DISRUPTIVE COLLABORATION: THE INTERNET AND BIOSCIENTIFIC RESEARCH

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> *There is a moderately humorous future world being touted by some Wall Street Analysts, it goes something like this; they envisage a day when there will be only one internet stock to buy, AolAmzYahRedhatLyc (AAYRL). The company will have every possible combination of software and service provision organization under one company banner and will trade at 4 figures per share.*
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> *Logan (1999)*

1. Disruptive Technologies – an Introduction:

The first definition of disruptive technologies comes from Banks (1996):

> *…a disruptive technology starts as an untested product with an unknown business model or one that offers lower profit margins. Most significant, few customers even seem to want the new thing. Any rational manager would stick with the old approach and brush aside the product as best suited for marginal, niche markets. At the same time, constant improvements in the traditional technology make it all the more valuable and seemingly invincible - giving rise to the breathless accounts of a company at the peak of its power. By the time the disruptive technology makes the jump to the mainstream and undercuts the incumbent with a "good enough" product at a markedly lower price, it's usually too late for the incumbent to recover.*

Technology means all the processes by which an organization transforms labor, capital, materials, and information into products and services of greater value. Most technologies are sustaining in nature; improving product or service performance along dimensions that the mainstream customers in major markets have historically valued. In contrast, disruptive technologies typically have worse performance, at least in the near term. However, they have features that a few fringe- and generally new-customers value. These same features often represent a key source of competitive advantage in the future; products based on them are typically cheaper, simpler, smaller, and frequently, more convenient to use, and they often bring a new and different value proposition.

Disruptive technologies are unsettling to tried-and-true (and often stale) business practices. As these technologies mature and the niches they serve gain momentum, innovation catches up to customer need and lays a foundation for new business models. Even after the original disruption becomes pervasive, aftershocks may unearth additional innovations and expose new marketable services. Disruptive technologies can emerge from grassroots efforts, or they can be helped along by benefactors. Regardless of where disruptive technologies come from, corporate executives must recognize their significance and how quickly they can affect the heavy-weights on the market (Adner, 2002).

A very good example of how disruptive technologies work is the software market (Christensen, 1999). In the late 70's, the market for disk drives consisted of large mainframe computer makers. These customers demanded an aggressive improvement in capacity of more than 20% a year, above the minimum required capacity of 300 MB. The leading and most innovative 14-inch drive makers (namely IBM, Memorex, EMM, and Ampex) competed vigorously, maintaining the industry's aggressive rate of R&D investment that had led to dramatic improvements in capacity and cost. a few startups developed 8-inch drives with less than 50 MB capacity, but only minicomputer startups companies could use them. Because these drives were easy to make, and because mainframe customers did not want them, profits margins and sales volume were extremely low. New entrants struggled to find a viable market for these drives, while IBM and other established drive makers pondered whether to divert scarce engineering and financial resources to this small new market and risk eroding their market share of the high-margin, high-growth 14-inch market, or wait until the market was big enough, and then invest aggressively to capture it. Unexpectedly, 8-inch drive makers sustained a capacity increase of more than 40% a year. Their products soon met the needs of mainframe computer makers, while offering advantages intrinsic to a smaller disk, such as reduced vibration. Within four years, 8-inch drives had taken over the mainframe market. every independent 14-inch drive maker had been driven out of the industry by the end of the '80s. And of the 17 disk drive companies existing in 1976, all but IBM had failed or had been acquired by 1995. The 8-inch manufacturers, however, were no wiser to the disruptive technology phenomena and found themselves fighting a losing battle several years later against the 5.25-inch drive (Nice, 1997).

2. Scientific Research in the Information Age: Too Much Data For a Hypothesis?

Today, the Internet and the Web, wireless communications and more broadly information and communication technology (ICT) are becoming increasingly ubiquitous. The PC, enabled by the advent of the microprocessor was such a jump which changed radically the world of computing and its applications. Another "miniaturization", that of laser technologies, widened the pipes and enabled the Internet as we know it. A new plateau thus emerged, that of networked computing. The plateau that is to be coming next is brought about by a new vision. It can be attributed again to a kind of miniaturization, that of sensors and actuators and to advances in embedded software. Their combination will thus create an environment of ambient intelligence: with computing embedded in any/every physical object in our surroundings and with everything linked together through seamless communication networks spanning from the home to the global level. Complementary disruptive technologies are also emerging at the same time: a new generation of intuitive and natural human computer interfaces, anthropocentric interfaces, that will greatly increase the usability of systems; and a new family of intelligent systems that will remove the complexity of building large-scale, interactive and inter-communicating systems. The just started integration of ICTs with upcoming advances in bio- and life-sciences combinations are bound to be at the origin of the next revolution in medicine and related life-science applications.

Medical research and the majority of biotechnologies wouldn't be happening without IT. Looking at the developments in drug discovery, data integration and management tools, application servers and the ability to use data to create simulations and visuals are key factors. Scientists now spend their day in front of a computer, trying to figure out how chemical processes are going to work.

IBM’s Life Sciences Caroline Kovac (2002) is responsible for bringing together IBM strengths in such areas as e-business, supercomputing, data and storage management, data mining, knowledge management, and services as well as IBM's world-renowned research expertise in computational biology and parallel computing to deliver leading edge solutions for life sciences. Kovac stated that comparing IT to biology, the former has seen exponential growth over the past 30 years while exponentially declining in cost, while the later has never been such an exponential growth law until the last few years. She believes that in biology we are at a stage prior to the comparable time in the information technology industry. The time needed for doubling the information in biology has been decreasing over the last few years. The rate of change is increasing, because of new techniques that change the way in which people perform experiments in science. According to Jasinski, senior manager of the Computational Biology Centre at IBM Research in Australia, it is a fundamental challenge in science that it has changed from being hypothesis driven to being much more data and discovery driven, thus driving this exponential growth (Thorp, 2002). His group works in bioinformatic algorithms, computational and modeling studies in structural biology and functional genomics, and protein simulation. Computation could help people understand biological systems in a way that would allow more efficient drug design, for example by doing simulation of how certain molecules might work as drugs in a computer without having to make them and test them experimentally. computational biology would also play a role in the development of personalised medicine -- the notion of treating individuals based not just on the symptoms they exhibit, but their genetic make-up as well.

This exponential growth in data and processing has gotten the attention of all IT companies, IBM included. The rate-limiting step is not lack of fast enough computing or big enough computer, but the lack of an integrated environment that can be used for data management, data mining and knowledge extraction. It is much more about building an infrastructure that is scalable and extensible to support Life Sciences computing. Both IBM and Microsoft seem to be addressing these issues; IBM with its Discovery Link (IBM, 2001) and Microsoft with Sharepoint.

A new study by Computer Sciences Corporation (www.csc.com) identifies the "disruptive technologies" that are fostering the most significant change in biochemical sciences: computing advances in miniaturization, speed and storage, genomies and informatics, intelligent systems, robotics and improved human-to-computer interfaces are on the forefront of the report (Chemical Market Reporter, 2002)

Are these technologies necessarily disruptive? Between Bank's definition in 1996 and today, things seem to have changed. More is being written about the "technologies" and less about how they are going to "disrupt" traditional research. Maybe the word "enhance" would suit the R&D context better. After all, these technologies are not being applied in "product manufacturing" but in "product research", and scientists have always been an adventurous lot. They do form a "niche market", but it is a niche market with plenty of funding and great interest in acquiring more powerful research tools. Has the microscope been disruptive to research? When the electronic microscope became available to researchers, did that require a totally new philosophical outlook at the way R&D was being managed? The answer is a definite "no".

3. Menage la Trois: The Internet, the Laboratory and the Information Professional

Logan (1999) sees a possibility that there will come a day when there will be only one Internet stock to buy within the analytical sciences field, and the providers of products to this market might be consolidated into one conglomerate. The business would be based not on instrumentation and the services provided, but predicated on the Internet as the backbone of a major knowledge brokering system. Recipients of the Internet, the lowest entity in the supply chain of data and information input and output, are end users or consumers, who have a great power over the Internet itself, as they interact with it in a two way process which is vital in order for the intrinsic wealth of the Internet tool to be enhanced. We are moving away from Bioinformatics and other scientific IT toys into the world of e-commerce, knowledge management, B2B portals and other marketing issues which the white-robed scientist behind his computer doesn't have to deal with in his day-to-day job.

Logan wrote his article before the dot.com bubble burst. Of the three examples he provided for B2B portals marketing chemicals in bulk, only e-bay survives. As disruptive at these start-ups were, B2B portals and transactions now are the bread and butter of large pharmaceutical companies. Knowledge management is king at Buckman Laboratories. Thermo LabSystems (www.thermolabsystems.com) is actively engaged in knowledge brokering. In bioinformatics, it is the data held within the genomic, protein and medical informatics data bases that holds the key to company success. The drug discovery process requires the availability of a large number of data streams from various sources. The content and format of these information sources is a major issue here as no standards are available. It's an information manager's heaven (or nightmare, depending on how one looks at it). The use of a disruptive technology like the World Wide Web will permit wholesale universal access but it will come at a price in terms of data integrity, a lack of proscribed standards and technology which constantly changes, using rules which are characteristically chaotic.

Many companies selling chemicals, pharmaceuticals and doing life science consulting world-wide, see this as their intrinsic wealth-creating investment and therefore fund enormous internal IT projects of their own, to process and maintain the raw data sets coming out of the discovery laboratory environment. This is unfortunately not so in Australia, where many of the bigger multi-national life sciences R&D companies have taken their businesses offshore. Such combinatorial chemistry organizations as Cambridge Combinatorial (www.cam-com.com), Accelrys (http://www.accelrys.com), Pharmacopoeia (http://www.pharmacopeia.com/index.html) and Tripos (http://www.tripos.com) offer information and knowledge as the product, not necessarily novel chemistries or technology. What is clear is that unless the discovery company invests equally in its IT business as well as its core competency, it will not be able to provide a complete service to clients.

Information professionals will continue to provide expert information consultation and analysis, as well as coaching and support in the use of web and other desk-top information sources. Although some suggest that R&D practitioners will increasingly need to develop their own competencies to optimize their use of these key R&D knowledge and information assets, this seems to be a far-fetched proposition. With the massive quantities of data now available to researchers, computers have become essential. However, having the data in the computer does not mean that it can be used in any meaningful way. The challenge for bioinformatics developers is to design platforms that can manage, retrieve, organize, compare, manipulate and integrate data in a way that accelerates research, rather than acting as a bottleneck. This may be accomplished either by integrating a number of independent applications via an accessible, standardized interface, or by designing a single package that provides cross-database search and analysis functionality.

4. Required for the Job: New Wine for Old Casks

The uptake of IT in Australia has been much slower than in the USA. Australia has always had great scientists and researchers, lots of talent in little start-ups with smart ideas. But interstate rivalries were costing Australia valuable resources as people and businesses moved to more welcoming venues. the federal system in Australia creates an inward view of the market. The states are more concerned about competing against each other than they are about understanding that Taiwan has gone after business that should be oursLionel Binns, of HP Life Sciences, is currently in Australia overseeing the supercomputing installation at Australian National University in Canberra. He has been critical of both the bickering and the fact that Australians tend to look at IT in general as a “start up” business. His advice was to look at at the skills of professionals who had been laid off, and see whether they could be retrained to work in such new fields as Bioinformatics, where People with engineering, mathematical and statistics backgrounds are needed just as much as biologists (Dearne, 2002) His advice couldn’t come at a better time. A few days ago, Fiona Balfour, the CIO of Australian only air carrier, Quantas, was quoted in The Australian as saying that she was surprised by the number of “middle-age IT people” in her company who could be replaced by “new graduates” paid much lower wages (Hayes, 2002).

According to Philip Fersht, the author of “Australia's Bio IT Market: Understanding the Future”, while Australia was ahead of the pack in the Asia-Pacific region, Taiwan and Korea were both likely to overtake Australia in the next few years. The governments of Taiwan and Singapore are spending five times more on biotech than Australian government (Dearne, 2002b).

The reason that disruptive technologies are frequently lethal for industry giants is that when responding to outside threats, established firms typically look to the management philosophies that made them successful in their given markets. In other words, they heed the desires of their best customers, they invest in the products that offer the highest gross margins and the greatest immediate returns, and they frame disruptive threats as technological, rather than marketing, issues (Borck, 2002). Over and over, in industries as diverse as microelectronics, steel, motorcycles, and software, leading firms whose management practices at one point were widely admired and imitated have stumbled badly and even failed. The factor that consistently has triggered these failures has not been complacent, arrogant, or bureaucratic management. It has been the emergence in their markets of disruptive technology-simple, convenient-to-use innovations that initially are used only by unsophisticated customers at the low end of markets. Ironically, two of the fundamental paradigms of good management-the importance of listening closely to customers and the necessity of bringing to market a regular flow of improved products that can be sold at higher profit margins-are the reasons why well-managed companies have consistently failed when confronted by disruptive technologies in their markets.

Those incumbents that have successfully identified and cultivated disruptive technologies, on the other hand, have employed one of two similar strategies. They have either acquired disruptive technologies and kept them separate from their core businesses, as Intel has done with the StrongARM chip design that it bought from Digital (Turley, 1998), or they have launched separate organizations, as Hewlett-Packard did for its ink-jet printers. IBM barely survived the PC threat by establishing an independent organization in Florida. Either strategy necessarily results in the erosion of the established firm's market share. This might seem suicidal, but if the only alternative to losing market share to an outside competitor is losing it to an offshoot from within the parent company, the choice is clear. Disruptive technologies by their very nature effect radical shifts to new business models that meet the demands of new customers. Industry players, when faced with these shifts, must meet change head-on or risk fading into oblivion.

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