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The Relationship Between New Technologies and Strategic Activities

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ABSTRACT

While “new technology” and “strategy” are pervasive and foundational to this journal’s inquiry, each term is filled with ambiguity. This paper seeks to extend our understanding by developing a model relating technology to strategy. The model is a two-by-two frame based on the distinction between ‘planned’ v ‘emergent’ strategy and ‘latent’ v ‘sensible’ technology. The frame generates four distinct domains which we label ‘development’, ‘capitalisation’, ‘creation’ and ‘cultivation’. The paper then considers the ‘creation’ quadrant through a case history of the stent industry. This case indicates that (a) new technologies lack the ‘revolutionary’ characteristic with which they are normally associated; (b) that the courthouse rather than the marketplace is an important if not primary domain where new technology firms compete; and (c) that new technology firms are much more aggressive when interacting with other new technology firms than they are with firms from the existing industry.

INTRODUCTION

The centrality of technology to strategy is illustrated by the range of contributions that focus on technology-based firms.¹ For instance, it is fundamental to Prahalad and Hamel's² 'core competency' work, as when they state that the 'real sources of advantage are to be found in management's ability to consolidate corporate-wide *technologies and production skills into competencies* that empower individual businesses to adapt quickly to changing opportunities'³. An implicit assumption here is that technology is not only *a* significant input into strategy, but that it is *the* significant input.

However, this significance mutates into confusion when the concepts are grounded in empirical world, where we find the same term used to describe what are quite clearly different situations. For instance, exploiting existing competencies in a new situation may be understood as a 'new technology', but so too is developing new competencies in an existing state of affairs.⁴ Prahalad and Hamel depicted the former in their description of how NEC, Casio and JVC took the skills and technologies in which they were expert, and applied them to different markets – the essence of the resource-based view – while an example of the latter is the replacement of diffusion technology by the ion implantation process within the semiconductor industry⁵. Or consider Ryanair's introduction of the internet to facilitate direct seat booking by passengers and Tesco's strategy of installing petrol stations in their parking lots. These might be considered as examples of the strategic leveraging of new technology, but this 'bolting-on' of an unrelated technology is conceptually problematic since it is easily copied, is not central to the firm's work, and does not improve the firm's core competencies in any meaningful way. In that sense, it is hardly a 'new technology'.

Another set of circumstances relates to the case of a new technology created and introduced by firms that do not compete in any standard way but ‘change the competitive rules of the game’⁶. Together, these examples highlight the nuances in the relationship between technology and strategy, which necessarily vary given the range of different circumstances in which it is examined.

The range of possibilities associated with technology-based competition needs to be clarified so that the circumstances associated with each may be investigated. In this paper, we develop a model to help classify the possibilities. We then focus on one new technology situation to demonstrate the framework’s application and usefulness. In brief, then, the research question driving the study is: ‘What constitutes a new technology and what strategies are characteristic of firms that create and introduce them?’

MODEL DEVELOPMENT

The terms ‘strategy’ and ‘new technology’ are what we might call ‘fat’ terms, in that they are pregnant with multiple and varied meanings. And when the terms are conjoined – as in ‘new technology strategies’ – the meaningful possibilities multiply, to the point of confusion. There is need for clarity, while still retaining a focus on the essence of both concepts.

We begin by considering the concept of strategy. An important discussion within the strategy literature is whether strategic action is the outcome of formal planning processes or whether it emerges in response to *ad hoc* opportunities and are only subsequently interpreted as part of a ‘strategic’ plan. This is the ‘planning’ versus ‘emergent’ debate. The planning perspective⁷ involves the use of SWOT analyses,

charts and other means of analysing and planning a firm's future path. Within the emergent strategy perspective the strategist is probably best perceived as a craftsperson⁸, constantly adjusting the strategy to take account of contingencies so as to maximise the organization's effectiveness. Both of these approaches attract considerable support and the dichotomy is central to modern strategic thought.

In the field of technology, 'radicalness' is a critical issue, though how exactly this characteristic should be measured is subject to much debate. One distinction is between 'disruptive'⁹ and 'sustaining' technologies¹⁰. The former offer a different package of attributes to those valued by existing customers (and which may under-perform on one or more of the dimensions most valued by them), while the latter improve the performance along existing dimensions. Others prefer terms such as 'evolved' and 'novel'¹¹, or 'evolutionary'¹², while others¹³ skirt the issue entirely by examining 'successive generations of... competing technologies'¹⁴.

Of course, these issues provoke substantial differences of opinion. Ehrnberg²¹, in her useful review of many of these antonymic pairs, states that technological change has variously been described as:

incremental vs. radical innovations; continuous technological change vs. technological discontinuity; technological evolution vs. revolution; evolution vs. breakthroughs; technological progress along a technological trajectory vs. technological paradigm shifts; etc (*ibid*, p.438).

Ehrnberg suggests that these terms reflect the dichotomy between small and large technological change, as distinct from that between old and new technologies, which she says have been expressed with terms such as 'technological substitution, creative destruction, emerging industries, emerging technologies, invading technologies, technological transition, etc'²². She acknowledges that there is much confusion

regarding the meaning of the terms and indeed she uses the fact that a large proportion of the researchers do not define the terms as a basis for her own work. Dahlin and Behrens²³ agree that previous researchers of radical technological change have no commonly understood definition for the phenomenon. Their focus on technological content as a measure introduces its own problems, notably that a disruption of a technological paradigm doesn't necessarily translate into further and more substantial success for a firm or industry.

Regardless of which characteristic of change these terms are applied to, they represent the recognition that some technologies have fundamentally different natures to others. The essence of the problem is that this difference in nature, and the means by which it might be identified and measured, has not been agreed. The issue is as fundamental to technology as the planned vs. emergent argument is to strategy, but it is even more bothersome because an agreed vocabulary has yet to be developed. An example is useful here. Variations of, and improvements upon, ball-point pen technology won't ever make it a *new* technology. In contrast, if a simple electronics circuit is implanted into a human body and interprets electrical signals from the human nervous system to operate remote equipment, then the simple electronic circuit becomes part of a 'new', 'disruptive', or 'radical' technology.

Terms that capture the intrinsic nature of technology are necessary to manage this difficulty. We will describe technologies as either *latent* or *sensible*. The word 'latent' describes that 'capability of becoming' which while possessed by something is unrecognised or inactive. In contrast, 'sensible' describes that which is already perceptible to understanding. So '*latent technology*' defines that which has the potential to become useful, while a '*sensible technology*' is one that is commonly

perceived to be already useful in a function. We believe that this terminology captures the essence of the new/old or radical/sustaining dichotomy at the heart of this discussion without being diverted by chronological or product performance issues.

For example, the first fuel cell was built in the 1800s, but it had no effective function and remained a curiosity. Further development during WWII (as an alternative submarine power supply) had limited success and fuel cells had no impact until the 1960's 'space-race' generated further interest. Even now, at a time when energy sources are under serious examination, this technology has generated only modest industry success. So a technology's age or performance is only relevant to its characterisation within a technological paradigm. A technology is not 'new' because it has just been invented, but because it has just achieved a new function, and changed the market.

These two dichotomies - emergent versus planned strategy and latent versus sensible technology – may be used to establish a framework within which the nature and nuances of the relationship between new technology and strategy can be addressed. This can help discriminate between the different situations described in the introduction, for example, where an understood technology is deliberately re-applied to a new area, or where existing technological strengths have become the basis for new products. We propose to illustrate this range of potential relationships using a simple but powerful model, which was developed by taking the relevant dichotomies in strategy and technology and using these as orthogonal sets of poles. When graphed against each other, these orthogonal poles create four quadrants that represent four separate sets of circumstances in which the relationship between technology and strategy is enacted. These axes are graphed against each other in Figure 1. In this diagram, the condition of

the technology is represented on the horizontal axis as between ‘latent’ to the left, and ‘sensible’ to the right. Strategy is represented on the vertical axis as being between ‘emergent’, at the bottom and ‘planned’ at the top. The four potential situations resulting from the intersection between technology and strategy are: *development*; *capitalisation*; *cultivation*; and *creation*. It is important to clarify that while this model is a useful means of conceptualising the differences between the circumstances in which firms find themselves, it is not proposed as a means of categorising all new technology firms in the marketplace. We also emphasise that each quadrant depicts an ideal type. Even though we will find elements of each type in any given situated practice, there is still much of conceptual value in distinguishing between these ideal types. In particular, the circumstances that the quadrants describe are distinctive enough to allow us to map and make sense of the empirical world in an interesting and relevant way.

In the remainder of this section, we will briefly discuss and describe the development, cultivation and capitalization quadrants. In the next section we consider the creation quadrant in more detail.

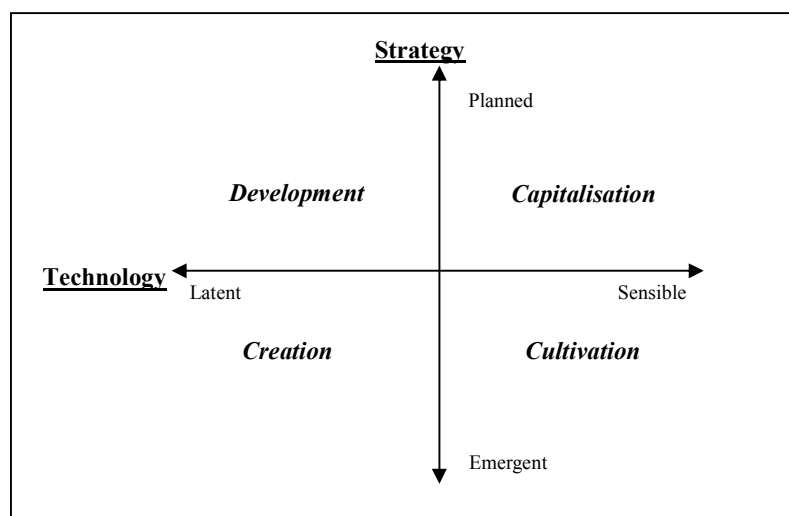


Figure 1: Technology - Strategy Relationships

A ‘development’ relationship exists in the quadrant representing the meeting of a latent technology and a planned strategy. This combination describes the situation where a firm deliberately develops a technology to meet the requirements of a potential market it has recognised. Examples of firms that have operated in this quadrant are taken from the literature and include Medtronic with the development of pacemakers²⁴ and Analog Devices with the development of micro-electro-mechanical systems (MEMS)²⁵. These firms fit into the development quadrant in the sense that they recognised gaps in the marketplace and then developed portable pacemakers and MEMS accelerometers to fill those gaps through a deliberate planning process.

The ‘cultivation’ quadrant describes how the further cultivation of a technology may take a firm in a direction that had not been originally planned. In this case the strategic action emerges out of, most typically, an opportunistic response to a situation, or an action is taken, perhaps for idiosyncratic reasons, that is only in retrospect understood as ‘strategic’. Examples of the types of situations/stories from this quadrant include Sharp’s experience with LCDs, and Intel’s with microprocessors²⁶. In both cases these firms had a good understanding of a particular technology – in Intel’s case, despite the plans of senior managers – and successfully moved them into different markets.

The ‘capitalisation’ quadrant describes how firms may bolt-on existing well-understood technologies to an existing business. This has already been adequately described using Ryanair’s internet booking and Tesco’s petrol retailing initiatives. Petrol retailing and internet booking are well-understood – i.e. sensible – technologies and the initiatives to bolt these on to existing businesses resulted from planned initiatives by the companies.

STUDYING THE CREATION QUADRANT: RESEARCH METHODOLOGY

Our framework presents a potentially useful and novel way to consider the inter-relationship between technology and strategy. Considerable empirical research, going beyond the illustrative examples of the previous section, would be required to assess fully the taxonomy's value. In particular, it is only through grounding in the empirical world that we can adequately identify the appropriate unit of analysis that would populate the taxonomy – is it the firm, the industry, the technology, or (our preference) a techno-economic narrative that blends all three? As a first step, we now present a case history of one such narrative that is centred on the 'creation' quadrant.

An important benefit of the framework is methodological, in that its distinction between quite different understandings of new technology and strategy provides a good way to orientate a research inquiry. More pointedly, it asks us to consider in which quadrant the study is located? Of course the answer to this question may itself require some prior empirical work, but *prima facie* there seems to be a clear distinction between, for instance, the techno-economic activities of Ryanair and Tesco in the capitalisation quadrant and the type of narrative that we will now explore in the creation quadrant.

Since the 'creation' quadrant provides perhaps the most intriguing case of strategic action in a new technology situation, we chose to study this quadrant in more detail. Following Mintzberg's assertion that 'strategy is a pattern in a stream of actions' and Latour's exhortation that we should inquire into how things come to be, we decided that an industry case history was the appropriate research method to employ.²⁷ Following Ragin's³² suggestion that cases are defined by 'boundaries around places and time periods', we mark a boundary around an industry over a given time period, using historical as well as contemporary data. But the case is not merely a chronological listing of historical events. It is a narrative used because it both represents a particular

entity within a theoretical construction, and it may reveal something new to us about a very complex reality³³.

In order to investigate the circumstances that NT firms experience we chose to investigate the stent industry, which we are positing as a paradigmatic case of the creation quadrant.³⁴ This industry has been in existence since the 1980s, so it is old enough to have impacted upon existing industries and established its place in the market, but young enough to remain relevant to practicing academics and managers in the new technology field.

Our case history is primarily based on secondary data which was obtained from a broad range of sources such as company annual reports, product brochures, financial data, commercial sources such as the London and New York Stock Exchanges, reports from newspapers such as the *Boston Business Journal*, *The Guardian* and online issues such as *Healthcare Purchasing News Online*. Other online medical sources included the British Medical Journal, In Vivo, Medical Device Link and the Pharmaceutical Business Review. Regulatory oversight bodies such as the FDA and the Japanese, Irish, Australian and UK equivalent agencies, also provided data. Relevant agencies outside of the industry included clinical trials listings, court records, patent and trademark offices, and trade oversight authorities such as the SEC in the US and the World Trade Organisation. Other sources included academic databases (Science Direct, Ebsco and so forth) and some more focused sources such as the Nobel Prize organisation and the Emory Law School website. This wide range of sources provided a very rich and detailed dataset from which to tell the case history.

A challenge associated with the data collection was that, although we chose to investigate a clearly defined technology and its associated market, industry, and firms,

the volume and range of data along time and across these elements was very substantial. To deal with this issue we decided to supplement the secondary data with a limited amount of primary data. Specifically, we interviewed two senior employees in four of the five primary competitors in the industry using a variation of the repertory grid technique.³⁵ These interviewees included both technical (e.g. R&D manager or design engineer) and non-technical (e.g. IT manager, sales manager) staff. An important objective in this part of the research was to develop constructs that were, as far as possible, grounded in the situated experience of those in the industry. It was this requirement that attracted us to the repertory grid technique because it seeks to identify the personal constructs that actors use to make sense of the world. The technique also substantially reduced the tendency of the interviewer to influence the direction of the interview – useful in most interviews but critical in these interviews which were performed at a time of competitive turmoil within the industry when the majority of interviewees could be characterised as reluctant. A triadic methodology was used whereby the interviewee was presented with three words (on cards) and asked to select a pair which fit together, and to separate the third from this pair. The two issues which this pairing and separation process generated – one for why each pair fit together, a second for why each third was different – became ‘poles’ on scales about which the interviewee was concerned. This was done with a series of sets of cards which were chosen randomly from a set written by the interviewer prior to the interviews. The types of poles generated by this process included terms such as: balloon-based/not balloon-based; market/product; after arrival in market/prior to arrival in market; external to company/internal to company; primary objectives/how to achieve; patent/stent; business area/means of acquiring patent; regulatory body/product. These outcomes generated scales which largely confirmed the issues which the ongoing research had led

the authors to consider as important. For example, product specificity was important – what type of technology is being discussed? Location of activity was important – is it within the firm or the industry, or is it external to both? Access to intellectual property was critical – is it useful, can we make it ours, can we access it somehow/anyhow? These were among the important issues examined during this research.

The repertory grid technique provided a useful way of abbreviating the data, while staying grounded in the practitioners' view of their situated practice. Although the interviews were relatively few in number their impact on the process of making sense of the data was significant as they kept us focused on the issues that were seen as important by the actors within the industry, and also the interviewees' responses confirmed the importance of issues arising from the secondary data.

A CASE HISTORY OF THE STENT INDUSTRY

Stents are small structures that are inserted into arteries to clear blockages. They can be visualised as something similar to a ballpoint pen spring. Stents are delivered to blockages by catheters and are frequently expanded into position by balloons³⁶.

In 1929 the German doctor Werner Forssmann self-catheterised his heart, the first time this had been achieved. Further progress was made in this area over subsequent decades until, in 1964, 'transluminal angioplasty' was introduced by Dr. Charles T. Dotter. This operation, in which successive catheters of increasing diameter were inserted to clear a blocked artery, was the fore-runner of modern angioplasty, which uses a balloon on a catheter to expand a stent within the human body. In 1977, Dr. Andreas Gruentzig performed the first catheter lab coronary angioplasty on a conscious patient in Zurich. These advocates – Forssmann, Dotter and Gruentzig – of the technology championed it

in the face of sometimes hostile reactions, and educated potential customers as to its usefulness.

But the arterial blockage frequently re-appeared following the angioplasty procedure. Stents were designed to prevent this re-blockage, and the first coronary stent, the Palmaz-Schatz, was granted approval by the FDA in 1994. By 1995, in the absence of competition, its producer Johnson & Johnson (J&J) dominated the market, with stent sales estimated at \$450 million. But less than two years later Guidant launched a competing stent and J&J's market domination was shattered. Annual sales in excess of \$700 million declined to \$200 million and Guidant claimed 70% of the market almost instantaneously. Exacerbating J&J's difficulties, Arterial Vascular Engineering (AVE) and Boston Scientific launched their stents shortly afterwards.

This market collapse occurred for several reasons. Surprised by spiralling demand, J&J needed approximately eight months to meet orders. This meant that customers, primed to receive this exciting new technology, were disappointed. The firm also priced its stent at approximately \$1,600 each and refused to offer any discounts. The effects of this aggressive pricing approach for customers were exacerbated by the initial refusal of Medicare in the US to offer any reimbursement for the stents. Although this was out of J&J's control, the price situation generated an unforgiving attitude among the firm's customers. Coincidentally, Medicare began offering reimbursement the same month that Guidant's stent entered the market. Also, while J&J was monopolising the stent market, the firm failed to design the next generation product and thus, when faced with competition, had to deal simultaneously with unhappy customers and uncompetitive products. This is not the only example of a collapse by a market-leading stent manufacturer, with the AVE market share declining from 30% to 10% shortly after

being acquired by Medtronic in 1999, and J&J/Cordis (first to market again) having trouble retaining its drug-eluting stent market share in 2003. These episodes indicate how closely a firm has to watch the realities of the market it is serving and how it needs to maintain realistic expectations of what is required and what will be tolerated by the market.

Despite this, the firms in the stent industry have to get their products to market without delay. This means that they have to force the inevitable and prove that their products are effective as quickly as possible. By this we mean that they have to ‘force’ acceptance of their technologies, although in retrospect, it may appear that the technology was so appropriate that its adoption was ‘inevitable’. While this is a reasonably structured process now, with clinical trials and approval processes familiar to the firms, it was less so previously. For example, Forssmann’s self-catheterisation and Dotter’s initial angioplasty were very dramatic ways of proving the effectiveness of the technology. This forcing the inevitable might be considered a small part of the story of stent technology, but the divided reactions received by the technological pioneers involved grant it greater significance. For example, Forssmann was fired from his job for his self-catheterisation, but recommended to a larger hospital, where he could continue his work. He was fired from that job within two years for a variety of related issues, by which time he had ‘cut-down’ his own arteries more than two dozen times. Consigned to the life of a country doctor he subsequently shared the 1956 Nobel Prize for medicine for his work. Similarly, Dotter’s introduction of angioplasty was received with suspicion in the US, with the take-up being much more enthusiastic in Europe. When Gruentzig presented his experimental findings of coronary angioplasty in 1976, he also met with a mixed reception. These issues, associated with the need to prove the usefulness of a technology prior to there being an appropriate infrastructure to support

it, are characteristic of the approach taken by new technology pioneers. They illustrate that the new technologies are situated so close to the borders of what is acceptable that their use is barely tolerated for an initial period.

The activities described thus far show how the stent industry relates to the external world. Its activities of championing and educating, maintaining realistic expectations, and forcing the inevitable comprise what we call *subversive incrementalism*. This means that the industry attempts to reveal itself as part of the landscape rather than confronting and immediately attempting to replace the existing powers. It attempts to co-opt the existing market and infrastructure rather than compete with them.

In terms of its relationship with competing providers of broadly similar technology – the activities are dramatically different. Legal leverage is used between these competitors endlessly and ruthlessly. Patent litigation is endemic, with the losers automatically appealing negative outcomes. The costs associated with this legal activity can be very significant with penalties of hundreds of millions of dollars being incurred, as when Medtronic and Boston Scientific were ordered to pay J&J/Cordis \$271 million and \$324 million respectively, in 2000. These judgements were, as is typical in this industry, subject to reversals and new trial dates, and reversals of these reversals. As a result, by 2008, these payments had been adjusted to \$521 million and \$703 million, respectively. These ongoing and dramatic judgements are typical of the stent industry.

Another characteristic of the internal competition of the stent industry is the opportunistic flexibility practiced by the competitors, which is consistent with the conceptualisation of strategy as emergent. This describes the approach competitors take to maintaining the terms of agreements made with other firms and is illustrated by Boston Scientific's opportunistic approach to their relationship with their Israeli stent

supplier, Medinol. The American firm admitted to attempting to covertly build its own plant to manufacture the stents it received from the Israelis. This was the subject of ongoing legal actions until Medinol settled for an out-of-court payment of \$750 million in 2005. Similar opportunistic flexibility was exhibited by Guidant in its dealings with Cook as it struggled to enter the drug-eluting stent market. Initially it signed an agreement with Cook, which was subsequently described as a 'sham' by the courts. Guidant then began the process of acquiring Cook, but the courts ruled that the firm could not benefit from any drug-eluting technology developed during its earlier illegal agreement. Guidant jettisoned the smaller firm claiming its drug-eluting stent was no more effective than its own, and Cook retired from the market. Guidant later suffered similar treatment at the hands of J&J, when the latter firm agreed an acquisition price and then attempted to reduce it. Guidant was eventually acquired by Boston Scientific.

The forcing the inevitable issue described as part of subversive incrementalism has a counterpart in the industry's internal activities. In this case, bringing the technology (which has been proven effective) to market as quickly as possible is the issue. It is illustrated by describing how Guidant brought the Ancure Endograft system – a means of treating abdominal aortic aneurysms incorporating the use of stents – to market and persisted with it, despite it being associated with several deaths and dozens of emergencies. The firm eventually withdrew the product from the market and incurred legal penalties. J&J/Cordis's Cypher drug-eluting stent was rumoured to be associated with blood-clotting in patients, and although this was subsequently attributed to placement techniques and the rigour of subsequent anti-rejection drug regimes, it remains an example of how unprepared the medical industry and patients were for its proper use, despite it being an effective technology. This is an important issue as it illustrates well the challenges faced by new technology firms. Even if the new

technology is effective – in isolation – the market and infrastructure often needs to be adjusted to properly utilise it. In the absence of, or prior to, such adjustment, the use of the new technology can be quite dangerous. These examples illustrate how quickly firms are willing to go to market with new products despite even the most serious implications for customers, if poor judgement is used.

These legal leverage, opportunistic flexibility and forcing the inevitable activities all illustrate the aggressive and bitter *internecine competition* at the heart of the stent industry.

DISCUSSION

This research addresses the relationship between strategy and new technology. Initially it attempts to clarify these terms, which are simultaneously fundamental but ambiguous, through the development of a two-by-two framework. A case history of the stent industry is then used to examine the most interesting of the four domains defined by this model – that which relates an emergent strategy with a latent technology.

The findings of this work can be summarised in four points. The first is that new technologies are created and introduced over significant periods of time. In this respect they lack the ‘revolutionary’ characteristic normally attributed to them when they are viewed through the ‘destructive’ or ‘disruptive’ technological frames of reference.

The second is that legal activities are endemic within new technology industries and it is common for very large financial judgements to be awarded and appealed repeatedly, and for lawsuits and counter-suits to be continuously engaged in. The courthouse rather than the marketplace is a major competitive arena for new technology firms.

The third point is that relationships between new technology competitors tend to be mutually antagonistic, with alliances being created and demolished without regard for consequences, and with the strong acquiring the weak, and their technologies. As a result of this, combined with the legal leverage utilised to gain competitive advantage, the speed and scale of market share changes in new technology industries is very substantial.

Finally, and as a consequence of the above points, it becomes clear that new technology firms are much more aggressive when interacting with direct competitors – internal to the industry – than when dealing with existing industries and infrastructures – external to the industry. This suggests that there are two mechanisms at work in the stent industry and this has several implications for both further study and future new technology company strategies.

The first – subversive incrementalism – characterises how the new technology industry manages external relationships (i.e. by avoiding confrontation, accepting that it will not replace the existing technology/industry, and attempting to reveal itself as part of the competitive landscape as distinct from trying to replace that landscape). This mechanism is illustrated by the fact that the coronary stent industry has not destroyed its existing competitor, the cardiac surgery expertise. Stent technology is not in a position, more than two decades after its introduction, to eliminate the previously established heart by-pass surgery technology. In this sense, this research provides only limited support for the concept of ‘disruptive technology’ as it suggests there is a period during the time when a new technology is being created and introduced that the objective of the introducing industry is not the destruction of the existing industry, but rather its co-option. The stent industry finds itself in a situation where it needs the existing markets

to accept its technologies, and the regulatory and legal structures to accommodate its activities. It also needs customers to change from the previous technology to its own offering, and other agencies to change their processes to suit the new technology products. This supports Christensen and Raynor's concept of 'competing with non-consumption'³⁷. They suggested that new technology industries should not confront the incumbent industry in order to survive, but rather should address a niche in the market that is not being served by the incumbent, by which means the new technology industry can build some strengths without being perceived by the incumbent as a threat. The stent industry's subversively incremental activities align with this concept quite neatly.

The second mechanism – internecine competition, describes how the stent industry manages its internal competitive activities. The industry is ruthlessly internally competitive, with firms relentlessly using legal leverage to restrict the activities of competitors. Firms also frequently disregard constraints resulting from partnerships, alliances and agreements between competitors. Finally, the internal activities also include an aggressive advocacy of the new technology which is exhibited by the determination of pioneers to persist with the creation of a new technology, even in the face of suspicion and rejection by their peers.

These activities, characteristic of the internal dynamics of a new technology industry, lead to several implications for new technology industries. Managers in new technology industries are likely to face substantially more challenging competitive manoeuvres from their firms' direct competitors than managers in more established industries. In parallel, new technology firms are likely to be more challenged by their direct competitors than from any firms within the incumbent industry – which it might be supposed would feel threatened, especially when viewed from the 'disruptive

technology' perspective. With this knowledge, new technology managers, hoping to reap competitive benefits by focusing on strategically important issues, are likely to be less fearful of any incumbent industry (once adhering to subversive incrementalism) but have more to fear from direct competitors than previously anticipated.

These challenges faced by new technology firms and industries may be significantly different to the challenges faced by actors in the development, cultivation and capitalisation circumstances. Being aware of these challenges and differences can move us closer to understanding how to succeed in these various situations.

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