12	Press	10.31
		Fixed costs†:	2.68

NOTE: Figures represent averages of two 12-month periods: January–December 1996 and July 1998–June 1999. Percentages are based on financial data that have been adjusted to 1999 dollars. *Because of numerous accounting deferrals and accruals, this percentage was derived using composite and averaged data. †These include cost-of-living adjustments (required raises in staff and consultant pay levels).

technology and a *disruptive* technology via studies of numerous, diverse industries (including computer disk drive manufacturers, excavating equipment, discount retailing, and motorcycles). His findings strongly suggest that the very business practices that count as assets under normal circumstances actually accelerate the failure of companies in the presence of a disruptive technology.

Sustaining Technologies

Sustaining technologies can themselves be radical, but they result in improving established products along dimensions of performance demanded by traditional markets. For STM publishers, sustaining technologies include direct-to-plate printing technologies, high-resolution digital scanning, automated ink coverage on

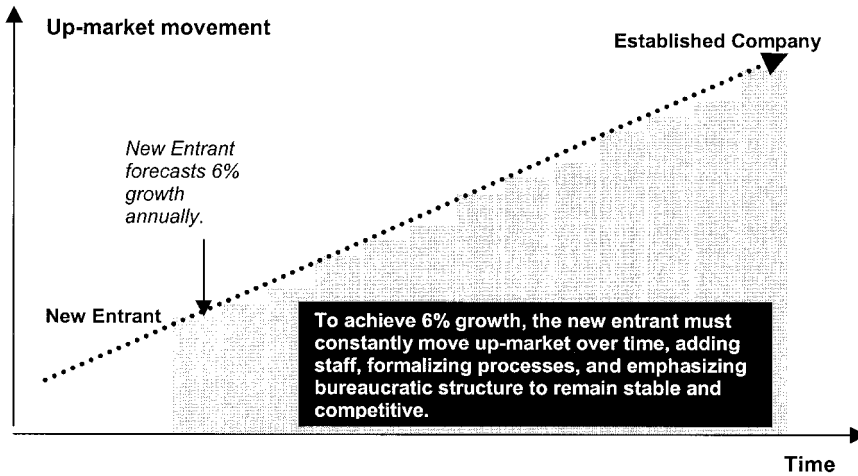


Figure 1 The inevitability of north-east on the profit compass.

press, and improvements in postal coding (bar coding and Zip + 4). Essentially, improvements emerged, but the same value network existed after these changes were implemented.

Disruptive Technologies

Disruptive technologies are qualitatively different from sustaining technologies. They are attractive to previously unanticipated markets, are often disdained by established market forces in their early stages, yet are able to survive as smaller entities until the technology becomes more mainstream and is proved, at which time they may exceed market demands of value and overtake existing players, supplanting or subsuming them. They fundamentally alter the value equations of the market and the measurements of value that the market uses to gauge providers.

North by Northeast

This motivation for established companies to move up-market over time (an orientation that tracks north-easterly when graphed, as shown in Figure 1) transforms into inertia over time, as incumbents that survive such competition (that is, end up in the high northeast corner of the price, value, and size graph) are typically large, have high overhead costs (salaries, fringe benefits, staff size, and facilities), possess rigid manufacturing processes (to reduce product variability), and support significant distribution networks. These companies consist of management teams that function in a highly structured fashion, and the personal ambition of each manager makes recommending a new venture with the attributes of a disruptive technology (no known market, less revenue, core customer rejection of concept, etc.) highly unlikely. Established firms are effectively forced into a set of pro-

scribed behaviors by these factors, the primary one being the fear of moving southwesterly.

Meanwhile, a new entrant, starting at the opposite, southwestern corner, is initially geared to survive in an environment consisting of low overheads, possesses flexible manufacturing processes, and holds limited distribution and property, plant, and equipment commitments. If the new entrant possesses a disruptive technology, movement up-market may occur very rapidly, and the entrant may be able to deliver more value than its rival in both the newly discovered markets and traditional markets for the displaced technology. By virtue of years of experience with the disruptive technology, the new entrant often shows more market and technical savvy, may hold key patents, has important recognition among the newly discovered markets and value network, and most often triumphs even when the established firm attempts to replicate the new entrant’s technology.

Table 3 ■

Criteria for a Disruptive Technology

- Markets are not known and are unknowable at beginning.*
- Core customers initially reject the new technology.*
- Managers hesitate to recommend the technology.*
- The technology’s perceived weaknesses are really its strengths.*
- Profits and prices are lower for new technology applications.
- The new technology is perceived as underperforming in comparison with existing technologies.
- Markets are viewed as insignificant by entrenched players.
- The new technology heralds a shift in the basis for competition.
- The new technology is simpler, cheaper, and more dependable than existing technologies.

NOTE: The four crucial criteria appear in italics.

The Internet as a Disruptive Technology

Table 3 illustrates the ways in which a disruptive technology can be identified, with the most crucial four criteria listed first in italics.

While the segment of the current core market for *Pediatrics* online is relatively small compared with the entire subscribership (12 percent of total readership actively uses the online version), the rate of growth of this market is the more important indicator. (The possible significance of this is covered later.) Also, the nonsubscriber use of the site is significant (about 40,000 unique users per month), as are per-article use and occasional use of the site. These are intriguing, suggestive tensions—a small but rapidly growing use by core customers; a larger, unknown market of occasional users; and appreciable per-article traffic.

We have also found that we can reduce the price of an online-only subscription by approximately 40 percent while maintaining the same margins, assuming stable commercial advertising revenues. We have offered online-only subscriptions to the segment of our market for whom delivery is most problematic—international subscribers. So far, more than 125 subscribers have accepted this option, with many other international subscribers expressing gratitude for immediate access to the online version. We have also received a number of requests from domestic subscribers to stop sending print copies; we have not honored these requests yet, since doing so may be perceived as placing our advertising rate base at unnecessary risk. This is clearly a symptom of management frozen by a business model and revenue expectations emanating from the print paradigm.

We have also noticed a significant increase in the amount of direct service we offer for *Pediatrics*. E-mail places us much closer to our customers, and the expectation of rapid response is clear. We have aggressively added services to the online journal (data retrieval, presentation, and communication services), which are not possible in print. While the quality of information was paramount previously, the basis for competition may be shifting to accessibility, searchability, granularity of content, and services around the information.

Disruption to STM Journal Value Networks

For print STM journals, a hypothetical value network is shown in Table 4. The table is organized roughly in reverse sequence (closest to customer vs. furthest from customer). This value network clearly shows some of

the major value elements harnessed by publishers. Table 5 shows the hypothetical value network for an *online* STM journal. The differences between the two value networks include:

- The collapse of the printer and distributor categories from the print paradigm into online vendors for the online paradigm
- The removal of libraries as key providers of structured access and archiving for STM journals
- The removal of subscription agencies as providers of consolidated subscription purchasing
- The diminution of advertisers, at least initially, for STM journals

Printers and Distributors Become Online Vendors

The economics of printing, with volatile paper costs and, for STM publishers, disadvantageous postal regulations, are bound to give way to the lower and less variable costs of Internet publishing. With computer prices falling and other electronic delivery modalities (e.g., palm-top and electronic book technologies) maturing with Internet technologies,³ it is only a matter of time before market penetration and technologic strides make having, carrying, reading, and updating Internet publications convenient and inexpensive. For *Pediatrics*, an extensive analysis of 3.5 years of printing invoices, page counts, and other measurements showed that an average of 84.6 percent of our variable expense has been consumed solely by the costs of paper, printing, and postage (see Table 1). For *Pediatrics*, moving on line would eliminate 43.82 percent of our overall costs (fixed and variable), mainly by eliminating 88.73 percent of our variable costs.

A spike in paper prices or continuation of current postal trends could precipitate an aggressive movement by publishers toward online publishing. The proliferation of online resources has occurred during a period of flat paper prices, probably leading to some inertia on the part of publishers. Postal regulations continue to favor large-volume, lightweight publications and punish small-volume, heavier publications. Pricing of raw materials and current delivery modalities may drive STM publishers on line, in a rearguard action.

Removal of Libraries as Key Providers of Structured Access and Archiving

In recent years, library subscriptions to journals have fallen as prices for STM journals have skyrocketed.⁴

Table 4 ■

Hypothetic Value Network for a Print STM Journal

Contributors	Contributions	Recipients
Subscription service/support	Record maintenance for subscribers, processing of payments, feedback to management	Readers, publishers
Libraries	Structured access, archiving	Readers, researchers
Subscription agents	Consolidated ordering, service intermediation, claims processing	Institutional subscribers (libraries, hospitals, universities)
Distributors	Distribution network, border transit, accurate delivery, resolution of problems, expertise	Publishers, readers, printers
Printers	Capital equipment; expertise; supply chain; coordination of delivery; paper, ink, plates, etc.	Publisher, readers, membership society, vendors.
Managers	Professional staff, budgeting, coordination of activities, innovations, stability	Editors, membership society, readers
Advertisers	Revenues, resources	Publishers, membership society
Society affiliation	Financial and management resources, imprimatur	Editors, society members, authors, readers
Redactory	Uniform style, presentation; standardized organization; fact-checking; structural mark-up	Readers, authors, editors, publishers, downstream publishers (document delivery services) and researchers
Reviewers	Expert critique, selectivity, standards of excellence, improvement of raw articles	Authors, editors, publisher, downstream editors (for rejected manuscripts)
Editors	Organized review, administration, reputation for acceptance	Authors, peer-review network, publisher
Authors	Original manuscripts, research, commentary	Peer-review network, editor, other researchers, general public, granting bodies
Funding agencies, institutions	Research funds, resource allocation, support of research	Researchers, authors

Resources from other library activities have been redirected to bolster journal acquisitions in light of these rising prices, and this has been a major complaint among specialist librarians.⁵ With the cumulative archive of full-text articles available via the Internet growing each month, there will be a time, perhaps in 20 years, when the vast majority of historical research into relevant prior findings can be accomplished on line. Services like PubMed and MEDLINE already make this possible to a large extent, and the first peer-reviewed research article relying solely on Internet resources for bibliographic research has been written, reviewed, accepted, and published. In addition, a recent study comparing hand searching of bibliographic citations by a trained librarian and a computer search of MEDLINE showed that the computer search yielded comparable results and an improvement over similar earlier trials (an improvement trajectory).⁶ Finally, the

nature of the Internet makes the collection of information much less rare. It has even been said by some that the emergence of the online journal “is seen as a savior for libraries concerned with STM fields,” in that it may solve the pricing dilemmas libraries face.⁵ In short, libraries may *wish* to fall out of the print STM journal value network. Denmark’s National Technical Knowledge Center and Library has already phased out journals altogether, delivering journal content to patrons solely via the Web.⁴

Also, completing the move to online-only journals may rid libraries of the new problem of having multiple online versions of the same journal content in place—one version from the publisher, two from different document delivery companies, and perhaps an archival CD-ROM for storage.

These redundancies in the current market also may be

Table 5 ■

Hypothetic Value Network for an Online STM Journal

Contributors	Contributions	Recipients
Subscription service/support	Record maintenance for subscribers, processing of payments, feedback to management	Readers, publishers
<i>Online vendors</i>	<i>Expertise, capital equipment, administration</i>	<i>Publisher, readers, membership society, vendors</i>
Managers	Professional staff, budgeting, coordination of activities, innovations, stability	Editors, membership society, readers
<i>Advertisers (diminished)</i>	<i>Revenues, resources</i>	<i>Publishers, membership society</i>
Society affiliation	Financial and management resources, imprimatur	Editors, society members, authors, readers
Redactory	Uniform style, presentation; standardized organization; fact-checking; structural mark-up	Readers, authors, editors, publishers, downstream publishers (document delivery services)
Reviewers	Expert critique, selectivity, standards of excellence, improvement of raw articles	Authors, editors, publisher, downstream editors (for rejected manuscripts)
Editors	Organized review, administration, reputation for acceptance	Authors, peer-review network, publisher
Authors	Original manuscripts, research, commentary	Peer-review network, editor, other researchers, general public, granting bodies
Funding agencies, institutions	Research funds, resource allocation, support of research	Researchers, authors

NOTE: Changes to the value network for a print journal (shown in Table 4) appear in italics. Elements that do not translate from the print paradigm are libraries, printers, distributors, and subscription agents. Advertisers may be diminished by the resulting business models.

disadvantageous for publishers. The staff of *Pediatrics* recently completed an analysis of 20 representative markets served by a major online document delivery company (which currently provides a transitional model of online publishing). The results showed a nonmember subscriber attrition rate more than double our average rate (23.65 vs. 11.35 percent), and the decrease in individual nonmember subscription revenues mentioned earlier (see Table 2) was strongly associated with the increase in royalties from this document delivery service ($r^2 = 96.37$ percent; F critical = 0.1219; F observed = 26.58). Aggressively moving online may help publishers remove these aspects of interference and redundancy between them and their customers.

Removal of Subscription Agencies as Providers of Consolidated Subscription Purchasing

The convenience factor of subscription agencies for institutions, libraries, and other large organizations has to do with the traditionally decentralized nature of

publishers. With the Internet, online agents have already emerged, offering click-through ordering, order recall for modification in subsequent years, and other services. The linkages that will develop over time between publishers and customers via the Internet should sufficiently disintermediate subscription agencies' services. Also, the price premiums agencies demand from both publishers and customers will probably be revealed as unsustainable by this disruptive technology. A few entrepreneurial newcomers only need apply existing technology to displace the agencies.

Diminution of Advertisers

Commercial advertisers contribute approximately 31 percent of the gross revenues generated each year by *Pediatrics*. Primarily, the advertisements are for pharmaceutical products, vaccines, or over-the-counter preparations. Because of the cost savings generated by migration on line, a large portion of these revenues can be foregone. Also, because online advertising is

Table 6 ■

Projected Revenues and Expenditures for *Pediatrics* Online

Revenue Source	%	Expense Source	%
Member subscriptions	46.46	Variable costs:	9.83
Nonmember subscriptions	30.21	Online vendor	15.88
Article reprints	5.78	Redactory	84.12
Classified advertising	15.35	Fixed costs*	90.17
Royalties and international editions	2.26		
Summary of Changes in Revenues and Expenses:			
Change in gross revenues (overall revenues)	-31.33	Change in gross expenses	
		Variable costs	-88.73
		Fixed costs*	No change
		Combined	-43.82
Change in net revenues (revenues minus expenses)	-16.09		

*Include overhead charges (salaries, travel, space charges, telephone, distributed costs) for management staff.

immature, and because direct-to-consumer advertising via the Internet has become more popular with many pharmaceutical companies, these revenues are not naturally migrating to online journals. With diminished pressure to secure these revenues and a nonaggressive approach to Internet advertising by pharmaceutical companies and other traditional advertisers, online publishers will probably feel less pressure to accommodate advertisers or retain advertising representatives at the level they currently do. For example, the cost savings of complete Internet publishing combined with the lost revenues from commercial advertising would leave *Pediatrics* at an average of 83.9 percent of its current profit levels (Table 6). A 16.1 percent loss in profit is significant, but not calamitous. Other opportunities in these unknown and unknowable markets could offset this effect.

This assumes, of course, that subscription models continue to provide current levels of revenues on a sustainable basis, but the success of e-commerce in many applications, and our experience with this for the purchase of both single articles and online-only subscriptions, suggest that value translates effectively into transactions over the Internet. However, the increased granularity of information (article-specific instead of issue-specific or title-specific) over the Internet may threaten subscription models fundamentally, with users finding articles via search engines, purchasing just what they need, and moving on. Future purchasers of journal content may not feel the need to subscribe. The protection offered by having journal subscriptions tied to society membership may provide some safety in this regard.

Publisher vs. Market Value Metrics

A list of possible value metrics for print and online journals is shown in Table 7.

Publishers may infer that competitive forces in print or online markets will be similar (e.g., better presentation and strong authors would be equally weighted assets in either environment). However, publishers also need to consider two special questions raised by a disruptive technology:

- Whether nontraditional, online sources of published research can exceed market expectations in many or all of these value metrics
- Whether the revenue levels achieved in this pursuit will provide competitors in the disruptive technology environment with the resources they need to continue to move northeasterly in the value compass

Figure 2 shows a possible level that online STM journals may have reached by late 1999 in terms of a summary set of STM journal value metrics. It is possible that only readability, portability, and archival integrity will remain as distinguishing value metrics.

It is important to emphasize, as Christensen¹ does, that to succeed, new entrants do not need to match existing levels of peer review, indexing, or contributions to academic credibility. Instead, new entrants need to satisfy only the market's minimum standards in these areas. Publishers may have, unwittingly, far exceeded the minimum standards in these areas for

Table 7 ■

Value Metrics and Markets for an STM Journal in Print and Online

Print Journal		Online Journal	
Value Metrics	Markets	Value Metrics	Markets
Peer review	Readers	Author/editor reputation	Readers
Author/editor reputation	Researchers	Contribution to academic credibility	Researchers
Contribution to academic credibility	Librarians	Uniform presentation	Authors
Uniform presentation	Authors	Readability/legibility	Translators
Readability/legibility	Archivists	Reliable access	General public
Reliable delivery/access	Database vendors	Stability over time	Students
Stability over time	Translators	Widely read and cited	Databases
Widely read and cited	General public	Tie with membership society	
Good service when needed	Students		
Tie with membership society			
Indexed in MEDLINE			

their readers as they continued to move up-market (northeasterly). In fact, they may not know what these minimal standards are. The entry of a disruptive technology allows markets to realign along true *market* value metrics.

Two major value metrics—inclusion in MEDLINE and society affiliation—may serve to protect the status quo of STM journal publishing and may seem less susceptible to technologic disruption. However, with the ability of PubMed to accept materials almost immediately into its very active and accessible index of a broader variety of literature sources, the MEDLINE value metric may be made less critical because of technology (e.g., XML), novel audience expectations, and the inability of manual systems to match the speed of more automated systems. Also, new metrics of value may compete with MEDLINE inclusion, such as information about citation impact factors (i.e., measures of utility in the literature), which is becoming more timely and accessible than ever. It may someday be possible to score the quality of an article’s heritage (as

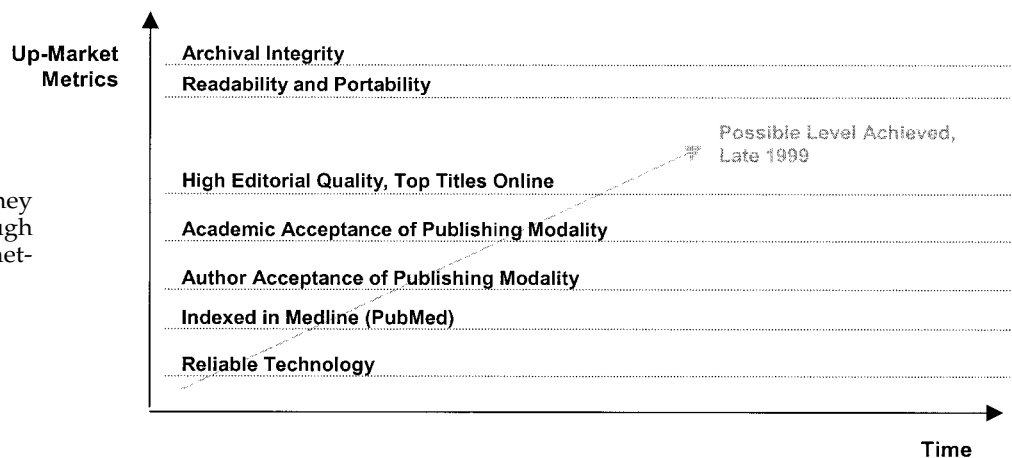
well as the lineage of a journal’s contents, and thus its relevance to current research) by quantifying in some manner the impact factors of an article’s sources, the article itself, and the journal in which it appears. The effects of networked journals have yet to be felt on a broad scale.

When Can We Anticipate Disruption?

From a study of one year of online subscription use and linear extrapolation from these data, it appears that more than half the readers of *Pediatrics* will be active users of the online version of the journal within 51 months from July 1998, which translates to October 2002. Using the same data, but taking out the current rate of adoption until 100 percent conversion is achieved, we project that the migration from print to online publication would take 103 months to complete, until sometime in the year 2007.

The Internet is a disruptive technology, and such technologies generally follow a typical product life-cycle

Figure 2 Theoretic journey of an online journal through STM journal market-value metrics.



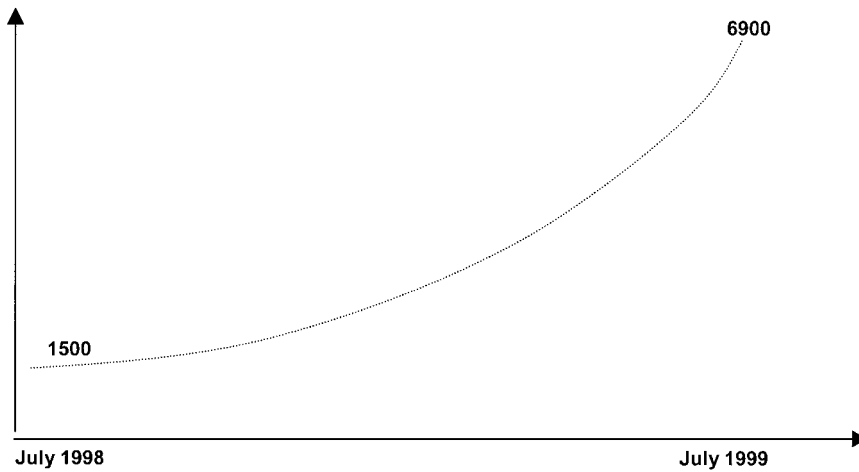


Figure 3 Online subscription activations for the online version of *Pediatrics*.

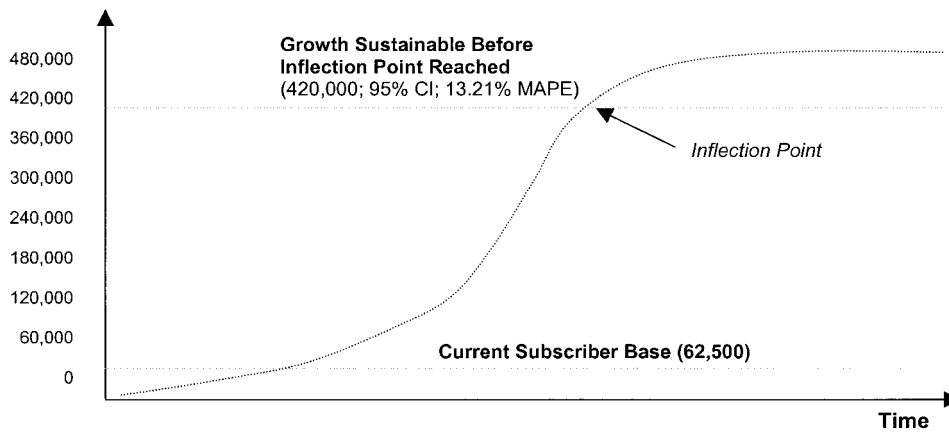


Figure 4 Pearl curve for adoption of online version of *Pediatrics*.

curve, or S curve.⁷ The point at which an online journal is projected to reach its mature stage (inflection point) seems to be the point at which an STM journal would finally cross the line from print to online publication. It appears that *Pediatrics* online is just moving from the “early adoption” phase into the “rapid growth” phase (Figure 3). A Pearl curve shows that the current rate of adoption for *Pediatrics* online is more than sufficient to migrate the entire readership online. Based on these calculations, the rate of growth observed thus far would support migration of 420,000 subscribers before the S-curve inflection point would occur (at 95 percent CI; 13.21 percent MAPE). This strongly suggests that migration for *Pediatrics* is a plausible outcome of our online publishing initiatives.

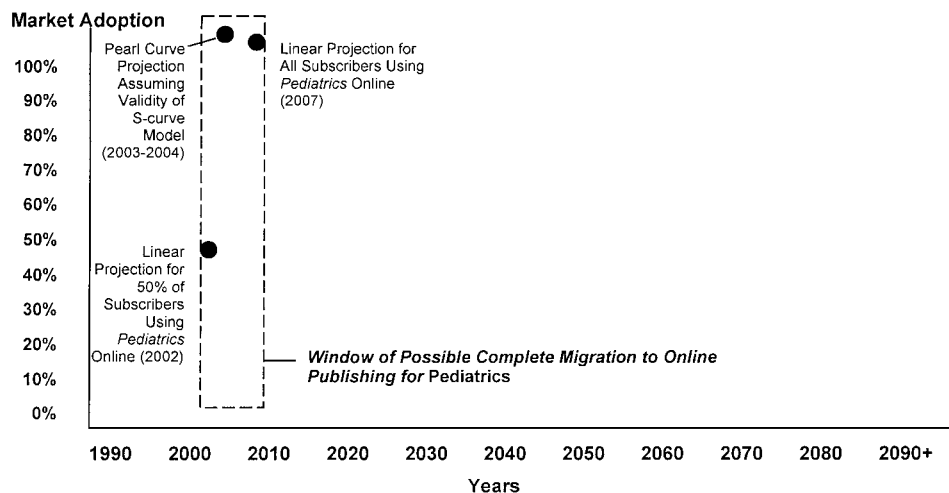
Extending the S curve yielded by this logistic curve analysis and using the resulting formulas to calculate the point at which 100 percent of the current subscriber base would be active on line, the result is 33 months. This assumes that the S-curve model is valid for this

data set and that the curve of accelerated growth noted in Figure 3 continues as indicated in Figure 4.

The capacity of the Internet is increasing at a faster rate than is computing power (Moore’s law), with both fiberoptic technologies and router speeds generating increases of a factor of 1,000 in just 25 years.⁷ As of 1997, more than 60 percent of surveyed pediatricians stated that they had a modem on their computer and access to the Internet.⁸ Also in 1997, a study by the U.S. Census Bureau showed that more than 80 percent of primary school students have access to the Internet in either their schools or homes.⁹

These two statistical glosses on the available data reveal a possible “window of disruption,” shown in Figure 5. While this analysis relies on divergent statistical approaches that generate some problematic tensions between the conclusions, and therefore must be accepted as a current “best guess” requiring monitoring and recalculations, the following statements may be made with some confidence:

Figure 5 Possible “window of disruption” for *Pediatrics*.



- General adoption of online journals seems to lag behind that of the Internet as a technology, as illustrated by the 2002 date for 50 percent adoption by *Pediatrics* subscribers of the online version of the journal, and other data.^{8,9}
- The S curve for the adoption of this technology for *Pediatrics* indicates the start of an accelerated phase, and the rate of adoption of the online version clearly supports the migration of the entire subscription base.
- Adoption by the complete subscriber base will probably occur earlier rather than later, given the data points shown in Figure 5.

Caveats for STM Journal Publishers

Christensen's original research is highly suggestive but not completely translatable to the STM publishing environment. First, his research itself may change the environment and the assumptions under which established firms behave regarding disruptive technologies, allowing them to identify such technologies by logical criteria (see Table 3) and anticipate and avoid typical problems. Second, many societies tend to have very different operating environments from the for-profit, commodity-driven businesses Christensen studied. Third, the presence of independent and relatively unassailed value metrics such as peer-review and MEDLINE make replicating the “commodity” of an STM journal more difficult for new entrants. Finally, the commodity in question with STM journals is more akin to intellectual property than to commodities like steel, disk drives, or motorbikes. There is nothing in Christensen's research to suggest how a disruptive

technology may affect a business based largely on intellectual property rather than on more traditional commodities and raw materials.

Intellectual properties may be more malleable, and hence less prone to disruption, than hard goods or pure commodities. However, this same malleability may be used to work against entrenched STM journals, either by document delivery companies with competitive business models or by new entrants using a disruptive technology and gaining access to strong intellectual properties.

How STM Publishers May Deal with Disruption

Faced with changing market emphases, a disruptive technology, and management practices that are counterproductive, the options for an STM publisher seem few. However, Christensen's research showed two successful management approaches to this dilemma. The first is to spin off a separate, majority-owned company to develop the new markets and integrate the disruptive technology. The second is to acquire expertise later by buying a company that has successfully developed new markets, integrated the disruptive technology, and perhaps even assailed one's traditional markets.¹

The latter option, which we consider first, poses two difficulties for STM publishers. First, the capital outlay to acquire a growing Internet company would probably be beyond the reach of all but the largest STM publishers, especially with current valuations of these companies in the public sector; second, the management decisions that would preclude effectively in-

tegrating a disruptive technology would probably also lead to the rejection of this idea at some point. Also, once the acquisition were made, pre-existing management expectations and practices might lead to an uncomfortable and possibly unproductive match. Therefore, this is not a very advisable option.

On the other hand, creating a self-sufficient, majority-owned spin-off devoted to developing the new technology has a number of advantages, including:

- Realistic and attainable profit expectations
- Freedom to experiment and probe the unknown markets
- The opportunity to tailor the organizational structure, incentives for performance, pricing models, and management philosophies to the disruptive technology and its true markets
- The opportunity to completely explore and exploit the disruptive technology, once it is mature, which the parent organization can then reintegrate
- Creation of an enduring business form that is not subject to incompatible management whims and irrelevant financial pressures
- Complete reintegration into the parent entity and preservation of all derived benefits, once disruptive forces have abated.

Conclusion

STM publishers facing disruption from the Internet can consider the following priorities:

- Create an enduring business structure capable of exploiting the new cost mix and markets of the Internet
- Build services around the information
- Create pathways for more granular, selective access to published information
- Experiment with new publishing modalities springing from Internet publishing
- Begin orienting business models and strategic thinking toward this disruptive technology as soon as possible

Ultimately, this translation of Christensen's research gives rise to three important messages for STM publishers. First, the presence of a disruptive technology

in publishers' lives is virtually unique. Arguably, the last legitimate disruption on this scale occurred with Johann Gutenberg's implementation of movable metal type for high-quality printing, more than 450 years ago, so there are few precedents or guides available for publishers today. Second, the *market's* value metrics may differ from the value metrics we currently use in the print publishing paradigm, and the markets will be the primary forces that determine the new hierarchy of STM journal value relative to the Internet. Finally, sound management practices of listening to core customers, driving profits northeasterly, and allocating resources to winning programs may accelerate the disruption of conventional business.

Findings Particular to *Pediatrics* and a Possible Strategic Response

It is clear from this analysis that *Pediatrics* is being disrupted by the Internet and that the disruption will continue throughout the entire subscriber base. The implications are as follows:

- The rate of adoption of the online version of the journal appears sufficient to support migration of the complete subscriber base to online publication early in the 21st century.
- Variable costs should diminish in this scenario, increasing net revenues from subscriptions and reducing the need for ancillary revenue streams (e.g., advertising) while also improving the speed and consistency of service.
- *Pediatrics* has already experienced disruption via a major online document delivery service.
- The management and leadership of *Pediatrics* will require an even greater degree of autonomy during this transition to propose and act on plans that may seem, in the short term and relative to conventional management expectations, counter-intuitive if this migration is to be as low-risk and productive as possible. A possible approach to ensuring this autonomy would be for the AAP to establish a separate, majority-owned online publishing subsidiary with independent fiscal goals, complete access to all AAP information resources, autonomous management structures, and a plan for ultimate reintegration once the transitions to new markets via this disruptive technology are completed.
- Services ancillary to the content of the journal will become increasingly important as a basis for competition among STM journals in this new publishing environment and as a basis for competition

gcwith non-journal suppliers in the health care information marketplace.

- The value network and value metrics associated with *Pediatrics* in a decade are likely to be somewhat different than they are currently, with libraries and subscription agents disintermediated and commercial advertisers still desirable but less crucial to the fiscal health of the journal.
- Finally, revenues from the journal operations may fall during this transition, but most likely as an unavoidable consequence of sustaining this function of the AAP's mission and adapting it to a disruptive technology. This phenomenon may actually be a sign of health, showing that the journal is adapting to the disruptive technology and the new economics of publishing that the technology dictates. We can also anticipate that *revenues will decrease in a more controlled fashion* if management is allowed the freedom and flexibility to adapt rapidly and completely to this disruptive technology.

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