

Evaluating Clayton Christensen & Disruptive Innovation

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This draft, unreleased monograph was scoped in late 2005 and written in early 2006 for 'The Disruptive Internet' stream in the Next Generation Internet Users project of the Smart Internet Technology CRC (SITCRC), an Australian research consortium.

The monograph's formal milestone was: "Prepare a research critique that offers the first consolidated analysis of Internet-related disruptive technologies and users with some key implications for commercial opportunities."

The monograph's brief included an evaluation of Clayton M. Christensen's work in disruptive innovation, from *The Innovator's Dilemma* (Harvard Business School Press, Boston MA, 1997) onwards. It advocated the development of a disruptive innovation capability within the SITCRC. It dealt with parallel developments in agile software development, knowledge management, and creativity. Apart from Christensen, I was influenced by postgraduate experiences in Swinburne University's strategic foresight program (2002-2004) and in Monash University's counter-terrorism program (2005-06).

The monograph anticipated themes later explored in two books: Scott D. Anthony, Mark W. Johnson, Joseph V. Sinfield and Elizabeth J. Altman's *The Innovator's Guide to Growth: Putting Disruptive Innovation to Work* (Harvard Business School Press, Boston MA, 2008) and Jeff Dyer, Hal Gregerson and Clayton M. Christensen's *The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators* (Harvard Business School Press, Boston MA, 2011).

The SITCRC's internal reaction was mixed. Some senior management were familiar with Christensen's ideas and saw value in developing an organisational capability. This led to 'commercial in confidence' discussions with Sensis, Telstra, The Distillery, and Westpac, and regarding the Services Innovation Foundry and Services 2020 programs proposed for the Smart Services CRC. Others were more sceptical or felt the conceptual, theory-building aspects of this monograph were irrelevant. Although the monograph went through several drafts and one internal review it was never formally cleared for publication. In retrospect, this was a missed opportunity for the SITCRC despite interest from its commercial research partners.

This monograph version is the draft released for SITCRC internal review in June 2006. It does not include other, extensive draft notes, blog post, interviews, or internal and client presentations created as part of 'The Disruptive Internet' stream. It does not represent the SITCRC's views nor those of its successor institution, the Smart Services CRC. It is provided for self-education purposes only and as a public record on what 'The Disruptive Internet' stream achieved.

My research program developed further insights on Clayton M. Christensen and disruptive innovation in subsequent refereed publications.

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Section Overview

Section 1 outlines the influential Disruption research of Harvard Business School's Clayton Christensen. **Section 2** evaluates Christensen's work, clarifies the potential misunderstandings and delineates several different Disruption categories: the Disruptive Technology meme; Dotcom-era models; Christensen's categories; and post-Christensen innovations. **Section 3** offers some initial guidelines on how to apply Christensen's Disruption work to business processes and problems.

Section 1: Clayton Christensen's Contribution

This section summarises the findings of Christensen's key works. These include *The Innovator's Dilemma* (1999), *The Innovator's Solution* (2003), *Seeing What's Next* (2004), and his major articles for *Harvard Business Review*, and other journals.

Christensen proposes a model that is different to life cycle and radical technology models. He focuses on market and industry analysis, and contends that disruption creates new value propositions. As his work evolves, Christensen has acknowledged flaws and blind-spots. His latest book *Seeing What's Next* (2004) recognises the importance of theory building, and applies it to healthcare, telecommunications, and other domains.

2006: The Year of Disruption?

'I think this is the year of Disruption - the year the Web - in all its forms - really flexes its muscle and begins to seriously turn the soil of the global economy in deep and permanent ways.'¹

– John Battelle, author of *The Search* (2005)

'[Apple's Steve] Jobs has proven himself unrivalled in the art of managing disruption.'²

– *Fortune* journalist Fred Vogelstein

'Societies or companies that expect a glorious past to shield them from the forces of change driven by advancing technology will fail and fall.'³

– Rupert Murdoch, 'Adapt to Technology or Die' (2006)

Disruption has moved from the margins to become an integral theme of the post-Dotcom era Internet. Once the Digerati vanguard held this revolutionary worldview: now Disruption metaphors and themes are amongst the most influential ways to describe the Internet's near-term future. The dramatic counter-moves by News Corporation's Rupert Murdoch, Apple's Steve Jobs, and Google founders Larry Page and Sergey Brin have legitimated Disruption as a form of strategic leverage. Each of the Digerati vanguard has "in-depth knowledge of how these changes affects their problem domain," notes author Mark Pesce.⁴ A Disruption-oriented culture is now perceived to be necessary for high-value creation in a highly complex environment.

Beyond the Information Technology (IT) jargon and merger mania is a deeper perceptual reality: Disruption has shifted from being about IT project management failures to now being about adaptive enterprises, business resilience and innovation. In the 1990s the CHAOS Group and Aberdeen Group undertook high-profile annual reports on IT project failures and mistakes. These studies catalysed the software development community to search for holistic solutions to complex problems.⁵ Simultaneously, traditional Research & Development (R&D) labs such as Xerox PARC and MIT Media Lab have been eclipsed by a new entrepreneurial breed who favoured ‘open innovation’ models for Disruptive Innovation.⁶

This Report evaluates the research contribution of Clayton Christensen, the Harvard University scholar whose book *The Innovator’s Dilemma* (1997) introduced many business analysts to Disruptive Technology and Disruptive Innovation. It explores Christensen’s insights, explains why he has been misinterpreted, and provides an overview of post-Christensen work. This Report also provides initial guidance on how Disruption can be applied to many business areas and problem domains.

Clayton Christensen’s Background

Harvard Business School’s Clayton Christensen has emerged as the world’s high-profile theorist of technology disruption. Christensen’s early academic career included a BA in Economics from Brigham Young University (1975), an M.Phil in Applied Economics from Oxford University (1977), and an MBA from Harvard Business School (1979). From 1979 to 1984 he was a Boston Consulting Group consultant and was appointed a White House Fellow in 1982 during the Reagan Administration. He co-founded the ceramics manufacturing company Ceramics Process Systems Corporation in 1984 and served as chairman and president. These experiences and institutions would have a decisive influence on Christensen’s Disruption models.

Christensen’s 1992 DBA thesis examined Disruption patterns in the computer hard-disk industry. The DBA became the basis for the opening chapters in Christensen’s first major book *The Innovator’s Dilemma: When New Technologies Cause Great Firms to Fail* (1997). Christensen became a Professor of Business Administration at Harvard Business School. In 2000 he co-founded the consulting firm Innosight (www.innosight.com) to promote his models and research to a corporate audience. Innosight’s success enabled Christensen to appeal simultaneously to academic, corporate and business media audiences.

Christensen’s Disruption Types

Christensen distinguished between three main Disruption types in his books. For business analysts interested in Disruptive Innovation, these are the equivalent models to Michael Porter’s 5 Forces in competitive analysis.

Low-End Disruption focuses on ‘discount prices and growth business in a current market which scares the incumbents away.’⁷ This type resembles Michael Porter’s ‘low cost/focus’ strategy.⁸ It relies on organisational reach within mature markets to influence consumer behaviour, control pricing and shape procurement strategies.

Wal-Mart's discount strategy to displace Sears in the US retail sector, and the rise of steel mini-mills in manufacturing are cited by Christensen as historical examples.

Low-End Disruption Case Studies

- **Dell Computers:** Michael Dell used *Just In Time* procurement and supply chain management to establish a Low-End Disruption position against IBM, HP and Compaq. The “Dell Direct” business model relies on several intersecting factors to achieve this. At a user level Dell's ‘choiceboard’ site enables customers to explore component options and configure customised solutions that hide the complexity of back-office systems. At a manufacturing level Dell uses Lean and Theory of Constraint insights to manage resources, keep operational costs to a minimum, and respond quickly to customer orders. These economies of scale mean that Dell can use Electronic Data Interchange to negotiate low-cost deals with preferred suppliers, modelled on Federal Express and Southwest Airlines. Dell's alliance with the Wintel axis also means that it can spend more on Lean infrastructure rather than long-term R&D investment. This strategy mix exemplifies Constantinos Markides and Paul Geroski's *Fast Second* (2005).

- **Amazon.com:** The online bookstore copied many of Dell's lessons in procurement cycles and negotiations with book publishers for bulk discounts. CEO Jeff Bezos played up the New-Market Disruption angle during the 1995—2000 Dotcom era for the business media. As Amazon.com has grown it has assimilated new innovations from streaming media to blogs and customer wiki's, and sought to reposition itself long-term in the Modular Disruption space. In turn, sites such as Abe Books (www.abebooks.com) have reinvigorated the second-hand book market by providing a searchable global database for niche sellers and customers. Amazon.com has also used its platform as a Sustaining Technology to expand the breadth and depth of products sold through its online store.

- **Warez Sites:** The growth of online warez sites with illegal copies of electronic books, music, DVDs and computer programs exemplifies Low-End Disruption at its most extreme. In the early 1990s writers including Steven Levy and Bruce Sterling tracked how hacker subcultures were infiltrated by organised crime and targeted by law enforcement officials. Contemporary warez sites have a symbiotic relationship with transborder capital flows: content source from the US and Europe; servers in Russia and Eastern Europe; integration with VISA and Mastercard facilities; and the cracking of Digital Rights Management protection. Consequently, the most sophisticated warez sites are now adopting Modularity Disruption insights.

New-Market Disruption creates ‘a new context . . . [and] products that are simple and expensive.’⁹ Christensen discovered New-Market Disruption when examining the early 1980s collapse of mini-computer firms such as DEC, Prime and Wang. This case illustrates how special interest groups and organisational blind-spots can create barriers to New-Market investments. For traditional ‘big R&D’ organisations such as Bell Labs and Xerox PARC, this failure was framed as a technological deficiency.

Although they may be simple and inexpensive New-Market Disruptions are different to Low-End discount strategies: they reframe the competitive space via new products and services that counter the incumbents' money and skill. Southwest Airlines' regional strategies and point-to-point flights exemplified this approach. New-Market Disruption also creates new niches and empowers customers—a vital link to user-led innovation. Consequently, New-Market Disruption links closely with Geoffrey Moore's 'chasm' marketing framework for technology diffusion.

- **Corporate Universities:** In *Seeing What's Next* Christensen and his colleagues discuss the emergence of corporate universities such as Motorola University to offer tailored courses and staff training. Christensen frames this as New-Market for the corporations involved whilst simultaneously being a Low-End Disruption for blue-chip university programs at Harvard, Princeton and Stanford universities. The corporations are willing to trade-off this reputation for the flexibility and customisation that corporate universities offer. In turn blue-chip universities have developed specialised courses and pathways, and off-campus options to recapture the higher education market. The University of Phoenix's online program has adopted lessons from first-generation e-learning and viral marketing to challenge both corporate and blue-chip universities.

- **Architecture Evolution:** Many of Christensen's IT examples for Disruptive Innovation occur at the architecture level. In *The Innovator's Dilemma* and subsequent keynote presentations he contrasts the transistor with the vacuum tube; the early Apple II and IBM PC computers with the DEC mini-computer; and the failure of the Xerox PARC laboratories to capitalise on its innovations in user interfaces, Ethernet networks and laser printers. Christensen uses each case to highlight that although engineers recognised the architecture shift and may have developed superior prototypes, the research-to-market pathway was blocked by the dominance of power users and organisational barriers to an intrapreneurship culture. Adrian Slywotzky offers a convergent explanation in *Value Migration* (1996) where he identifies a key Disruptive Innovation pattern for inter-firm competition.

- **Lego Mindstorms:** In the late 1990s the Lego Mindstorms product was hailed as the 'killer app' product that reinvigorated the legendary toy brand. Mindstorms' engineering and robotics made Lego relevant for the 'geek' teen demographic that had migrated to the Sony PlayStation. Anthropologists studied its team for lessons about new product development in high-velocity ecosystems. *Wired* and other magazines praised its 'geek' aesthetic and the design team's use of social network insights. Yet by late 2005 the initiative faced an industry backlash as the Mindstorms brand was perceived to have risen and fallen. This case illustrates the Janus-like role of media coverage in helping a Disruptive Innovation to 'cross the chasm'.

Modular Disruption is a new type Christensen identifies that combines aspects of Low-Cost and New-Market simultaneously to reframe the competitive space and identify new value propositions. Modular enables firms to reconfigure their value chain, and create architecture flexibility whilst also maintaining control of value creation in strategic areas.

Modular challenges industry structures and incumbents ‘because it enables independent, non-integrated organisations to sell, buy, and assemble components and subsystems.’¹⁰ This prioritises the limits of proprietary architecture ‘lock-in’ and favours ‘comoditised modular architectures’ that are adaptive to user needs, harnessed by fast-moving companies, and which re-segment the value chain.¹¹ Those companies unable to change or find value will be left in a ‘disintegrating industry.’¹² The primary agenda for survivors is to gain control of the conceptual ‘white-space’ at the market/industry level

Modular Disruption Case Studies

- **Linux vs. Microsoft:** The Open Source community offers many Disruptive Innovation case studies. Linus Torvalds’ operating system Linux and its commercialisation by Red Hat highlights how firms can create new value in the Modular Disruption space. Torvalds galvanised New-Market Disruption when he developed Linux and published the software code for developers and programmers. Over the next two decades a sophisticated user community with a libertarian ethic formed around Linux and enhanced its capabilities. Linux ‘crossed the chasm’ in the early 2000’s to become the operating system of choice for Low-End computers, thin client servers and mobile device developers. Its cross-platform interoperability and open code challenged the Wintel axis dominated by Microsoft, who sought to reframe Linux as a Low-End solution without the robustness for enterprise-wide deployment. The marketplace war-of-words between Linux proponents and Microsoft illustrates how Modular Disruption messages can turn into George Lakoff’s frame games.

- **Nokia:** In public keynote presentations Christensen cites Nokia’s decision to use the Open Source operating system Symbian as a recent Modular Disruption example. Nokia licensed Symbian to provide mobile device interoperability and compatibility for third-party software developers. However, it retained control of its chipset and hardware production as core capabilities that Nokia viewed as necessary for its strategic execution. This decision highlights a key principle underlying Modular Disruption: its flexibility derives from the ability to reframe the Low-End and New-Market elements at different positions within the value network. Nokia’s merger with Siemens in June 2006 promises to extend its Modular Disruption strategies into mobile television and other new markets.

- **Agile-Lean Software Development:** The Agile movement formed around practitioners who signed the Agile Manifesto in 2001 (www.agilealliance.org). As the movement has grown it has synthesised trans-disciplinary lessons from the chaos and complexity sciences, learning organisations, self-organising teams and strategic execution strategies. Its body of knowledge has adapted frameworks from Lean manufacturing, empirical process control and self-reflexive research practices. Agile exponents have created a range of methodologies: Kent Beck’s Extreme Programming (www.xprogramming.com); Ken Schwaber and Jeff Sutherland’s Scrum project management (www.controlchaos.com and www.jeffsutherland.com); and Alistair Cockburn’s Crystal (www.alistaircockburn.ws). Each of these methodologies has been positioned as Disruptive Innovation in comparison to industry practices.

The evolution of Christensen's theories from New-Market and Low-End to Modular Disruption parallels a shift in business strategy from the relatively 'static' models taught in MBA programs to the fluid and relational models of inter-firm competition and industries. In this strategic landscape, fluid and relational value ecosystems and networks replace the more command-and-control value chain. For many analysts, Christensen's books and journal articles are the entry point to grasping these new realities.

Christensen's Books

This section summarises the key insights from Christensen's three major books. Each had its roots in Christensen's academic work: his PhD research, journal article collaborations and public talks. This meant that Christensen's books featured theory-rich models with more depth and niche 'fitness' than parallel Dotcom era models on supply chain management. The generative role of academic research for Christensen also underlies the methodological development of Robert Kaplan and David Norton's Balanced Scorecard model for organisational metrics. In both cases the authors interacted closely with industry leaders. For example, Christensen's *Harvard Business Review* articles have applied his insights to the banking and finance, entertainment, health, and telecommunications domains.

The Innovator's Dilemma is Christensen's most influential book, based on his PhD dissertation. Christensen outlines six generic rules for analysing Disruptive Technologies, and situates the firm and value networks as his levels of analysis. He uses case studies on the disk drive industry, backhoes and excavators, and Honda motorcycles to articulate the Theory of Disruptive Technology Innovation that defines Christensen for many analysts. Rather than just technology, Christensen also examines decision-making, marketing and resource allocation. To show inter-locking complexities and interdependencies, he considers Digital and Intel's history in the computer industry. This sets up the Resource-Processes-Value (RPV) theory of management that Christensen would explore further in *The Innovator's Solution*. Christensen's final chapter is a hypothetical exercise on Electronic Cars: a walkthrough of the decision-making process faced by a manager who is assessing the possibilities for electronic cars. Christensen uses this hypothetical to show managerial thought processes and judgments rather than offering a definitive answer. He also details a Technology Map metric for technology forecasting.

Christensen's *TID* advances a Theory of Disruptive Technological Change: he counter-intuitively concluded that good management can kill companies rather than ruinously intense competition. Christensen tracked two key trajectories: technology improvements which customers could use, improvements created by the introduction of new products, and then the managerial blind-spots these trajectories create within organisations. Companies failed because they were biased towards short-term revenues and high-profile customers rather than risking smaller markets and unproven technologies.¹³ Intriguingly, Christensen's analysis of the hard-disk market in *The Innovator's Dilemma* foreshadowed the emergence of Flash memory in the early '00s.

The Innovator's Solution (2003), co-written with Michael Raynor outlines a theory of firm-based capabilities, resources and processes. Christensen and Raynor develop an intrapreneurial model that is oriented to high-growth 'challengers'. *TIS* deals with a

key problem raised by *The Innovator's Dilemma*: how firms can develop the internal capabilities and processes for Disruptive Innovation. *TIS* focusses primarily on intrapreneurship and resource allocation as the keys to this.

Christensen's *TIS* notes that the relentless drive for short-term growth in firms will persuade them to focus on the needs of primary customers. Equity markets punish firms whose management teams fail to deliver sustained growth. This growth imperative means that most firms focus on Sustaining innovations rather than Disruptive.

To deal with investor perceptions, Christensen and his colleagues believe that firms must be careful about making investments in Disruptive Innovation. He notes that firms who have attempted to develop Disruptive capabilities in-house have been unsuccessful. Therefore, the best strategies are challenger firms, new firms and spinoffs—the latter is a dominant option for new value creation.

Seeing What's Next (2004), co-written with Scott Anthony and Erik Roth advocates how theory construction principles can improve strategic thinking about Disruptive Technologies and Disruptive Innovation. Christensen and his colleagues explain a Discovery-based Planning methodology which scans the strategic landscape for 'forces of change' and 'weak signals' that may restructure markets and industries. They apply this methodology to energy, health, telecommunications and technology domains. *SWN* is primarily about fluid competitive dynamics: how analysts can monitor competitors and model their likely signals and strategic counter-moves.

Breakout Box: Business Case for Disruption

Disruption strategies provide the following value:

- Divergent thinking for firm strategy
- Identifies a blind-spot in managerial thinking about innovation strategy
- Alignment of resources, marketing and value propositions
- Way to create sustainable competitive advantage and counter-moves
- Frame to assess project portfolio and product development
- Generator of new intellectual capital
- Disruption has a unique view on force multipliers

Sustaining Technologies

For Christensen, the vast majority of innovations—incremental, radical or modular—are not Disruptive in nature. Instead they are Sustaining Technologies: line extensions and new products that extend the existing product and service capabilities, and that appeal directly to a firm's core customers. Strategic marketing has the best understanding of how Sustaining Technologies build niches for core customers due to brand equity and specific solutions. Despite its short-term success, strategic marketing contends that Sustaining Technologies can undermine a firm's brand equity and positioning if line extensions become too great.

ICT business models rely on Sustaining Technologies when they demand vendor-specific solutions and user lock-in. The managerial decision to prioritise Sustaining

Technologies is usually made to protect the products and services that generate the firm's major revenues. This decision also may reflect the political power of senior elites in hierarchical organisations over strategic planning processes.¹⁴ In turn, this political power is often enhanced by compartmentalisation, operational silos, and the 'need-to-know' principle that restricts information flows within firms.¹⁵

The pathology of Sustaining Technologies and special interest groups point to how a firm's core customers can influence its attention cycle, its cultural norms, and how it models and interacts with the strategic landscape.¹⁶ Internally, funding for Sustaining Technologies projects can often sabotage the R&D programs to develop Disruptive Technologies. If 'weak signals' that anticipate emerging Disruptive Technologies challenge the mindsets of special interest groups who advocate Sustaining Technologies, they risk being ignored. Therefore, a firm's 'real-time opportunity scanning' process should be distributed throughout the firm, independent of any special interest group control if possible.¹⁷

Christensen's full Disruptive Technology definition points to multifactorial combinations—technology, execution, customer niche, and response—that will ultimately constrain firms that rely solely on Sustaining Technologies solutions. Disturbingly, Thomas Barlow contends that Australian innovation is largely imitative—based on Sustaining rather than Disruptive technologies.¹⁸

Sustaining Technology Case Studies

- **IBM /360:** The IBM /360 series became the cornerstone of IBM's dominance of the mainframe computer sector throughout the 1960s and 1970s. As project leader Fred Brooks notes in *The Mythical Man Month* (1975), the /360's architecture was designed to be cross-compatible so that users could upgrade the mainframe hardware without becoming trapped by legacy systems. This decision illustrates how Sustaining Technologies extend upon existing architectures and frameworks.
- **Market Failures:** Strategic marketing literature has many case studies on the flipside to Sustaining Technologies success: the erosion of brand and marketplace positions via line extensions that alienate the core customers. High-profile examples include IBM's PCjr, the Apple III, Coca-Cola's 'New Coke' debacle and the digital movie format for Sony's PlayStation Portable device. Post-mortems on these failures note poor strategic execution, flawed technologies and a defensive position in tit-for-tat battles with competitors.
- **Legacy Computer Systems:** The banking and financial services industry faces a major technological bottleneck: the continued use of legacy computer systems developed in the 1960s and 1970s as core infrastructure. Legacy systems have a range of problems from now-arcane programming languages such as Cobol and Fortran to transaction processing resilience. Software engineers have been forced to develop innovative practices to port legacy system code to new architectures. However these barriers also mean that legacy systems also face interoperability difficulties with end-user and front-end systems. Therefore, legacy computer systems illustrate the incompatibility of tightly-coupled Sustaining Technologies with Disruptive Technologies that are loosely-coupled or built on new architectures.

Disruption Categories

The following categories have been developed by the Smart Internet Technology CRC to describe the Disruptive Innovation literature. Each category provides a layer with different insights, scope and application.

Disruptive Technology is a narrow definition that deals with how changes in technology can impact on business models and strategic execution. Disruptive Technology is perceived as an event to be predicted or reacted against. IT analysts and the media have touted Disruptive Technology because its emphasis on artefacts is alignable with vendor offerings.

Disruptive Technology has several different meanings in the innovation arena. The 'disruptive' label is applied to technology solutions that are perceived as radical on the radical-incremental scale; to 'killer app' architectures that promise to alter the competitive structure of markets and industries; and to significant 'challengers' who emerge against incumbents. Peer-to-peer networks, wireless area networks and Web 2.0 technologies have all been described in media coverage as 'disruptive technologies'—yet often in technologically determinist ways.

Disruptive Technologies often began on the fringe and interested only specialist customers who may not have been high-revenue generators for a firm's core business; these became 'disruptive' when after several iterations they became more viable solutions for customers. The diffusion process for Disruptive Technologies and its three major types also mirrors Geoffrey Moore's distinction of a chasm between visionaries/early adopters and the early mainstream in *Crossing The Chasm* (HarperBusiness, New York, 1995). The combination of Christensen and Moore offers cross-model verification and can be easily integrated into an ES process or organisational unit.

Christensen's *The Innovator's Dilemma* is credited with popularising the term Disruptive Technology. However, Christensen's definition is frequently misunderstood: he refers to technology in its generic sense as inputs to a firm that create a strategic transformation. The majority of 'innovation' was for new products and services which were Sustaining—they extended existing capabilities or added new solutions that satisfied core customers, the industry majority and brand integrity.

Disruptive Innovation

Disruptive Innovation is a broader category that situates Disruptive Technologies within firms, markets and competitive strategic landscapes. Its framework emerged in the early 1990s as 'thought leaders' became more aware of globalisation impacts; the quality movement and process transformation; and the value creation potential of new innovation forms. The 1995—2000 Dotcom era led to an overemphasis on untested e-business models that were presented as radical change, and 'killer app' forms of Disruptive Technology. Disruptive Innovation focuses on innovation diffusion and processes in the firm, and on markets as biological-like ecosystems that adapt and evolve. The strong boundaries between a firm and its customer and supplier networks break down as co-evolution and nonzero-sum cooperation replaces zero-sum hyper-competition. Disruptive Innovation has interdisciplinary links with knowledge

management, organisational dynamics, chaos/complexity sciences and new systems thinking.

Christensen's model of Disruptive Innovation counterbalances technology with an emphasis on the 'shepherding' role of middle management to test new innovations, the importance of resource allocation, and faster cycles for prototype-to-market commercialisation. Eric von Hippel's *Democratizing Innovation* (The MIT Press, Boston MA, 2005) and *The Sources of Innovation* (Oxford University Press, New York, 1988) focus on the value of lead users in the creation of breakthrough products and services. Henry William Chesborough's *Open Innovation* (Harvard Business School Press, Boston MA, 2003) champions spin-offs, industry-university collaboration and start-ups as more effective than the traditional 'big lab' approach.

Disruptive Technology and to a lesser extent Disruptive Innovation are dominant perspectives in the business press and media. Underlying both is a worldview called Disruption Thinking.

Disruption Thinking

Disruption Thinking is the deep structure that is the foundation for Disruptive Technology and Disruptive Innovation models. It is an exploratory mode of creative synthesis that looks for anomalies, divergences, uncertainties and weak signals. Disruption Thinking relates to creativity: it involves Arthur Koestler's 'abductive' thinking rather than deductive or inductive. It also may have a different mix of Howard Gardner's 'multiple intelligences'. Further research in this area needs to be undertaken. Because its thinking style is divergent, Disruption Thinking may be first introduced through creativity tools such as Edward de Bono's 'po' that illustrate these principles. An awareness of Disruption Thinking can be helpful to evaluate the hidden assumptions and limits of business models and theories. For example, Christensen's work applies across several of Henry Mintzberg's strategic management schools.¹⁹ This flexibility also speaks to Christensen's appeal for different audiences.

Disruption Thinking is trans-disciplinary in nature: its body of knowledge spans the hard and soft sciences, aesthetics, information technology and business management. In the hard sciences, Disruption Thinking models have been adapted from chaos/complexity, cybernetics, evolution and systems thinking. In the soft sciences, Disruption thinking has been discussed in behavioural economics, organisational psychology and sociology. Aesthetic schools and traditions have drawn on the Disruption power of novelty and shock in visual art, design, film and digital media. This trans-disciplinary scope and depth offers many insights to strengthen our understanding of Disruptive Innovation.

Business management perspectives on Disruption Thinking have been historically dominated by military strategy. This trend peaked in the 1980s with guidebooks by Sun Tzu and Carl von Clausewitz; case studies on commander decision-making; and the adoption of psychological warfare tactics in hostile takeovers. This pseudo-knowledge was communicated in aphorisms and maxims. Consequently, both Disruptive Technology and Disruptive Innovation have been framed as challengers versus incumbents, and as stratagems that outflank competitors.

Military strategy prioritises the ‘killer app’ model to explain Disruptive Technology. It adopts lessons on force from guerrilla insurgencies, although the harsh realities have been muted after September 11. The most insightful work in this strategic thinking has revived two strategic traditions: 14th century castle sieges and 18th century manoeuvre warfare exemplified by Napoleon’s European campaigns.²⁰ Disruption as a Disintermediation model for markets and industries came from siege tactics that tried to destabilise the target structure at a weak point. The key was disequilibria rather than direct confrontation with your nemesis.²¹ During the Cold War ‘balance of terror’ US nuclear strategists including Herman Kahn and Thomas Schelling developed sophisticated models of crisis signalling and conflict thresholds. Kahn and Schelling used systems analysis, Monte Carlo simulations, war-gaming and game theory to model how conflicts in the international system could be played out. Throughout the 1970s and 1980s these tools migrated from defence strategists into the business community.

In the 1990s these zero-sum assumptions were replaced by hard sciences metaphors from biology, chaos/complexity and systems thinking. Analysts framed innovation as occurring at the ‘edge of chaos’. Thinking shifted from instrumentalist to ecological. The search for non-zero-sum thinking in competition theory led to game theory models from econometrics and mathematics. The competitive space was perceived as a ‘fitness landscape’ that could flip and mutate very quickly. This was the death knell for ‘static’ models, and led to debates in the 1995-2000 Dotcom era about the applicability of traditional strategic models. The dominant metaphor became the *Drosophila* fruit fly, a symbol for fast cycles and iterative-incremental innovation.

Breakout Box: The Historical Roots of Disruption Thinking

Clayton Christensen’s work and Disruptive Innovation solutions have deeper roots in Disruption Thinking: a trans-disciplinary body of knowledge which provides counterintuitive insights drawn from aesthetics, economics, military strategy and the new sciences. The underlying connectivity between these different traditions is their understanding of disruption and shock.

The practitioner and strategist’s knowledge of this trans-disciplinary body of knowledge will in turn shape the frames, metaphors and models which are developed to understand the change dynamics at play in the strategic landscape. Two boutique firms that exemplify this approach are Paul Saffo’s Institute for the Future and the ‘star’ practitioners—Peter Schwartz, Kevin Kelly, Stewart Brand, and Brian Eno—associated with the Global Business Network.

Bruce Mau’s *Massive Change* (Phaidon Press, New York, 2004), a collaboration with the Institute Without Boundaries, also exemplifies this trans-disciplinary approach to Disruption Thinking. Mau and his colleagues use the intersection of design and disruption to provide a graphic overview of global change dynamics and interview relevant ‘thought leaders’.

Military Strategy and Security Studies

- 14th century castle sieges
- 18th century manoeuvre warfare (Napoleon)

- 20th century nuclear strategic thinking (Herman Kahn and Thomas Schelling)
- 19th and 20th century and guerrilla warfare
- 20th century counter-insurgency and psychological operations
- 21st century energy security and oil geopolitics

Mathematics and Science

- Chaos and complexity sciences
- Mathematical laws of form
- Popularisations of biology and genetics

Economics, Psychology and Sociology

- Behavioural Economics modelling of group behaviour and mental models
- Game Theory tit-for-tat strategies and counter-moves
- Business continuity and disaster management lessons on socio-technical systems

Aesthetics and Digital Media

- Non-linear digital editing
- DJ turntablism and electronica subcultures

Section 2: *Evaluating Clayton Christensen*

This section covers conceptual issues, common misunderstandings of Christensen's research, and how others have evaluated it. A Smart Internet Technology CRC critique is offered of Christensen's research. Finally, the commercial implications of Christensen's work are considered. Specific recommendations for application within the CRC's research culture have been made to senior management.

Initial Critical Reception

The Innovator's Dilemma was a 'sleeper' hit for Harvard Business School Press. It took over 12 months for Christensen to make the covers of agenda-setting business magazines such as *BusinessWeek*, *Fast Company*, *Forbes* and *Fortune*. Much of this impetus was because Andrew Grove, the former CEO of Intel Corporation, viewed Christensen's work very favourably.²² Grove felt that Christensen's Theory of Disruptive Technology validated his Strategic Inflection Points model, in which critical incidents and shifts within industries can cause 10x-scale change that destroys firms. Christensen's seminar anecdotes also mention that Grove reminded him soon after *The Innovator's Dilemma* was published that intrapreneurship and resource allocation were key model concerns, and not just 'killer app' technologies.

Christensen's research into Disruptive Innovation occurred as interest was waning about first-generation Business Process Reengineering interventions.²³ Advocate Michael Hammer had an engineering background which translated into the popular misconception that BPR solely meant workplace downsizing, and ignored Human Resources issues. Go-Live dates on Enterprise Resource Planning projects have been so traumatic that they are synonymous with negative views on Disruptive Innovation. This created a receptive space for Christensen's early work, which was interpreted first as dealing with market and industry transformation.

In this early period Christensen also received scathing criticism. Many interpreted him in the shadow of Austrian economist Joseph Schumpeter, who emphasised business cycles and how 'creative destruction' could free up resources for new capital.²⁴ Because the mid-point of the 1995-2000 Dotcom era coincided with Christensen's public visibility, many analysts interpreted him in 'first mover advantage' and 'revolutionary' terms.²⁵ Veteran columnist John Dvorak offers the most controversial critique: he contends that Disruptive Technologies do not exist, and that Christensen's viewpoint is a 'false premise' used to confuse decision-makers.²⁶

Australian Innovation Debates on Disruption

Disruption has recently been debated by government policymakers and business roundtables in Australia. Two papers released in February and March 2006 both highlight the role Disruption has in debates about international drivers and Australian innovation. If the widely held social image of Australia as the 'lucky country' fits Christensen's Sustaining category, the Disruption social image is closer to Silicon Valley IT firms and Hollywood film production environments.

In February 2006 the Business Council of Australia (BCA) argued for a generalist approach to R&D that recognises incremental innovation and adaptation of global 'best practices'. The BCA's critique is aimed at what it perceives as the Australian Government's overemphasis on science and technology R&D, and the reliance of firms on tax concessions. The BCA's advocacy of incrementalism is designed to make innovation strategies more palatable to Australian firms and evidence-based managers. At the centre of this debate are three important distinctions: incremental versus radical change; the shift of Technology Foresight that develops 'killer app' Disruptive Technologies from university-based research institutions to companies; and the investment/policy mix that Disruptive Innovation requires to be sustainable in the long-term. To its credit the BCA used clear language to resolve the misunderstandings and mystique that often surrounds innovation. The BCA's advocacy of incrementalism pragmatically acknowledges that many Australian innovations are adaptations from overseas markets.

In March 2006 the Australian Department of Communications, Information Technology and the Arts (DCITA) released the much-anticipated Digital Content Industry Action Agenda.²⁷ Senator Helen Coonan has proposed opening up media ownership in metropolitan and regional areas; digital content; and no fourth channel. Critics of the DCITA paper contend it offers conservative solutions to the tumultuous changes in digital media's strategic landscape that have been unleashed by specific Disruptive Technologies. The debate illustrates how different interests perceive the forces and magnitude of Disruption change demanded to be internationally competitive.

In the above two debates each stakeholder had different views about the forces of change, the Disruptive Technologies at play and the cost-benefit analysis of Disruptive Innovation. The confusion in these debates is due partly to the disjuncture between Disruption and earlier traditions of innovation thinking. David Ricardo's thesis on economic comparative advantage underpins much thinking on national innovation strategies. Early writing on economic globalisation emphasised Disruption as a generic force of change with geopolitical, socioeconomic and cultural impacts.²⁸ The contemporary work on Disruptive Technology more focuses on Joseph Schumpeter's 'creative destruction' mode.

Issues In Model Building and Theory Construction

1. *'Surfacing' Assumptions.* Each model and theory reflects its creators' biases, cognitive complexity and worldviews. A crucial aspect of model building is to understand the history and genealogy of its construction so that these hidden assumptions can be 'surfaced' and understood. This requires self-reflexivity by the practitioner and access to a knowledge base of the model or theory in question. For Christensen this may include Boston Consulting Group's culture and approach to client engagements, his DBA supervisor's intellectual interests, and the conceptual frames in econometrics.

An effective designer defines for the reader what his assumptions and simple rules are. Christensen outlined 5 Principles held by mid- and large-scale firms about Technology Disruption in *The Innovator's Dilemma* were:

1. Customer/Investor resource chokeholds
2. Small Markets block growth
3. Unknown Markets cannot be analysed
4. Capabilities define disabilities
5. Technology Supply may not equal Market Demand

Each of these Principles makes assumptions about capabilities, knowledge and strategic execution that Disruptive Innovation case studies and literature have challenged. Principles 1 and 2 prompt analysts to search for different resource flows, new market niches, and even to embrace the niche fragmentation that occurs in online ecosystems. Principle 3 holds true for fact-driven logical positivism yet not for Communication Futures and Foresight methodologies. Managers have looked to new frameworks—the Theory of Constraints in project management, the Agile movement in software engineering, and insights from Lean manufacturing—to workaround Principle 4’s assumptions. Finally, Principle 5 is always a challenge as firms escalate new products and services from niche to mainstream users.

2. The Diffusion and Legitimation Cycles. According to Jurgen Habermas, each model and theory goes through a legitimation cycle before it becomes part of accepted domain knowledge. The Dotcom era provided a crisis environment for incumbent firms and resources-starved ‘challenger’ start-ups which created greater receptivity to the ‘Disruptive Technology’ meme. Habermas warns that in such broader ‘legitimation crises’ for Western capital a model becomes reified as sociological propaganda rather than offering a single viewpoint.

3. The ‘Invisible College’ or Citation Network. The creators of famous models and theories can become part of an ‘invisible college’ which functions as a *de facto* elite and sets the boundaries of domain knowledge.

Common Misunderstandings About Christensen’s Disruption

The rapid diffusion and popularisation of Clayton Christensen’s work has meant that his work has been understood in different ways by different groups. This sections explores five common misunderstandings by critics and the media about Christensen’s research.

1. The Disruptive Technology meme.

Christensen’s *Innovator’s Dilemma* (1997) emphasised the role that technological artefacts had in Disruptive strategies. Although Christensen had defined technology in the generic sense of resources, processes and tools a firm may use, many business analysts and strategists interpreted this in a narrow manner. Consequently, much of the commentary on Christensen’s research is actually about a Disruptive Technology *meme*: a term coined in zoologist Richard Dawkins’ *The Selfish Gene* (1975) to describe the cultural software that replicates across our social ecologies of mind. The meme is promoted by magazines such as *Wired* and *Red Herring*; vendors like The Gartner Group and Ovum; and technology analysts like John Battelle.

Although Christensen also included a ‘value network’ model of competitive advantage, marketing and leadership, it was technology that was remembered by many analysts and interpreted in a determinist manner. This was also partly because Christensen’s major case study on the hard-drive industry had been adapted from his 1992 DBA dissertation at Harvard University.

The publication of *Innovator’s Dilemma* also coincided with the investor-led frenzy of the 1995-2000 Dotcom boom. Consequently, business analysis interpreted Christensen’s model in a technologically determinist context defined by *Wired* Magazine, MIT Media Lab’s Nicholas Negroponte, and Larry Downes and Chunka Mui’s competing ‘killer app’ theory.

The MBA and Computer Science emphasis on management information systems, also often technologically determinist, meant that *Innovator’s Dilemma* was understood to isolate the ‘high technology’ factors in opportunity screening and strategic execution. Several key ideas from *Innovator’s Dilemma* were widely diffused rather than Christensen’s more in-depth model. Nicholas Evans’ *Business Innovation and Disruptive Technology* (2003) exemplifies this approach.

This dominant ‘surface’ interpretation became a Disruptive Technology meme, a ‘cultural unit of information’ that was amplified by the Dotcom era and agenda-setting business media. Christensen acknowledged this after discussions with Intel’s Andrew Grove on business models, but it was too late to change *Innovator’s Dilemma* which had already been printed by Harvard Business School Press.

Therefore, the Disruptive Technology meme is primarily what IT specialists have discussed. The meme fits with earlier generation developers who looked to technology to provide what Fred Brooks calls ‘silver bullets’: technology-driven productivity gains that yielded ten-fold productivity increases. Enterprise Resource Planners and other vendors have promoted the Disruptive Technology meme to position their product and service offerings in the marketplace. This reliance on simplistic interpretations creeps into many texts: in discussing a ‘meme map’ for peer-to-peer technologies Tim O’Reilly mentions *The Innovator’s Dilemma* only once and fails to recount what Christensen actually meant by Disruptive.²⁹

2. Generic Market/Industry-level Disruption.

Christensen’s model in *The Innovator’s Dilemma* and *The Innovator’s Solution* has often been interpreted rigidly by business analysts at a market/industry level. This rigidity reflects the causal and static nature of many strategic models that are taught in MBA programs, which as Richard Pech, the Dean of La Trobe University’s Business School research program notes, provides an easily teachable pedagogy although they have been outdated by the fluid dynamics of business ecosystems. It also reflects the legacy view of mature industries in banking and finance, and manufacturing as slow-moving entities.

Two different views of the strategic landscape arose during the Dotcom era. The first viewed digitisation as a static force that disrupted markets and industries, a view reminiscent of the diagrams for Boston Consulting Group’s matrix and Michael Porter’s 5 Forces model. The second looked to biomimicry, the complexity sciences,

simulations and systems thinking for dealing with actor networks, emergent phenomena, uncertainty and high-velocity shifts. The first view prioritised top-down structure whilst the second preferred bottom-up agency and nested holarchies.

Many of the Dotcom era models acknowledged the limits of the first view yet did not have cognitive complexity to embrace the non-linear models of the second. Visa founder Dee Hock's 'chaordic' view and MIT professor Peter Senge's *Fifth Discipline* (1991) did. Christensen acknowledges Senge's work on mental models in *The Innovator's Solution*. Books such as Stan Davis and Christopher Meyer's *Blur: The Speed of Change in the Connected Economy* (1999) and Philip Evans and Thomas Wurster's *Blown to Bits: How The New Economics of Information Transforms Strategy* (2000) promoted models that lay in the transition between the static and complexity models.

3. Disruption is a relativistic process not a causal event.

In the Dotcom era Disruption was often compared with *A Perfect Storm*: a determinist change *event* that was inescapable and inevitable. This view suited the Dotcom investment climate and fitted with earlier business models. It continues to be the norm about how potential Disruptions are discussed.

Christensen has argued instead that Disruption is an unfolding process that is unrelated to incremental or other change modes. Christensen notes that firms must develop strategic capacities, processes and resources. In *The Innovator's Solution* Christensen details a model of internal opportunity screening and resource allocation by mid-level managers. This places Christensen in a strategy lineage that includes Rosabeth Moss Kanter and Gary Hamel.

Christensen's doctoral supervisor created the 'value network' model of firm relations in a market. One implication Christensen drew from this was that Disruption impacts on firms *relative* to their value network position. Therefore, if Disruption is viewed structurally it can be both pattern and antipattern to a firm depending on this position.

4. Disruption is a continuous and persistent process.

The 1995—2000 Dotcom era reinforced analysts' perceptions that Disruption was continuous and persistent. This remains the prevailing view amongst IT experts about Disruptive inter-firm competition and market forces. Christensen addressed this misconception when he notes that his Theory of Disruptive Technological Change is neither incremental nor radical.

Disruption is often equated with 'killer apps' and end-user technology adoption. This radical view is dominant because many technological innovations—TCP/IP, Graphic User Interfaces, Web browsers, distributed search and hyperdistribution—have had dramatic effects that mirrors Christensen's New-Market Disruption. Yet instead of being continuous and persistent, this Disruption pattern is actually closer to Ernst Mayr and Stephen Jay Gould's 'punctuated equilibria': there are long periods of incremental innovation followed by sudden and tumultuous shifts. New-Market Disruption processes trigger emergent effects in the knowledge economy.

Christensen's research reframes this technological determinist account by alluding to the crucial roles of user-centred design, the 'pull' of end-users, and the firm's processes and resources. In this holistic view technology was one important element of a larger picture that also included conceptual design and end-user functionality.

5. *Disruption is synonymous with Digital Darwinism.*

The rapid expansion of IT financial markets in the 1995—2000 Dotcom boom created a sociological side-effect: the emergence of Digital Darwinism as a justification for the Schumpeterian 'creative destruction' that was reshaping the US economy. Digital Darwinism was depicted books such as Evan Schwartz's *Digital Darwinism* (1999); in Dotcom era magazines that included *Business 2.0*, *Fast Company* and *The Industry Standard*; and in the rise-and-fall of marchFIRST and Razorfish consultancy firms.

In retrospect Digital Darwinism was the ideological choice of analysts who were building the first conceptual models of the digital ecosystem. Key themes included business rules for the new environment, the business process reengineering of supply chains, and shifts in business-customer relations. Schwartz and others reflected one view of Christensen's New-Market Disruption. Yet their ideology was closer to Herbert Spencer's crude Social Darwinism than Darwin's *The Origin of Species* (1859). In reality, it was simply an extension of the Mergers & Acquisitions mania and downsizing that swept Wall Street in the late 1980s and early 1990s. Just as the leveraged buyout of RJR Nabisco depicted in Brian Burrough and John Helyar's *Barbarians At The Gate* (1991) became symbolic of the 'greed is good' decade, the high-profile implosion of marchFIRST and Razorfish took Digital Darwinism to its logical nihilistic conclusion.

6. *The April 2000 Dotcom Crash ruined Christensen's reputation.*

As Dotcom era entrepreneurs adopted his early models Christensen became identified with e-business strategies. This public image was carefully cultivated by Harvard University and agenda-setting business press such as *BusinessWeek*, *Forbes* and *Fortune*. Some critics of Christensen contend that the April 2000 Dotcom Crash has ruined Christensen's reputation.

In fact Christensen survived the Dotcom Crash with his reputation largely intact: Harvard Business School Press has continued to publish his books, the consultancy Innosight has grown, and Christensen still receives major press coverage. This is partly because Christensen was more rigorous in his model construction and more cautious in his claims. Many of the other models that failed were overoptimistic in their revolutionary fervour—or were conceived as 'challenger' manifestoes by consultancies such as the Boston Consulting Group to digital consultancies.

The allegations may also stem from critics' confusion of Christensen with technology pundit George Gilder. Gilder evangelized about the paradigmatic impact that 'last mile' broadband would have on the US telecommunications network in the books *Microcosm* (1989) and *Telecosm* (2000). Yet Gilder's techno-futuristic vision failed to pass due to US regulatory barriers, slower than expected uptake, and 'last mile' problems. Gilder's investment advisory service had problems and his reputation reached his nadir with GlobalCrossing's collapse. Gilder's most recent book *The*

Silicon Eye (2005) is a more cautious study of Foveon, a company using innovation processes to develop a prototype digital eye for computers and mobile phones.

7. Disruption is primarily about IT-driven technologies and ‘killer app’ solutions.

Clayton Christensen’s models are often perceived by analysts as focusing on Disruptive Technology and ‘killer app’ solutions. This interpretation overlooks the latter half of *The Innovator’s Dilemma* and *The Innovator’s Solution* where Christensen focuses more on managerial decision-making and resource allocation. Christensen’s counterintuitive insight was that good companies missed ‘disruptive’ opportunities because they prioritised the needs of core customers rather than those in emerging markets. The short-term emphasis for maximising profit means that managers allocate resources to projects that meet these customers’ needs, rather than ‘disruptive’ projects that would create new markets.

Debates on the Disruption Model

Christensen’s insights have sparked intensive debates about his models. Christensen is adamant that models and theories are guides to business decision-making, and necessary as conceptual tools for reality-testing. This perspective shows a post-positivist understanding of the relationship between theory and action,

Intel’s Andrew Grove was one of Christensen’s earliest supporters. Grove cross-compared Christensen’s early model with his own work on 10x “strategic inflection points” which radically restructured industries and markets.³⁰ Christensen has recounted how Grove attended a seminar, and successfully argued that the technological determinist focus of *The Innovator’s Dilemma* was wrong, and that the real issues were about managerial mindsets, business models, and adaptation failure. A reliance on the best customers and profit margins created a trap for decision-makers, even if their engineers were aware of and able to build new technologies.³¹

The early Disruption model parallels other influential analysts. Christensen’s focus on discovering the right customer echoes Geoffrey Moore’s ‘chasm’ distinction between visionaries/early adopters and the mainstream.³² He suggests that products that integrate User-Centred Design insights can ‘cross the chasm’ far easier. Christensen’s model of competition is closer to manoeuvre explanations rather than static forces.³³ Other analysts have extended Christensen’s initial insight and clarified its limits. The Disruptive Technology meme emphasises Disintermediation and Reintermediation strategies, although these are only two of over 20 patterns that have been identified.³⁴ Controversially, John Dvorak contends that Disruptive technologies do not exist, and that Christensen’s viewpoint is a ‘false premise’ used to confuse decision-makers.³⁵

New Academic Research

Harvard University’s support has made Christensen the exemplar of Disruption research. However subsequent academic research has suggested some new possibilities. The shift of Disruptive Innovation research from Harvard University to MIT highlights the critical role of research laboratories and universities on the social

diffusion of new Internet models. It suggests a growing community of practice that may play an integral role in developing new business models.

The Management of Technology Program at Massachusetts Institute of Technology has published several Masters and PhD dissertations on Disruption since 2000.³⁶ Several dissertations expand Christensen's generic categories to include customer behaviour, product attributes, and down-market migration. This research alludes to the links between Disruption and User-led Innovation. Other dissertations apply Christensen's Theory of Disruptive Technological Change to case studies not explored in his books, such as the aviation and microprocessor industries.

MIT's IT courses have explored implications of Disruptive Technology that Christensen failed to do in his early work. MIT postgraduate students have looked at switching costs, user-centred design and customer innovation perspectives. This has filled in some major gaps in *The Innovator's Dilemma* and popular media narratives on the Disruptive Technology meme. Some of the major insights include:

- Aiping Guo contends that 'disruptive customer switching' is the key shift rather than new technologies.³⁷ Guo was amongst the first of Christensen's students to prioritise the disruptive power of customer 'pull' over vendor-driven technology 'push' factors.

Christensen's later books also illustrate the Medieval Guild and European Master models of academic scholarship, where a student begins as a novice at the feet of a master, then becomes a journeyman practitioner. Christensen co-wrote *The Innovator's Solution* (2004) and *Seeing What's Next* (2005) with colleagues and former students who counterbalanced his theory-creation strengths with relevant case studies and industry insights.

Christensen's former student Michael George made a major contribution to Disruptive Innovation with his book *Fast Innovation* (2005). George developed the optimal organisational structure for Disruptive Technology innovation.

Finally, communities of practice have made explicit links between Disruptive Innovation and their own body of knowledge. Communications Futures practitioners have adopted the Disruptive Technology meme for use in scenario planning and technology foresight exercises. Lean management practices developed by 3M, General Electric, Toyota and others also have similar underling assumptions on resource allocation to Disruptive Innovation. These communities of practice will hopefully take Disruption research into new problem domains and embody its practices. The Smart Internet Technology CRC is one such community of practice.

A Smart Internet Technology CRC Critique

Five criticisms about Clayton Christensen and Disruptive Technology have been debated in the Smart Internet Technology CRC. This section summarises these criticisms and suggests strategies to move forward.

First, Christensen's Disruption research needs to be differentiated from Dotcom era buzzwords and other strategy analysts who argue for all-encompassing macro-level

models. As this Report explores the Disruption domain has complexities and misunderstandings. Without a solid conceptual foundation—that encompasses academic theory-making, action learning and corporate strategic execution—Disruption risks becoming just another buzzword like ‘information superhighway’ and ‘clicks-and-mortar’ infomediaries. Web designer Jeffrey Zeldman notes that Tim O’Reilly’s promotion of Web 2.0 has likewise created a meme and advocacy subculture that differs from the technological artefacts involved.³⁸

Second, this differentiation means there is variance between the ‘Disruptive Technology’ meme and embodied Disruption knowledge. Forecasts about the Disruptive potential of emerging technologies—hyperdistribution, the Open Source movement, ‘last mile’ broadband uptake, peer-to-peer networks, and virtual game worlds—often differ from the second- and third-order effects that actually occur. Many of these technologies and Tim O’Reilly’s Web 2.0 proposal have nonlinear properties that hybridise both Disruptive and Sustaining properties.

Third, there is internal debate with in the CRC about Christensen’s analysis of the competitive space. Dotcom era interpretations aligned *The Innovator’s Dilemma* with ‘first mover’ strategies. Consequently, other analysts with a narrow interpretation have focused on Disruptive technologies and examined how industry incumbents could defeat ‘challengers’. Constantinos Geroski and Paul Markides’ *Fast Second* (2005) exemplifies this approach, although Christensen criticises the authors in *Seeing What’s Next* as having a shallow understanding of Disruption as an event rather than a process. Therefore, competitive and strategy models need to shift from their traditional emphasis on static forces to a more dynamic outlook. Three examples of this direction are Richard D’Aveni’s signalling and counter-moves model in *Hypercompetition* (1994) which predates Christensen’s research; Andrew Grove’s identification of ‘strategic inflection points’ in *Only The Paranoid Survive* (1997) which supports Christensen; and Adrian Slywotzky’s analysis of inter-firm shifts in *Value Migration* (1997). The Nobel Prize work by George Akerlof, Michael Spence and Joseph Stiglitz on asymmetric information in markets also has implications for Disruption that Christensen has not divulged yet.

Fourth, fusion of these vanguard thinkers—Christensen, D’Aveni, Grove and Slywotzky—enables business strategists and policymakers to more realistically model their industry’s competitive space. One leadership challenge is to integrate these frameworks within firms in a distributed manner to enable real-time opportunity detection.³⁹ Yet although Christensen acknowledges resources and processes in *The Innovator’s Solution* further integration is required to deal with barriers within the firm⁴⁰ and unanticipated impacts by external players.⁴¹

Fifth, although Christensen has moved away from being technologically determinist, his theory lacks a deeper integration of change, dynamics and systems characteristics. Christensen’s early Disruption patterns—Low-Cost and New-Market—were essentially adaptations from similar distinctions made in Porter’s 5 Forces and earlier strategic literature. Christensen’s work stands in transition from traditional ‘static’ business models to the dynamic, holonic and multi-dimensional models that will be required for contemporary adaptive enterprises.

Implications For Commercialisation

Christensen's Disruption types and the Disruption categories in this Report have clear implications for commercialisation and innovation processes.

Disruptive Innovation is a pivotal theme for many models of industry evolution. What is less understood is that Disruption emerges on the analyst's radar at specific periods of diffusion and industry growth. Debora Spar's four-phase model of technopolitical diffusion suggests that Disruption emerges as a major theme during the 'Creative Anarchy' phase when innovators and corporations battle over legal rules and standards.⁴² This can be seen in the peer-to-peer debates over how Napster, Grokster, and Kazaa were used for illegal music downloads. Siva Vaidhyanathan contends that analysts have over-focused on 'online' and 'technology' rather than the second- and third-order disruptions that this battle creates in our everyday lives and societies.⁴³

Christensen's work has some crucial implications for managers, product developers, and strategic planners. The search for Disruptive markets and technologies must be linked to a real-time opportunity scanning systems.⁴⁴ This needs to be decentralised within the CRC as a commercialisation mindset shared by developers and researchers. Execution must be a strategic 'core competence' to ensure the best commercialisation outcomes for the CRC's intellectual capital.⁴⁵ Christensen's warning that many industries go through predictable migrations in their value chain highlights the importance of pattern recognition.⁴⁶ A "disintegrating industry" does not necessarily mean an organisation's demise.

Christensen has urged in his articles, books, and seminars for managers to have familiarity with case studies of marketplace disruption and execution failures. These include RCA's targeting of wrong customers for its transistor technology; Kodak's failure to shift from film to digital cameras; Xerox PARC's execution problems; Digital's misreading of the PC market; and current innovators such as NTT DoCoMo, the University of Phoenix's online business courses, Intel, Southwest Airlines, and Voice over Internet Protocol. In each case the incumbents had strategies that created insurmountable technical hurdles. Recent work on 'fast second' strategies offers new hope for incumbents in mature industries.⁴⁷ Others have opted for the acquisitions strategy, such as Rupert Murdoch's purchase of MySpace.com, and eBay's purchase of Skype.

Another overlooked point is Christensen's distinction between Disruptive Technologies, business paradigms and incremental innovation. Small markets that signify emerging business paradigms are ignored because they appear irrelevant to current revenue generators. Yet if these small markets show resonance, information fidelity, and have a core group of influential consumers, they may trigger perception changes in the marketplace.⁴⁸ This can be seen in Amazon.com's shift from 'chasm' marketing to 'long tail' strategies with data-mining analytics. It can be seen in the success of new Internet services—such as Google, the MySpace.com community, and Six Apart's Movable Type blog publishing system—which all provide user-oriented functionality that helps them to cope with change and uncertainty in high-velocity environments. Christensen explains that although many analysts have discounted the

Open Source movement, its Low-Cost strategy is successful due to displacing the Wintel axis in the PC market.

Disruptive Service Models

Several business models have become dominant in the post-Dotcom era. The growth of these models signifies a re-evaluation of 'killer app' technology and a more holistic outlook. The most successful are hybrids that recombine Christensen's Disruptive and Sustaining needs in new ways to reframe the strategic landscape. Future growth areas will include the development of Disruptive Ecosystems and Disruptive Service Models.

· *Services Sciences*: Louis Gerstner's turnaround of IBM in the mid-1990s shifted its emphasis from manufacturing to innovative services. Gerstner signalled this revamp by purchasing PwC Consulting for US\$3.5 billion in July 2002.⁴⁹ His successor divested IBM's personal computer unit to China's Lenovo in 2005. Gerstner's new direction was to synthesise Business Process Reengineering, modular Object-Oriented thinking and Web Services architecture into a Services Science brand.

IBM's strategy exemplifies New-Market Disruption as a paradigmatic reframe of the strategic landscape. Gerstner's analysts understood that New-Market Disruption requires a coherent philosophy and strong conceptual basis to influence end-users. IBM's implementation of the Services Science perspective spans philosophy, services, and strategic execution.

· *Service Oriented Architecture (SOA)*: SOA is a platform for modular reusable applications that can be recombined, rather than developing custom separate applications. Vendors have touted SOA's flexibility to workaroud the technological limits of legacy systems and past vendor solutions. Analyst claims for SOA's next-generation impact echoes similar claims made for the first generation of Business Process Reengineering in the early 1990s.

SOA's uptake is being driven by the growth in business process modelling and Extensible Markup Language (XML). Analysts believe the SOA and XML combination will enable companies to capture value-creating processes at the business logic layer for data warehouses and metadata management. Consequently, SOA-empowered companies would be able to create New-Market Disruption opportunities in their business ecosystem. Further research needs to be conducted on the interface between Disruptive Innovation processes and SOA.

· *Social Ecologies*: The growth of Social Networking Software (SNS) has created an Internet social ecology that is an integral part of Tim O'Reilly's Web 2.0. Social Ecologies are a 'Hybrid' Disruption: they provide Low-Cost content for Internet portals and New-Market niches for blog publishing systems and 'star' bloggers.

Yahoo! has followed the most high-profile market New-Market Disruption strategy in the Social Ecologies space, which it dubs Social Search as the 'killer app'. Its first initiative was the Yahoo! 360 service that acquired insights from danah boyd. Yahoo!'s recent acquisitions include the photo site Flickr (March 2005), the social bookmarks site del.icio.us (December 2005) and the online music community Webjay

(January 2006). This is a counter-move against Google's market dominance and competing services such as MSN Spaces.

'Star' bloggers have gained eye-balls since Matt Drudge ignored a media embargo and leaked the Monica Lewinsky scandal. Nick Denton's Gawker has used freelancers, subject-focused blogs and salacious gossip to build an extensive and profitable network.⁵⁰ Denton is regarded as the first post-Doctcom entrepreneur to successfully monetise blogs into a revenue stream. Despite this success Denton has recently faced barriers. Wonkette's founder Ana Marie Cox resigned in January 2006 to pursue 'old media' publishing interests. Denton's UK-based gadget blog Gizmodo has also filed for bankruptcy in Europe.

BoingBoing is one of the most successful blogs on digital culture and technology. BoingBoing transformed from a zine to a high-traffic non-mainstream portal. It leveraged a well-known team—Cory Doctorow, Mark Frauenfelder, Xeni Jardin and David Pescowitz—under the guidance of *uber*-technology analyst John Battelle. All have links to other institutions, a long history of involvement in digital culture issues, and are 'thought leaders' on Open Source and Web 2.0 topics.

· *Virtualisation*: Large-scale networks have created pressure on organisations to control costs and leverage resources. Virtualisation enables firms to deploy these resources without vendor lock-in or large-scale ERP rollout. This is a Low-Cost Disruption that delivers cost savings in hardware and management. Virtualisation has been adopted in test and development environments: it 'crossed the chasm' when x86 servers and management tools for disaster recovery became available. Virtualisation has created demand for new products—new rack and virtual servers—and new business models such as enterprise virtualisation.

· *Agile-Lean Development*: Christensen's insights on enterprise-wide innovation processes parallel the growth of the Agile movement in software engineering and the adoption of Lean methodologies from manufacturing. Michael L. George, one of Christensen's most significant students, has also made explicit links between Lean methodologies and capacity-building for Disruptive Innovation in his book *Fast Innovation* (2005).

Section 3: *Applying Christensen's Research on Disruptive Innovation*

Introduction

Unlike other popular management approaches—Disney, Toyota's production system, Peter Senge's systems thinking and Peter Block's consulting—Clayton Christensen does not have a popular fieldbook available on implementation. Instead, his consulting firm Innosight offers a range of case studies, journal articles and Internet webinars. A recent Harvard Business School monograph offered an appendix on Disruptive Technology and opportunity evaluation.

This chapter offers some guidance from Christensen's writings on practical applications and his Innosight webinars. It offers some preliminary suggestions how how Christensen's insights on Disruptive Technology and Disruptive Innovation may be applied to various problem domains. *The Innovator's Dilemma* (1997) popularised Christensen's work in the IT domain. The implementation guidance below suggests that Christensen can be applied in other problem domains: business strategy, knowledge creation, information systems and new methodologies.

1. Business Strategy

Project Portfolio Management

The combination of Disruption and project portfolio management is an invaluable flywheel for selecting the right projects to undertake. Disruptive Innovation and Disruption Thinking provide explicit ways to draw out program management and resource allocation issues. The various Disruptive Technology models can address an R&D project's likely impact: the underlying technologies, the chosen systems architectures and the likely customer niches for R&D prototypes.

The Disruption frame explicitly relates functional requirements, the technology system and resources issues to program management. Programmer Edward Yourdon notes that firms who fail to undertake this analysis at the requirements gathering and project initiation stages will endure Death Marches: high-profile initiatives with serious budget and estimation limits.⁵¹ Yourdon regrets that Death Marches are the norm in the IT industry, and especially so for Disruptive Technologies that are often created in skunkworks-like conditions. Counter-intuitively, the bid to create a viable Disruptive Technology is a long-term proposition that can be resource intensive. It will need to establish a viable New-Market niche and fend off initial counter-moves from potential competitors. Clayton Christensen and Edward Yourdon's models both highlight the importance of organisational politics and resources allocation in successful projects. Ironically, Death Marches and 'project rescues' are how Disruptive Innovation is conceived and misunderstood in the IT industry.

Disruptive Innovation adds a new frame to traditional portfolio tools such as Boston Consulting Group's influential 'BCG Box'. In BCG's system the Disruption frame can assist managers to distinguish between projects that are Stars (high-growth and high-market share) and Question Marks (high-growth and low-market share). Disruptive Innovation is more slanted to medium/high risk and high-yield projects

that require long-term investment and risk buffers. The portfolio mix can be balanced according to OPEX (operational expenditure) and CAPEX (capital expenditure) risk profiles. This allows project sponsors and analysts to hedge their bets on the likelihood of marketplace success.

Each of Christensen's major categories—Sustaining, Disruptive and Modular innovations—could be used to screen projects at the gate stage. This is when Christensen's triad of Resources-Processes-Value can be applied. Its specific applications include the weighting of individual projects in a portfolio; to identify resource synergies between projects; to select the best project life cycle for client delivery; and to align scope with delivery time. As part of assessing go/no-go criteria, managers should ask: 'Does this project and its systems infrastructure meet Christensen's criteria for a Disruptive Technology?' Organisational learning and quality issues on Disruptive Innovation projects also demand that a robust After Action Reviews (AAR) process be used for post-project closure.⁵²

3M, General Electric, Eli Lilly and other firms have recognised this strategic insight in developing their in-house innovation processes. This track record shows that Disruption is not purely the domain of Internet start-ups or entrepreneurs: it has a valid place in incumbents and mature markets, as part of a firm's strategic repertoire. The different Disruption categories provide a way to evaluate the commercial potential for projects and the resources demanded for research-to-market commercialisation.

Product Development and Innovation

The new strategic landscape is fluid and dynamic. Steve McConnell contends in *Professional Software Development* (2002) that his Gold Rush model is a recurring trajectory or vector for the IT industry. McConnell's thesis is an apt description of how industry trends create the illusion of a 'killer app' Disruptive Technology. This model also illustrates that Fred Brooks' famous warning against 'silver bullets' applies to the majority of Disruptive Technologies. Rather, firms are adopting the 'evolutionary prototyping' practices in McConnell's *Rapid Development* (1996) to deal with commercialisation issues where practice trumps theory.

Christensen warns that a focus on core customers only can create blind-spots to Low-Cost and New-Market strategies. Christensen's categories are also useful to identify gaps between customer needs and industry/market solutions that could erode leadership in product and service innovation. Disruptive Technologies can be used as a filter to assess the competitive advantage and market positioning of new product development. Competitive advantage techniques can extend this into patents, reverse engineering of prototypes, and wind-tunnelling of projects.

Increasingly, game theory and systems thinking are being used instead of 'static' business models for innovation analysis. These tools enable analysts and managers to model the competitive counter-moves, signals, escalation possibilities and thresholds of competitors. They may be integrated into Business Intelligence tools. Because BI relies on publicly available information, it would critically evaluate the technology architectures and solutions of competitors, map out the dynamics of the strategic landscape as a potentially fluid ecosystem, and carefully analyse the public statements

made by leaders of competing companies and government policymakers. Other stakeholder sources include industry and professional associations, trade shows, and investor relations material provided to the Australian Stock Exchange and shareholders.

One significant gap in Christensen's work to-date is the lack of ratios and metrics for managerial accounting reports. Net Present Value and Payback Period fail to capture the unique criteria of Disruptive Innovation projects. George and others advocate Real Options pricing as one alternative that allows for real-time adjustments and variation.⁵³ Another possibility is Use Earned Value Analysis (EVA) to track project velocity and deliverables.⁵⁴

Process Mapping

Disruptive Innovation and Disruption Thinking can be applied to develop new solutions maps than competitors. Service Level Agreements are one example.

Process mapping is used to hone organisational capabilities and internal flows. External data in markets and value networks may be disruptive on these capabilities due to resource allocation and staffing issues. This can be considered in the following ways:

1. Sustaining and Disruptive technologies which trigger the shift for internal business processes. The development of Sustaining and Disruptive technologies will require shifts in processes and new synergies.
2. Disruptive Innovation engines may formalise process mapping as part of a broader agenda for business transformation. This is relevant for research-to-market commercialisation and rapid prototyping.
3. Disruption Thinking surfaces divergent assumptions and mindsets. It situates process mapping within two overlooked categories: enterprise ecosystems, and organisational cultures and systems.

Leadership

CEOs such as General Electric's Jack Welch, Apple's Steve Jobs and hedge fund maven George Soros are frequently portrayed in the media as being Disruption Thinking masters. Although a popular media narrative this was backed up in Jim Collins' exhaustive research for *Good To Great* (2001).

Scenario planning, simulations, war-gaming exercises and location based gaming are all used to provide experiential learning about angular and orthogonal Disruption conditions. Potentially, the heuristics identified for Disruptive Innovation by Christensen could be used to develop an expert system or neural net for different problem domains. Business models, processes and rules for case studies might also be extracted and refined, creating an evolving body of knowledge for leaders.

2. Knowledge Creation

Knowledge creation provides a domain to critically evaluate Christensen's models and their applicability to real-world business. Theory-Action-Review cycles from

action research offer one strategy: practitioners study Christensen's propositions and theories, apply them in business and consulting settings, then reflect on the insights and learnings that occur. In fact, Christensen has championed the importance of theory construction, the 'pracademic' value of domain knowledge and experiential learning, and the feedback value of belonging to an epistemic community. The Sears and Digital Equipment Corporation examples which open *The Innovator's Dilemma* also illustrate the 'knowing-doing gap' where the ability to intervene in real-world problems lags behind the awareness of those problems.

Disruptive environments generate cognitive complexity about forces of change and the need for pattern recognition. Therefore, this requires the Disruption practitioner to develop a critical distance self-reflexive awareness about forces of change. Chris Argyris and Donald Schon's double- and triple-loop learning, which surfaces and critically interrogates a practitioner's assumptions, can be invaluable. Action research principles hold long-term promise for maintaining the integrity of Christensen's research.

Managerial Training

Christensen's work has been adopted in MBA courses for IT project management and entrepreneurial innovation. In *Seeing What's Next* Christensen articulates the importance of theory-making for managerial skills and training. This echoes Daniel Kahneman's insights in behavioural economics on how filters and perceptions will influence if we conceive of something as a Disruptive Technology or not.

However, the exploratory nature of Disruption analysis is contrary to the data-driven models that are taught in most MBA courses. Christensen acknowledges the power of evidence-based management that relies on market intelligence, logic and financial scrutiny. Yet he also contends that because Disruption deals with unknown unknowns, the analyst must seek out different evidence. Henry Mintzberg has made independent criticisms of the MBA to Christensen in his book *Managers Not MBAs* (2005).

Other firms have adopted learning models from the European tradition of Teachers and the Medieval Guild distinction between novice, journeyman and master. Project management teams have adopted time-boxed iterations and 'after action reviews' at the end of each cycle for team and organisational learning. Problem domain expertise can also be shared across functional roles and the senior management team via pairing different staff to work on project iterations. Finally, team learning may use an incident such as the Kobayashi Maru sequence in *Star Trek II: The Wrath of Khan* (1982) where the team is set up to fail.

Creativity Techniques

Disruption Thinking is divergent and asymmetrical, two qualities that overlap with creativity techniques. Its structure of thought is close to Arthur Koestler's 'abductive' logic. Edward de Bono's idea of 'Po' or 'provocative operation' is also relevant: a counter-intuitive idea or juxtaposition used to advance thinking, and to open a space for new ideas, solutions and synergies. Therefore, because Disruption is a quality and mergers from figures/ground relationship, its practitioners need to actively develop

the cognitive complexity to identify forces of change and their cross-impacts in the strategic landscape. At its core Disruption Thinking as a creative field asks: ‘Where do disruptive technologies come from? What makes them disruptive?’

Disruption Thinking may have cognitive and neurobiological bases related to cognitive complexity. Books such as *Clockspeed* (1998) apply chronobiology metaphors and models to Disruptive Innovation. Two relevant models on cognitive complexity are Howard Gardner’s concept of multiple intelligences and Mihaly Csikzentmihalyi’s pioneering research into ‘optimal’ states of psychological experience. Csikzentmihalyi’s research into flow states and creativity suggests these states of consciousness can be an individual buffer against the shock of Disruptive Technologies.

Some key creativity techniques for Disruptive Thinking include:

- Edward de Bono’s Lateral Thinking and Six Thinking Hats (www.edwarddebono.com and www.sixhats.com).
- Tony Buzan’s Mind Mapping (www.mind-map.com)
- William J.J. Gordon’s Synectics (www.synecticsworld.com/)
- Paul Monk’s Argument Mapping (www.austhink.com).

The techniques also support innovation processes such as brand positioning, new product development and negotiation. They can provide an anchor or goal for lateral thinking and other techniques that would otherwise drift.

Daniel Pink’s work on the compelling stories we tell about new innovations, and Dean Kamen’s Segway human transporter show how Disruption Thinking can underpin Disruptive Technologies. Polymaths such as David Bohm, Brian Eno and Buckminster Fuller exemplify how this can be embodied.

Many IT firms have adopted creativity techniques during interviews to probe for cognitive creativity, adaptability and learning styles. Microsoft’s interview tests for problem solving are explored in *How Would You Move Mt. Fuji?* (Little Brown and Company, New York, 2005). The scanning strategies used by Disruption practitioners may also be potentially correlated with tools such as the Enneagram and Myers-Briggs systems.

Digital Continuity

For some analysts, Disruption Thinking is inherent in the Internet’s decentralised infrastructure. Legacy systems and rapidly changing software formats have created Digital Continuity as a new field. Digital Continuity deals with how to ensure these formats can be retained and reused with new platforms.

Design Aesthetics

Design aesthetics is a key Disruptive Innovation at the intersection of the emerging arts and sciences. Design aesthetics has been crucial for innovation as a hybrid and interdisciplinary practice, such as Donald Norman and Regis McKenna’s work on Apple’s Macintosh computers. It offers a way of thinking about Disruption using

different multiple intelligences than verbal or mathematical. Design can make explicit the flywheel and innovation engine process, and it raises awareness of globalisation and forces of change.

For many, David Carson's jarring typography in the early 1990s for *Raygun* and *Wired* Magazines defined a West Coast sensibility about the Dotcom era. Bruce Mau and Rem Koolhaas have applied architectural and design criteria to understand how large-scale systems can manage Disruption. Dee Hock's 'chaordic' model for VISA's global network illustrates how Disruption and design aesthetics can intersect with complexity and creativity. This shifting between different problem domains and abstract models requires cognitive complexity.

Finally, Wurman and Thackra highlight how the ambient design of digital ecosystems can create an immersive environment to cope with cognitive complexity. Wurman's *Information Anxiety 2* also shows that there can be distortion fields around ideas that lead to misinterpretation. Wurman's thesis provides one explanation for why Christensen's Theory of Disruptive Technological Change has been misinterpreted by others.

Science and Technology Studies

Science and Technology Studies has several areas that flesh out Disruption Thinking. First, the promise of evolutionary systems architectures— Charles Babbage's Analytical Engine, Vannevar Bush's memex, and Ted Nelson's Xanadu—that function as a social image and 'pull' of the future for Disruptive Technologies.

Second, STS and the risk sociology of Ulrich Beck, Zygmunt Bauman and Anthony Giddens provides a more solid epistemological and ontological foundation to consider Disruption issues. The literature on complex socio-technical systems, such as Charles Perrow's *Normal Accidents* (1984) on risk management and post-mortems, is directly relevant to Christensen's work. Third, as Thomas Hughes articulates in *Rescuing Cassandra* (1998), projects have grown in complexity, scope and stakeholders from the Atlas rocket system to the Boston Artery Tunnel.

Finally, Christensen does not explore the idea—articulated by Ted Nelson, Douglas Engelhardt, Belinda Barnet and others—that technology has its own mutative and evolutionary trajectory that differs from human agency and influence. This would provide a radically different way to understand Disruptive Technology.

3. Information Systems

Object Oriented Analysis

Object Oriented Analysis and Development (OOA/D) is a powerful paradigm of software development. OOA co-emerged with Fourth Generation Languages and Computer Assisted System Engineering (CASE) tools. In the early 1990s Peter Coad, Grady Booch and others developed OOA methodologies and software tools.

The different Disruption models outlined in this Report may provide OOA cases and rules for design. The analyst can use Disruption models to prioritise business needs,

gather technical requirements and consider the broad level architecture in general terms. The developer may identify constraints and limits on the architecture if ‘wind tunnelling’ using the Disruption models.

Requirements Analysis

Christensen’s ideas point to why the Requirements Analysis process must tap into divergent insights. Currently, analysts use a range of methods from user interviews to systems walkthroughs to identify potential innovations. In the 1960s IBM developed Joint Application Development (JAD) as a way to use co-located teams to gain divergent insights. They can filter the initial Requirements Analysis phases of the generic Systems Development Life Cycle (SDLC) in a project.

Technology prototyping and waterfall project management rarely considers user inputs until too late. The gap between product features and actual customer requirements is also significant: it partly explains why innovative products may be rejected at first by mainstream customers. The focus on high demands of early adopters creates an equally high price margin for immature technology that does not yet satisfy mainstream user requirements.⁵⁵ Christensen criticises analysts who frame New-Market Disruption as due to deficient technologies rather than being a better functional fit with the right customers. Instead he looks to personal fabricators as a key model in the near-term future: ‘Fab is a place where the money is made, if made fast.’⁵⁶

Disruptive Innovation can reinvigorate the Requirements Gathering process for software development projects. It will shape all phases of the System Development Cycle (SDLC) used as a framework, and its variants:

- **Planning:** project scope and tasking. Disruptive Innovation requirements gathering will have different customers to the usual reliance on lead users.
- **Analysis:** the distinction between Functional and Technical requirements; the types of users who are interviewed; the integration of Disruptive Innovation with business processes; researchers as domain anthropologists; tacit to explicit knowledge transfer; critical self-reflection by Requirements Gathering practitioners. Disruptive Innovation is integrated into the tasking stage of requirements analysis whilst Joint Application Development formalises it in group settings.
- **Design:** domain modelling and architectures. Christensen’s view on technology is often shaped by his focus on the systems architecture layer. Christensen’s recent interest in the Open Source software movement led to development of the Modular strategy.
- **Implementation:** diffusion of innovation, organisational dynamics

The fusion of the Resources-Processes-Values model and SDLC phases is crucial for resources allocation on a project. The RPV model also supports the decision by developers to use iterative-incremental workflow processes, or Rapid Application Development, in combination with SDLC images.

In requirements analysis, Disruption Thinking has several potential applications. Identification of divergent use cases and user stories can help to identify user-driven innovations. In testing, Disruption Thinking can work with software applications to uncover potential bugs in unit and integration testing.

4. New Methodologies

Discovery-based Planning

Clayton Christensen's most recent book *Seeing What's Next* (2004), co-written with Scott Anthony and Erik Roth, provides a Discovery-driven Planning model of how to monitor industries for emerging technologies and potential competitive shifts. It is a more exploratory approach to strategic thinking than predictive methods. Discovery-driven Planning provides a frame to define the 'force of change' and 'weak signals' at the markets and industries level.

The exploratory nature of Discovery-based Planning means that truly Disruptive strategies cannot be didactically created in advance. They emerge through requirements analysis, domain modelling and dialogue with cross-functional stakeholders. However, case studies in Disruptive Innovation can be used to model the dynamics and trajectories of industry evolution.

Disruption Domain Modelling

Disruption Domain Modelling (DDM) is a new methodology under development in the Smart Internet Technology CRC. DDM combines the Disruption categories and types in this Report with insights from IT domain modelling and the software patterns community to understand business ecosystems and to capture reusable solutions to domain problems. Clayton Christensen's research has primarily focused on IT architectures and the Disruptive potential of specific technologies. DDM reframes this approach in terms of domain models and pattern languages, also providing a framework for Service-Oriented Architecture repositories.

DDM draws primarily on the work of Christopher Alexander, Martin Fowler, Eric Evans and David West in domain models and pattern languages. Each has made key theoretical and practical contributions: Alexander on the codification and epistemology of pattern languages; Fowler on domain modelling and code refactoring; Evans on model-driven architectures and ubiquitous language; and West on domain anthropology and hermeneutics. Collectively, these practitioners and others provide industry-tested frameworks to capture knowledge and reusable solutions. The combination of Disruption categories and types, domain models and pattern languages promise to expand the applicability of Disruption Thinking as a problem-solving heuristic.

Smart Internet CRC Recommendations

Recommendation 1: *The Smart Internet Technology CRC should adopt the three Disruption types outlined in this Report as part of its strategic repertoire.* Disruption is crucial to surfacing the assumptions, blind-spots, drivers and implications in the CRC's strategic program. It is comparable to Edward de Bono's 'black hat' thinking, Donald Rumsfeld's distinction between 'known unknowns' and 'unknown unknowns' and the institutionalised use of alternative analyses within the intelligence community.

Once its counter-intuitive and divergent role is acknowledged, the Disruption types have pragmatic outcomes if senior management is receptive to its application in decision-making and program evaluation. Disruptive Technology models can assess R&D projects; Disruptive Innovation is a vital core competency for commercialisation; and Disruption Thinking provides long-term capabilities for creativity and value creation. Each Disruption type provides a filter to understand why common risks—management by exception, non-compliance, failure to meet deadlines and budget blow-outs—may be occurring.

Recommendation 2: *Disruptive Innovation framing will enhance the Smart Internet Technology CRC's project portfolio management and its evaluations during project gates.* At senior and program manager levels Disruptive Innovation can help to identify priorities, resources and cross-program synergies. Project gates can use the various Disruptive Technology memes to assess the commercialisation potential of R&D prototypes. New business models, processes and rules are often required for R&D prototypes to be commercially sustainable. Financial metrics such as Earned Value Analysis (EVA) and lean management's Burndown charts would also enhance the CRC's accountability and transparency to relevant stakeholders. Given the IT industry's history of high-profile project failures, this is an opportunity for the CRC to develop global 'thought leadership' in Value-Based Management metrics and reporting.

Recommendation 3: *The Smart Internet Technology CRC should cultivate Disruption Thinking via actionable 'minority reports' and business process redesign to enhance its organisational agility.* The CRC's centre of gravity and initial program design has had the negative side-effect of sometimes creating narrow interpretations, special interest groups and perceived biases in the resource allocation process.

The cultural effect is comparable to C.P. Snow's 'two cultures' distinction between the hard and social sciences. Stand-alone processes support a silo mentality. Although there is robust and detailed documentation, it is too 'heavy-weight' and may not reflect changing requirements and technology architectures. Tacit learning is currently restricted to individuals and not necessarily shared in teams or valued by the wider organisation. Approaches vary for the successful completion of projects. Disruption Thinking unapologetically invites stakeholders to confront reality rather than organisational myths and shibboleths, before it is too late for remedial action.

Three initiatives to overcoming the above problems are cross-functional teams; the deployment of Web 2.0 technologies such as blogs and wiki's for internal knowledge management and learning loops; and business process redesign of market intelligence, requirements analysis and organisational learning capabilities. Software engineering

initiatives that combine the most effective elements of the Agile movement, IBM's Rational Unified Process and SEI's Capability Maturity Model Integrated (CMMI) deserve further investigation. Aspects of these initiatives would also enhance the CRC's operational and strategic execution capabilities.

Recommendation 4: *Disruption Domain Modelling can enhance the Smart Internet Technology CRC's opportunity evaluation/screening and risk mitigation processes.* The popularity of Disruptive Technology theories has obscured the broader role of Disruptive Innovation in domain analysis and modelling. Domain Directors can hone the CRC's understanding of dynamic markets and industries via Disruption Domain Modelling which combines best practices from both areas. The potential applications are numerous: tailored strategies for CRC Partners; the recognition of non-traditional models such as user-led innovation; exploratory analysis using discovery-based planning and communications futures tools; and the early application of domain knowledge to requirements gathering/systems architectures for R&D prototypes. The CRC also has the opportunity to demonstrate 'thought leadership' by complexity/systems-aware simulations rather than

Recommendation 5: *The Smart Internet Technology CRC should deploy global best practices—such as evolutionary development, fast cycles, lean management and rapid prototyping—as an explicit flywheel for innovation flexibility and long-term value creation.* The Hawke Government's original design of the CRC system and 'blue sky' technology foresight was not conceived for the dynamic and fluid environment that IT research organisations must operate in. For CRC Partners, building a prototype in a 'pure' university research facility and then translating into a different commercial/organisational environment can be too disjunctive.

Consequently, this requires a new collaborative mode between the CRC research community and CRC Partners. An integrated development environment (IDE) is more viable if it combines market-aware researchers, optimised processes, action research methodologies, and tools for developers and project life cycles. This IDE would enhance researcher careers whilst also enabling CRC Partners to integrate lessons learnt into new product/services development and strategic counter-moves. A comparable shift is occurring in the MBA postgraduate market that embraces real-time learning and insights from the fine arts. By spearheading these capabilities, the CRC could also potentially reframe the Australian national debate on IT R&D futures.

Appendix 1: Modelling Clayton Christensen

This appendix offers a preliminary model of Clayton Christensen's influences and cognitive strategies. It draws primarily on Christensen's contributions to Disruptive Innovation, Robert Dilts' modelling of visionary geniuses,⁵⁷ and Jerrold M. Post's psychoanalysis of operational leader codes.⁵⁸ Further research needs to be conducted in this area.

Background

- Background in business development and policy-oriented strategic thinking
- Church of the Latter Day Saints as significant influence on moral outlook

Schools of Thought

- Primary exponent of discourse-building around Disruptive Innovation
- Boston Consulting Group industry outlook and methodologies
- The core capabilities school: Rosabeth Moss Kanter, Gary Hamel
- A precursor to Michael George's synthesis of Disruptive Innovation

Key Research Questions and Concerns

- Developing a new strategic vocabulary for Disruptive Innovation
- Understand why existing models have failed to account for change dynamics in the strategic landscape
- Apply the Disruptive Innovation lessons to intrapreneurship and new value creation
- Anomaly-seeking in case studies: why did mini-computer segment still fail with effective management?

Key Assumptions

- Disruptive Innovation practices can be modelled and understood in a variety of industry contexts
- Disruption Thinking is counterintuitive and an 'abductive' mode (Arthur Koestler)
- Model development must have a strong foundation in theory-generation

Strategic Thinking and Methodological Contributions

- Idea generation capabilities and ability to understand cognitive complexity
- Theory of Disruptive Technological Change
- Resources—Processes—Values model
- Discovery-based Planning model

Risk Communication Strategies

- 'Boundary-spanner' between academia and business: a model 'pracademic'
- Christensen oscillates between Dilts' Dreamer strategy to understand innovation strategies and the Rationalist strategy to communicate findings to a business or general audience

- Keynote talk and in-class seminar format allows for intense discussion of case studies (influence of Harvard Business School's case studies approach)
- Revises theories from business audience feedback (theory-action-review cycle)

Appendix 2: Disruption Patterns

In software engineering, designers and developers have turned to patterns—defined by architect and urban planner Christopher Alexander as “a three-part rule, which expresses a relation between a certain context, a problem, and a solution”—as tools to capture best practices and novel thinking. From its roots in object-oriented programming, the patterns community has expanded into architectural and enterprise-level designs and programming idioms, and to soft systems areas such as diffusions of innovation and organisational dynamics. Its popularisers include the Gang of Four, the Gang of Five, and the Hillside Group (www.hillside.net).

Anita McGahan’s *How Industries Evolve* (Harvard Business School Press, Boston MA, 2005).

Industry Evolution Patterns

- Progressive (retail)
- Creative (pharmaceuticals, film production)
- Radical (Federal Express)
- Intermediating (banking/financial services brokers)

Change Phases

- Fragmentation: shakeout, maturity, and decline
- Emergence: convergence, coexistence, and dominance

Appendix 3: Disruption Metrics

Disruptive Innovation requires the development of new Disruption-oriented metrics in commercialisation and financial reporting systems. Traditional accounting and financial systems provide an overview of the past yet have difficulties in dealing with critical uncertainties

- Earned Value Analysis
- Time-to-Market

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