The Innovator's Dilemma: Disruptive Change and Academic Libraries

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In May 1997, Clayton M. Christensen published *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*.[1] As the subtitle to his book indicates, Christensen was interested in understanding why some successful firms stumble and even fail for what appears to be no good reason. In his introduction, he states:

> This book is about the failure of companies to stay atop their industries when they confront certain types of market and technological change. It's not about the failure of simply any company, but of good companies--the kinds that many managers have admired and tried to emulate, the companies known for their abilities to innovate and execute. Companies stumble for many reasons, of course, among them bureaucracy, arrogance, tired executive blood, poor planning, short-term investment horizons, inadequate skills and resources, and just plain bad luck. But this book is not about companies with such weaknesses: It is about well-managed companies that have their competitive antennae up, listen astutely to their customers, invest aggressively in new technologies, and yet still lose market dominance.[2]

Based on a careful study of the hard-disk-drive industry, the book cites other examples, including the failure of mainframe-computer makers to adapt to personal computers, the inability of Sears and other established retailers to respond to discount chains, the collapse of the American motorcycle industry, and the failure of leading excavator manufacturers to move from cable to hydraulic technology.

It took a while for *The Innovator's Dilemma* to catch on, but when it did it exploded. Technology pundit George Gilder called it "the most profound and useful business book ever written about innovation."[3] Shortly after this statement was made, the book was featured on the cover of Forbes; in February 1999 it made the Business Week best-seller list and was one of the hottest books in the business world. Quoting from the introduction to a Business Week interview with Christensen in April 1999, "The surge seemed to be at least partly tied to the emergence of the Internet as a place to do business. For instance, Edward D. Horowitz, corporate executive vice president for advanced technologies at Citigroup, sent a copy to two hundred top Citigroup execs in December."[4]

The bursting of the Internet bubble has brought new issues to the top of the business agenda and may have diminished some of the book's appeal. However, it carries valuable

lessons for libraries that libraries ignore at their peril. Libraries, at this point in their history, are exactly the kind of successful organizations that Christensen predicts will stumble and fail.

This article will review major findings of *The Innovator's Dilemma* and apply them to libraries, particularly academic libraries, in the hope that it will prepare library managers to better navigate the stormy waters they will certainly face.

SUSTAINING VERSUS DISRUPTIVE TECHNOLOGIES

At the core of Christensen's analysis is a distinction he draws between two types of technologies. Both result in change, but they have different characteristics, and bring very different kinds of change.

SUSTAINING TECHNOLOGIES. Christensen calls the first type of technology "sustaining." Sustaining technologies improve the performance of established products along dimensions of performance that mainstream customers in major markets have historically valued. Sustaining technologies improve products or processes, and they can be driven by new, and sometimes even revolutionary, technologies, but what is important is that the improvements result in accomplishing the same thing, only doing it better. Because of this, established customers recognize the value of the improvements. Relationships in the market, cost structures, and organizational dynamics can thus remain largely unchanged.

DISRUPTIVE TECHNOLOGIES. The second type of technology is what Christensen calls "disruptive." Disruptive technologies bring a very different value proposition to the market. Generally, disruptive technologies initially underperform established products in mainstream markets. This makes them easy to ignore. But disruptive technologies have other features that are valued by a few fringe or new users. They also improve at a faster rate than established technologies. This is what makes them dangerous to established firms. Disruptive technologies often appear to be merely toys, but before you know it the toys have grown up and are cheaper, faster, and better than what established firms are selling.

Established organizations are generally good at change that involves sustaining technologies. They know the needs of their customers and how to work with and listen to them. Service models are effective because they have been refined over long periods. Sustaining technologies lead to improved quality that makes it possible to justify higher costs.

Established organizations generally fail when change involves disruptive technologies, and organizations at the periphery or from different sectors most often succeed. Products or services are designed for new, rather than established, users. Disruptive technologies are often developed before applications are known, and it is only after several fits and starts that applications for the technology and users of it are found. Invariably cheaper

and faster, disruptive technologies are often easier to use even if quality is not high and capacity is not large at the outset. In general, disruptive technologies require new service models and pricing structures that challenge established organizations and the interests and expertise of the individuals within them.

CHANGES IN LIBRARIES OVER THE PAST FIFTY YEARS

As Christensen's insights are applied to libraries, it is necessary to briefly review recent library history. In doing so, it is useful to look at the work of Buckland and his book *Redesigning Library Service: A Manifesto*.[5] Buckland describes three phases of library development over the last half-century. The first is the paper library, where collections and bibliographic control mechanisms were based on paper technologies. The automated library, where collections remain in paper format but bibliographic control was automated, is next. Lastly, he describes the electronic library, where both collections and bibliographic control mechanisms are electronic.

Using Buckland's model, there have been two major transitions in libraries in the past fifty years. The first was the change from paper library to automated library. This change began in the late 1960s with the development of MARC and was largely complete by the mid-1990s when every library had an OPAC and when CD-ROMs and the Web-based indexes had replaced their printed predecessors. The technologies involved in this transition were sustaining technologies. OPACs are very different from card catalogs, but they do the same things for the same users. Service models were not fundamentally changed as users still had to come to library buildings to get items from the collection. The new technologies did not save money, in fact they often required significant new investments, but most libraries were successful in arguing that this was appropriate because services had been enhanced.

The second transition, that from the automated library to the electronic library, began in the early 1990s with the development of full-text databases, the Internet, and the Web. Libraries are still in the early part of this transition and it is likely to run another decade or two. Many, but not all, of the technologies that are driving this transition are disruptive. They are cheaper and faster even though at the outset they do not seem powerful or sophisticated enough to meet current needs. The technologies involved are often developed outside of libraries and their established vendor community. In many cases, the services or products are marketed directly to library users. Finally--and this is probably the clearest warning sign--in most cases libraries and their most important users haven't asked for the new products and are quick to make a case for the superiority of current practices.

DISRUPTIVE CHANGE IN LIBRARIES

However, armed with Christensen's insights, it is easy to see disruptive technologies emerging in nearly every aspect of library practice. Three core areas of library practice--

collections, bibliographic control, and reference--will be briefly reviewed to see what these threats might be.

COLLECTIONS

Collections have been the heart of libraries for as long as there have been libraries. Many of the electronic products offered to and through libraries are sustaining rather than disruptive technologies. For example, electronic journals, especially when offered by established publishers or in collections such as JSTOR, don't fundamentally change the service model. Libraries still purchase output compiled by publishers and make it available to the libraries' users. Access and availability are enhanced, and the costs are a bit more, but the enhancements in service justify the increase. However, disruptive technologies are coming quickly. New standards like the Open Archives Initiative's Protocol for Metadata Harvesting make possible a new distributed model for the storage and retrieval of documents. This model will deconstruct the journal as it is currently known into individual articles in much the same way that music file sharing has deconstructed the record album. Repositories of e-prints, images, and other documents will use the developing standards to make these items available to the world. While peer review, citation analysis, and a clear understanding of the pecking order (which bestows the status required for promotion and tenure decisions) have yet to emerge, be assured that they will emerge. Like most disruptive technologies, repositories are significantly cheaper than existing products. Several years ago Odlyzko analyzed the cost of Ginsparg's physics archive and estimated that the cost of placing an article in the archive was $75 versus the $2,000 to $4,000 it cost to publish it in an academic journal. Odlyzko goes on to say, "As Andy Grove of Intel points out, any time anything important changes in a business by a factor of ten, it is necessary to rethink the whole enterprise. Ginsparg's server lowers costs by about two orders of magnitude, not just one."[6] Many repositories also provide more access than library collections. They are generally available to anyone with an Internet connection at any time from any place. The power of this disruptive technology is seen dramatically in the story of Lubos Motl, an undergraduate physics student at Charles University in Prague, as recounted in the New York Times:

> Mr. Motl posted a research paper on the archive and the results were flabbergasting. Established string theorists were so impressed by his work that he ended up with a scholarship to Rutgers, where he is completing his doctorate. "I was at first a little annoyed by the first paper, because it scooped me," said Dr. Thomas Banks, a physicist at Rutgers and the University of California at Santa Cruz and one of string theory's prime innovators, who had been working out a similar idea. "This feeling turned to awe when I realized that Lubos was still an undergraduate." Mr. Motl is a striking example of how the archive is changing physics.[7]

Note that the physics archive is changing the discipline. Note also that libraries are not part of the story.

BIBLIOGRAPHIC CONTROL

Librarians have great expertise and a long history of developing and using bibliographic control, but the systems in use were developed for technologies based on paper and have been migrated to an electronic environment through a series of sustaining technologies. There is still an assumption that an institution's catalog is a core-required activity. But in an environment where collections are housed in distributed repositories and harvesting services search them, what purpose does a centralized catalog serve? Would individuals not be better off with their own catalog of the items that interest them and updating tools that learn from the actions an individual makes while using this personalized tool?

Change has also come from another direction. For the past twenty-five years, librarians have largely ignored research on algorithmic retrieval. The technology did not scale, and authority control and Boolean searching worked as reasonably effective on large files. And then there was Google. Ask any reference librarian where they start when answering a question--Google or the library's OPAC. Algorithmic retrieval now works and scales, and it is no longer reasonable to suggest that the Web needs to be cataloged using established library practice.

Even in the more limited arena of books, there is the potential for disruptive change to overwhelm established library approaches to bibliographic control. Amazon.com is already used by many as a substitute for the library catalog. What will happen now that the full-text of many of the books in Amazon.com's inventory is searchable?

REFERENCE

Since the early years of the twentieth century, libraries have provided reference services. Users with questions came to the library and got assistance from well-read generalists, or, in more specialized libraries, experts in a field. Upon entering the library, users were met by a friendly, helpful, reassuring librarian who could almost always find enough information to satisfy the user's need. This help was required in paper libraries because of their complexity. Even in the current immature Web environment, across the country the number of reference questions being asked in libraries is in steep decline. Even with e-mail and chat services, fewer users seem to need a librarian's help. Google and other Web tools are easier and good enough, at least, for many questions.

Even expert help from librarians might be replaced. Google Answers, which creates an e-Bay-like market place for people with questions and people who are prepared to answer them, is one alternative. A recent study by Kenney et al. at Cornell University indicates that Google Answers is significantly cheaper than comparable reference services at Cornell. For the easiest questions, Cornell was five times more expensive than Google Answers, and for the most difficult questions, Cornell was twice as expensive. The Google Answers responses, even when graded by reference librarians, were nearly as good as the responses of reference librarians themselves.[8] The clear implication of this

study is that Google Answers or similar services that harness the expertise of a large number of people in a question marketplace could easily be competitive with library reference services.

What is clear in the review of all three areas of library practice is that alternatives exist, or could easily exist, that are cheaper, easier, faster, and more convenient than the comparable services now offered by libraries.

The past success of libraries, and the generally high regard in which they are held, will not protect them from potential competitors armed with new technologies. Past success with sustaining change should not provide libraries with confidence. Libraries are surrounded on all sides by disruptive technologies. Because of this there is much to learn from Christensen.

WHY DEMAND FOR GOOD PRODUCTS COLLAPSES

Key to understanding why disruptive technologies can overwhelm established organizations with good products and excellent customer relations is Christensen's concept of performance oversupply. As he explains it, "Once the performance level demanded of a particular attribute has been achieved, customers indicate their satiation by being less willing to pay a premium price for continued improvement of that attribute. Hence, performance oversupply triggers a shift in the basis of competition, and the criteria used by customers to choose one product over another changes to attributes for which market demands are not yet satisfied."[9] That is, once one attribute of a product meets my needs, improvements in this attribute don't matter to me and I look to other attributes as the basis for choosing between alternatives.

To make this concrete, consider that example of an undergraduate doing a research paper. The student is faced with two alternatives--library resources or the open Web. Assuming that this undergraduate is conscientious and academically inclined, the first attribute used in deciding which alternative to choose is the available amount of good scholarly material relevant to the project. In the past, the library had the clear advantage for this attribute, but the Web is quickly catching up. What is important to understand is that more is better only up to a point If the student needs ten resources for the project and can get ten from both the Web and the library, it does not matter that a thousand relevant items could be found in the library and only ten on the Web. On this attribute, both alternatives have given the student everything needed and wanted. As a result, in making the choice, the student moves on to another attribute. This attribute might be the amount of time required to find the required resources or it might be their availability late at night. On either of these attributes the library is probably much less competitive.

Christensen has found a consistent pattern in the attributes that are used as the basis for comparison. They move from functionality, to reliability and convenience, and finally to price.[10] This explains why academic libraries have lost many undergraduate users. Many of these users can get enough from the open Web and it is faster, easier, more

reliable, and takes less time to use--making it cheaper. That the library has a large and rich collection does not matter to them. What matters to these users is that alternatives that provide everything they need are better in other ways.

Large, rich collections still matter to faculty and graduate students, but over time, alternatives will be good enough for them as well. Like the undergraduate in the example, they will look to other attributes--where the library is not competitive--on which to base their decision about what information resources to use. Very probably, many faculty and graduate students in physics and computer science have already done so. Over time, the library will have fewer and fewer users, though these users may exercise undue influence on library services. As Christensen states, "Indeed, the power and influence of leading customers is a major reason why companies' product development trajectories overshoot the demands of mainstream markets."[11] For academic libraries, these leading customers are the faculty. In the end, libraries may be serving only a small number of leading customers without any significant decline in the cost of services. This is not a sustainable position, and when this happens, library services will either collapse or need to be radically restructured.

PRINCIPLES FOR UNDERSTANDING DISRUPTIVE CHANGE

Given that libraries are surrounded by many potentially disruptive technologies, what can library managers do to survive or even thrive? What happens when an organization confronts disruptive change? Christensen offers five principles that, if understood, give managers the conceptual basis for dealing with disruptive technologies.

PRINCIPLE #1 COMPANIES DEPEND ON CUSTOMERS AND INVESTORS FOR RESOURCES.

All organizations are dependent on customers and investors. This is the organization's value network. Organizations make decisions in the context of this value network. Since disruptive products bring a different kind of value, old customers and investors don't see the need for them. They are generally happy with the current product. They didn't ask for anything different and they don't see how they could use the new product when they are offered the chance. Christensen puts it succinctly, "Blindly following the maxim that good managers should keep close to their customers can sometimes be a fatal mistake."[12] Or, to quote Christensen again, "The innovator's dilemma [is] that 'good' companies often begin their descent into failure by aggressively investing in the products and services that their most profitable customers want."[13] For academic libraries, the most influential customers are the faculty, and the investors are administrators who generally have the same view as faculty as to what makes a good library. This makes it difficult not to create the kind of library that faculty value. That only a few years ago Baker could write a defense of the card catalog that was published in the New Yorker is an indication of depth of feeling that libraries often face.[14] While Baker was generally considered to have fringe views, he gave voice to a nostalgia that many faculty and administrators still feel. They are uncomfortable with library technology that they often

do not fully understand.

All of this means that it is easier to get funding and recognition for building collections, particularly paper collections, than for investments in other technologies. If there is any doubt, look at the sway the Association of Research Libraries Index has over university administrators. An additional aspect of this is that library staff often define success as catering to faculty. They do so because they have been rewarded for doing so in the past. They are thus unwilling to invest their time and energy in projects that don't fit into this value structure.

What this means is that even if a library manager recognizes a new technology that he knows he should invest in, he may not be able to do so because there will be no support for the project among faculty and administrators. This is particularly difficult to deal with because library resources are generally fully committed to established priorities, so redirecting resources to innovative projects is even more difficult. Would it be acceptable in any library to take 10 percent of the book budget and use it for an experimental project? Probably not.

Finally, it is important to watch new users rather than to listen to established customers. Christensen states, "Managers confronting disruptive technologies need to get out of their laboratories and focus groups and directly create knowledge about new customers and new applications through discovery-driven expeditions into the marketplace."[15] Since most librarians hate to leave their buildings or roam too far from home, exploring in unfamiliar territory is difficult But even if this hurdle is overcome, it is not clear that the results will carry any weight. Most academic librarians do not observe their mainstream student-customers; rather they only listen to the upscale faculty customers.

PRINCIPLE #2SMALL MARKETS DO NOT SOLVE THE GROWTH NEEDS OF LARGE COMPANIES

The general principle is that products or services based on disruptive technologies do not begin as big moneymakers. Since large companies need to make a return on investment based on their large size, they need new projects that can generate large dollar amounts to make the required return on investment. On the face of it, this might not seem applicable to libraries. Even very large libraries are small when compared to large corporations. In addition, libraries don't need to show a return on investment. On the other hand, libraries do need to show that they are wisely using the resources they have been given, and this, in a sense, is like the return-on-investment pressures faced by for-profit companies. It is likely that larger libraries will have the same issues with scale. Small exploratory projects with less visibility may not be worth their time and energy.

PRINCIPLE #3MARKETS THAT DO NOT EXIST CAN NOT BE ANALYZED

Christensen points out that "It is simply impossible to predict with any useful degree of

precision how disruptive products will be used or how large their market will be. An important corollary is that, because markets for disruptive technologies are unpredictable, companies' initial strategies for entering these markets will generally be wrong."[16] Librarians, like many others in established markets, love to plan. In the old world, this was a critical skill. In a world full of disruptive technologies, excessive planning can be a waste of time. It is more important to try different approaches, to anticipate failure and learn from that failure. In this mode of exploratory development; it is better to have a year's worth of experience, regardless of the success of this experience, than to spend that year producing a comprehensive plan of action. Most of today's library managers learned how to manage during the transition from paper to automated libraries. This transition involved sustaining technologies where planning mattered. The lessons it taught will not apply in the transition to the disruptive technologies of the electronic library.

A second problem has to do with resource allocation. To quote Christensen once more, "The dominant difference between successful ventures and failed ones, generally, is not the astuteness of their original strategy. Guessing the right strategy at the outset isn't nearly as important to success as conserving enough resources . . . so that new business initiatives get a second or third stab at getting it right."[17] Libraries rarely have, nor can they easily acquire, flexible resources. Neither do they generally have cultures that find it easy to accept projects that do not go as planned and result in what will be seen as wasted time and money.

PRINCIPLE #4AN ORGANIZATION'S CAPABILITIES DEFINE ITS DISABILITIES

Organizations, especially successful ones, have developed processes and values that guide the way people work in that organization. The processes define the way work is done and how the organization creates value. The values help individuals make decisions consistent with the way the organization operates. Individuals can be flexible and change the way they work to meet the requirements of the situation, but organizational processes and values are not flexible. It is their inflexibility that leads to consistent decision making and thus contributes to the success of the organization.

When a capable person is put on an innovative project that requires processes or values that run counter to those of the organization, the project is unlikely to succeed unless either the culture is changed, which is very difficult, or the project is isolated from the rest of the organization. Because few libraries are large enough to create separate isolated units to develop projects, cultural change may be the only option that will allow the development of disruptive technologies. How to create this culture and whether it would be acceptable to those inside or outside the library is unclear.

PRINCIPLE #5TECHNOLOGY SUPPLY MAY NOT EQUAL MARKET DEMAND

 As Christensen explains:

the pace of technological progress in products frequently exceeds the rate of performance improvement that mainstream customers demand or can absorb. As a consequence, products whose features and functionality closely match market needs today often follow a trajectory of improvement by which they overshoot mainstream market needs tomorrow. And products that seriously underperform today, relative to customer expectations in mainstream markets, may become directly performance-competitive tomorrow.[18]

This is the performance-oversupply concept previously discussed. The tendency is for companies to try to stay ahead of the competition by developing a superior product for the best customers that is higher performance and higher margin. As they do so they are unaware that they have created a performance-oversupply situation where competitors with lower-priced products based on disruptive technologies can enter and take away the majority of their mainstream customers. Only those companies that carefully track how their products are used will be able to know when they are approaching performance-oversupply situations and will be able to adapt their products or services.

For libraries, principle five raises two problems with current practice. First, as a rule libraries do not have good data on the way their products and services are used, and they rarely invest in the kind of research that would provide this information. Second, unlike companies that sell their products and services in the marketplace, libraries have almost no idea of what their products and services cost the user. It is sometimes possible to figure out what the service or products cost to produce, but not how much the user is paying for them. Since in general, there is no money changing hands, it might be argued that library users don't pay anything, but this is not the case. Library users pay by the investment of their time. As a general rule, library managers have no idea how much time it takes to use their libraries. If they were to estimate the time requirements, they would find that they significantly underestimate how much time is actually required for library use. This leads to a situation where libraries think they are charging less than they actually are, and they are left unprepared when quicker ways of getting information emerge and take away many of their customers.

WHAT CAN BE DONE?

 Christensen suggests that the best way for established organizations to develop products and services using disruptive technologies is to create autonomous organizations. Most libraries cannot do this. The alternative is to create an organizational culture that embraces the disruptive change and rewards those who harness it to serve the library's users.

However, it is said that only two things will change culture--war and famine. As librarians look at library culture, it is important to understand how different the culture that they need to create is from the culture of the recent past Less than thirty years ago, the most important thing that libraries did was to keep millions and millions of pieces of paper in the correct order. Libraries did other things, of course, but if the pieces of paper

were not in the correct order nothing else mattered. Libraries' processes and values made it possible for successful libraries to create and manage very large and complex paper files. The processes have changed as libraries were automated, but the values are in many ways still the same.

Two things are essential to change the culture. First, change what individuals need to do to be successful in the organization and in their careers. Second, create structures that encourage and reinforce the cultural change. These would include the following:

1. porous organizational boundaries that allow ideas and knowledge to flow in and out of the organization;
2. collaboration among all staff that creates the ability and willingness to share knowledge and expertise freely. This means, at least in part, addressing the long-standing class distinctions between librarians and other library staff;
3. impatience, which leads to a desire to explore, innovate, and change;
4. accountability and the ability and willingness to measure results and make consequences visible. If libraries can not do this, they will not be able to convince campus administrators that new approaches are really serving students; and
5. trust that colleagues will exercise competence and good professional judgment even, or especially, when they are doing things differently than you would.

Regular organizational realignments are useful. Like periodically moving the furniture, changing roles and relationships keeps people fresh and, over time, builds flexibility in the organization.

ARE YOU READY?

I would propose a short test to see if you and your organization are ready to live in the world of disruptive technology.

1. Can you consider buying half as many books as you now do and investing the money in other ways of providing information to library users?
2. Can you act on what you learn from freshman when what they teach you runs counter to what the faculty say they want?
3. Can you trust small groups in your library to develop products and services, or does everyone on the staff have to buy in to everything?
4. Are you prepared to spend money to develop exploratory projects knowing that one in three will fail?

If you can answer yes to all of these questions your library may be ready. If you cannot, you need to get ready. As a first step, read *The Innovator's Dilemma*.

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