Navigating the Double Death Valley Curve of New Product Introduction and Successful Product Lifecycle Management – A Longitudinal Study into Product Development Strategy in Regulated Australian Grass Roots Suppliers

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Abstract

Continuing the longitudinal study of Australian grass roots suppliers, this paper discussed the findings from organisations who operate within highly regulated sectors. Unlike more generalist grass roots organisations, it has been discovered that regulated organisations have a significant New Product Development capability and new product platform strategy that secures both near and longer term competitive advantage, driven by the requirements of the operating regulated framework. We argue that this continuous New Product Development activity has enabled organisations to bridge the commercialisation gap between more purist Research and Development and the more commercial applied near market development and we argue that ultimately *"regulation drives innovation".*

Key Words

Innovation, New Product Development, Regulated Industries, Technology Readiness Levels, Commercialisation

Introduction

Continuing the longitudinal study looking into the innovation capability of core "grass roots" Australian organisations commenced in 2008, this paper discusses findings from research conducted with specialist organisations operating in highly regulated and/or areas of significant customer specified product frameworks. A significant proportion of organisations within these groups can demonstrate a new product development strategy, whereas more generalist organisations typically operating in less demanding market frameworks cannot. We argue that the polarity of the findings within these groups, defined as latent innovation capability, is driven by the high level of regulation these organisations operate within. This is due to the inherent legislative drive that demands robust innovation within supply chain systems players to remain operational, compared to more traditional generalist and "free market" supply and demand marketplaces. Importantly, these organisations have also demonstrated a capability to bridge the gap between the near market needs of industry research and development and the blue skies research capabilities of academic institutions.

This paper discussed the polar positioning of Australian organisations New Product Development capability, how innovative and legislative driven organisations are engaging and successfully levering academic resources and their model for successfully navigating the "double death valley curves" of high value new product development and introduction.

Method

Our paper "A longitudinal study of new product development capability in generalist Australian grass roots suppliers - an insight into innovation" (Styger, Edwards, Chiang and Richardson, 2019) outlines a more detailed methodology and rationale for this study. A summary of that rationale is that the study has been conducted since 2008, through a combination of industry and Australian Federal Government initiatives, where "grass roots" Australian suppliers were invited to participate in a series of diagnostics to ascertain the health of their supply chain systems in terms of innovation readiness. All participants were senior officers within their organisations and as such were involved in determining the strategic direction of their business, and also the strategic and operational intent of their supply chain and the customer acquisition and retention tactics.

The diagnostics program that formed the body of this research was drawn from mature business modelling, analysis and due diligence methodologies. The diagnostics had been previously used successfully in many private business improvement consultation programs and supplier selection processes globally.

It should be noted that the analysis is focused on the basis that a series of focus groups provided an initial random sample of Australian business (i.e. supply base) and the mean averages of the collective focus groups is a representative and robust indicator of the generalist Australian supply base. There is no suggestion that there were not some outsiders within these study groups, however, it is the sample mean in this case that provides the core indicator of performance not selected "best (or indeed worst) in class" (Boyer & Verma 2010; Bains, Fill & Page 2008; Belch & Belch, 2007; Craig & Douglas, 2009; Gill & Johnson, 2010; Bryman & Bell, 2007; Montgomery & Runger, 1999).

The total diagnostic tool was developed around five key themes, these were:

1. Analysing Strategic Positioning and Market Trends
2. Analysing Supply Networks, Supply Competency and Capability
3. Analysing the Potential Risk Inherent within Supply Networks
4. Analysing Technology
5. An Insight into Innovation

Point five, an insight into innovation, is considered in this paper. The significance being that Australia is currently ranked as 20th in the 2018 Global Innovation Index. Although at first sight this ranking might appear to be admirable, McLeod (2017) provides some disturbing data suggesting that even within the Australian start-up community (a subset of organisations that should be rife with market ready, innovative, customer and product solutions) only 70% of these organisations report having "some innovation" in products or services. McLeod also suggests that 97% of the organisations active in this community in 2017 would have either failed or exited the market by 2019. The 2018 AMGC report stated that: *"Australia is currently home to one of the most volatile manufacturing industries in the world (AMGC 2018)"*, suggesting perhaps that the market could be to blame for the lack of competitiveness many generalist Australian grass roots suppliers find themselves within and not for example being in command of a robust product lifecycle strategy. A comparative case study conducted by Soosay (2016) and colleagues also suggested that Australian manufactures have been facing great competition while operating in both domestic and international markets due to lack of competitiveness. A key component of competitiveness is the alignment and fit of manufacturing strategy and overall business strategy (Bates et al., 2001; Sun & Hong, 2002). In other words, the lack of product variety offering (Soosay et al., 2016) to customers and vulnerability of recognising the constant changes of customer preference (Cusumano et al., 2015; Chang & Taylor, 2016; Zhang et al., 2016) result in the poor performance of sustainable Australian manufacturers (King, 2015).

This report claimed that as many as 33% of businesses would suffer considerable operational continuity issues if they were to lose one of their current customers suggesting there is little innovative agility within generalist grass roots suppliers. The report suggests that robust strategies to increase the resilience of these organisations can include:

1. Technical leadership
2. Flexible customer engagement models
3. Diverse product offerings

Point three suggests the need for a customer centric product offered by generalist grass roots suppliers and within the context of the volatile markets noted above, a need for a New Product Development strategy that is aligned closely to the customer, is essential for organisational longevity.

Context of "Grass Roots Suppliers"

Most supply chain research is conducted around the focal nodes and their interaction or dominance with tier one and tier two suppliers (Jaber & Goyal, 2009; Carter & Liane Easton, 2011). Studies that do cover wider supply chain systems typically focus on discipline or industry sectors (Oh et al., 2010; Touboulic & Walker, 2015; Durach et al., 2017). These studies are important because they develop acute knowledge specific to a supply chain system type or classification, however, they seldom delve deeper into the origins of value creation or indeed the "mix and muddle" of suppliers deeper in the system. It is however these deeply imbedded suppliers who often influence the strategic direction of the focal node and sector specific supply chains simultaneously. In this case, we investigated a smaller specialist organisation who often feed into much larger supply chain systems and from the core or "grass roots" of those supply chain systems.

The limited research conducted on total supply chains and the inherent risk lower down the system where grass roots suppliers could be selling into many sectorial key players at the same time is hidden and/or undervalued within the systems they typically operate within (Sarimveis, 2008; Styger, 2013). This is often due to supplier engagement strategies based around developing lower tier management to tier one and tier two suppliers by the focal node (Saunders et al., 2015; Wilhelm et al., 2016). The invisibility of grass roots suppliers brings significant organisational risk. There is also a tendency for transactional relationships with little strategic alignment at this level, that in-turn increases the cloak of invisibility due to a status of insignificance being awarded to many grass roots suppliers in most supply chain systems. As a result, there is a tendency for those suppliers to fall into a subset of a cost driven and value reduced player status and once on this road little can be done to turn an organisation around (Rossetti & Choi, 2005; Reuter et al., 2012; Wagner et al., 2019). However, this study has identified that in the case of those grass roots suppliers, operating within regulated sectors, a demonstrable innovative drive is evident and auditable via new product development strategies that both increase their value and also dominance within the supply chain systems they operate within.

Significantly, our study offers support to the work of Hines (2006) where he described accurately the setting of cost focused strategic direction in supply chain management. What has become apparent throughout our study is that at a given point in time, organisations face an event where a decision to value create through new product development, compared to organisational cost reduction, changes the economic wellbeing of both the grass roots supplier and their value chains (see Figure 1.0). To achieve a dominant value creation position and opera-

tional capability is necessary that it is based on a cus-tomer cen-tricity and there is the capa-bility for an organi-sation to bring new prod-ucts to market for their cus-tomers.

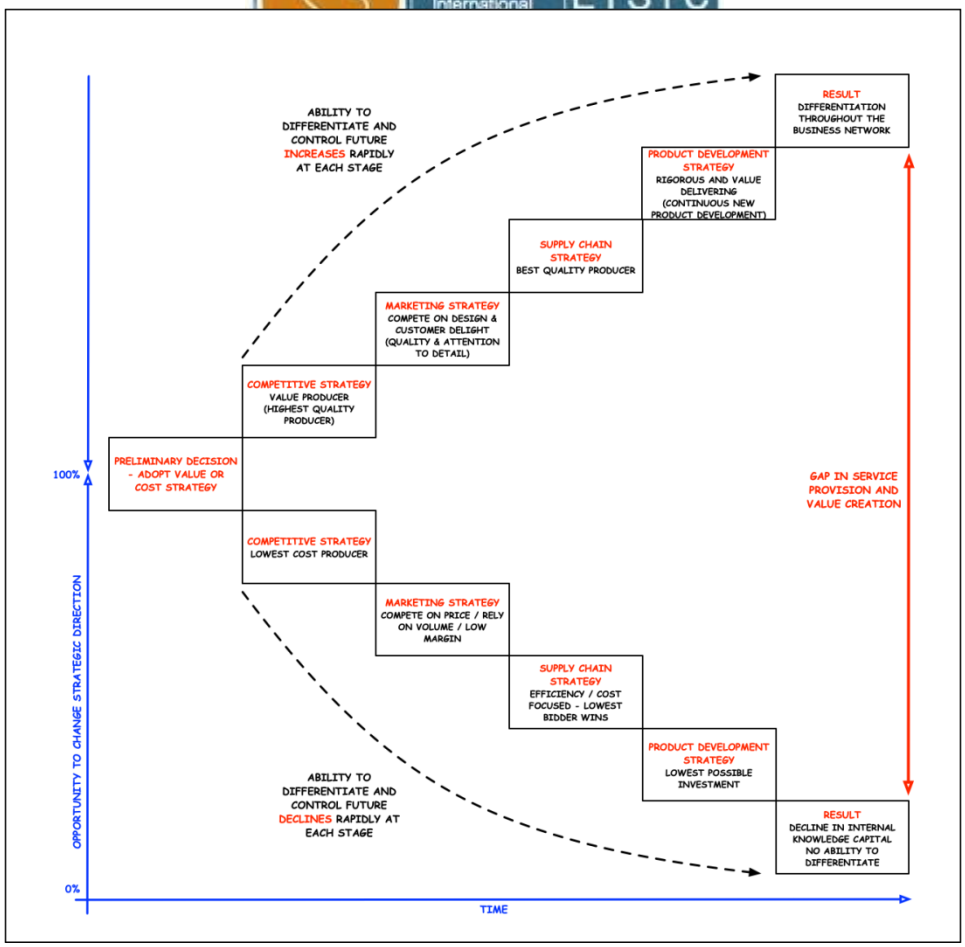

Figure 1.0 - Illustration of a Comparison of Cost and Value Driven Strategy

Source: Adapted Hines 2006

Context of "Regulated" Grass Roots Suppliers

In the context of this work, "Regulated" Grass Roots Suppliers are defined as organisations operating within strict government, industry or customer standards or frameworks. For example, a medical device organisation working within TGA regulations, an aerospace contractor working within CASA regulations or a defence contractor working within specific tender or organisational frameworks.

Results

Diagnostic 13 of the Audit addresses new product development strategy. This diagnostic is particularly important because it reflects an organisations ability to respond to current customer needs and an indicator of latent innovation capability within an organisation. This diagnostic is also a predictor of future is capability and flow within a supply chain system, and therefore an indication of organisations ability to future proof itself and the supply chain that it belongs to. This diagnostic is also an indicator of the measure of customer centricity and growth potential, and it is based on the status, positioning and level of innovation within that organisations future products (i.e. it is evident within an organisations new product development strategy). Figure 2.0 illustrates the consistency of new product development strategies within grass roots regulated Australian organisations during the overall period of study.

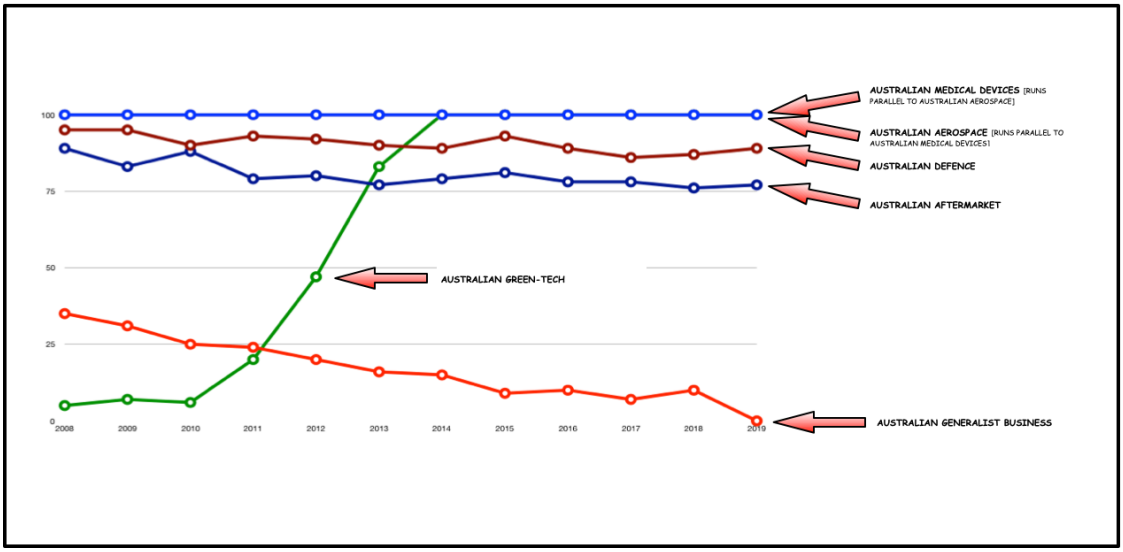

Figure 2.0 - Illustration of the Consistency in New Product Development Strategy in Grass Roots Regulated Australian Suppliers

The overall results are interesting because of the near consistency of result regardless of market or sector context. For example, the study was commenced around the fallout of the Global financial Crisis, where at that point in time it would have been reasonable to assume that organisations would have abandoned new product development strategies in favour of a more immediate need to preserve operational capacity, however, this is not the case. There is

a consistent response from regulated grass roots suppliers that there is an imperative to maintain new product development within regulated sectors and indeed in sectors such as these a need to innovate to comply, or innovate to survive. As such, a culture and quality management framework is imbedded within all of these organisations that not only places customer central to all aspects of the organisation but, also drives customer satisfaction through new product introduction.

Even in times of significant distress, regulated grass roots suppliers need to keep their new product development capability and as a result their value creation systems. Alternative value creation strategies such as waste reduction are practiced formally as a part of the quality management system (QMS), but are not morphed into "cost cutting" measures or indeed demand subordination from regulate requirements. The focus of these regulated organisations therefore remains on an advanced and energetic process of creating strategic advantage through new technological dominance that is fed and managed by a product platform strategy (Sage 2000). This strategy aligns with larger bodies of knowledge such as ISO 9001:2015 (ISO, 2015), that states clearly that:

"The organisation shall establish, implement and maintain a design and development process that is appropriate to ensure the subsequent provision of products and services"

This principal (8.3.1) demonstrates the importance of organisational strategies for new product development and also its alignment to customer centric organisations that can, via external audit, demonstrate measurable impact on both the customer and their own organisation.

Over the period of this study, those companies who were able to satisfy the terms of reference for this diagnostic demonstrated the following attributes:

1. All participants were operating within strict legislative regulations and/or within strict customer / supply chain systems specification frameworks.
2. Participants were able to articulate and demonstrate through documentation a new product development strategy. The New Product Development (NPD) strategy was always aligned closely to a defined and named customer, thereby making any strategic development and eventual product launch easier, because it is focused, therefore, making a new product development strategy and roll out less risky and more likely to succeed. This in turn instills a positive culture of ongoing new product development that increases more likelihood of success via a process of continuous improvement.
3. Participants were able to name and demonstrate through official documentation specific customers. These records were typically locked within formal quality management systems and customer specific product specifications. To be clear, customer identification was via specific traceable records and not simply generalist profiles or segment descriptions.
4. Organisations had formal QMS systems that aligned with regulative bodies framework. All QMS were audited externally as a prescribed requirement within the regulatory system and/or customer specification documentation.

5. All organisations operated and developed new product using specific international standards such as ISO 16355 (ISO, 2015).
6. All organisations were able to identify a tangible gap in current market offerings and articulate why competition was unlikely to fill that gap. This was reasoned to be due to the combination of active quality management systems and customer centric strategies that led to lower risk product rollout and therefore more new product rollout that led to a culture of innovation success.
7. All organisations had successfully bridged the Technology Readiness Level 4 *(NASA, 2017)* (see section below) and it was done by:
    i. Defining and actively managing their own internal "Double Death Valley Curve" of pure research and development and of new product introduction and product lifecycle management, and managing both of the "Death Valleys" and the associated risks commensurately with its risk profile. For example, the near market "Death Valley" for most organisations would be considered to be of higher risk and importance because typically 90% of regulated grass roots suppliers "research" budget is spent in near market development and process improvement and not, as would commonly be expected, in blue skies research.
    ii. Developed a strategic relationship with at least one academic research partner for blue skies and over the horizon research, usually within a "Halfway House" facility.
    iii. Developed a strategic relationship with at least one academic research partner for near market research and development, usually within a "Halfway House" facility.

Green-tech Performance

A separate discussion is necessary regarding Green-tech data and its seemingly low performance at the beginning of the study, rapid performance improvement and later stability in the second half of the study. When it was commenced, the Green-tech sector was comparatively new and the research indicated that many of the companies active at this time were young and involved in securing operational stability for their first minimum viable product (MVP). At this point in a company's development, there is little if any thought to product platform strategies. Quickly and inline with other regulated sectors once a foothold had been established, Green-tech businesses have stabilised rapidly and adopted product platform strategies (i.e. a state of significant stability and maturity to warrant a more strategic and longer term focus). This is atypical (Edwards, Ross & Styger 2018) most other young technology sectors who often take excessive, and highly risky periods of time to stabilise and therefore remain comparatively vulnerable to peer competition or indeed early product disruptors within the early stages of market entry. Green-tech differs because of its operation within an environmentally regulated space (i.e. EPA) where, in common with other regulated spaces, future competitiveness is driven by technological innovation, and, almost bizarrely, helps to set strategic goals based on more stable and predictable markets.

Double Death Valley Curve of New Product Introduction and Successful Product Lifecycle Management

The term "Double Death Valley" has been coined for the total lifecycle management of a new product (from initial inception through ideation into research and development, then commercialisation before entering near market development and eventual product commissioning, rollout and field management before end of life management) because the "Death Valley" element denotes a net output of resource and intellectual property with no resulting accumulation of revenue or assets. The total lifecycle process displays two distinct valleys where this occurs, but most commentators assume that the New Product Development cycle is "covered" in the inception portion of the standard product lifecycle curve (i.e. inception, growth maturity and decline) (Sudarsan, 2005; Ameri & Dutta, 2005; Gunendran & Young, 2010). Few authors (Taisch et al., 2011; Vila & Albiñana, 2016) have recognised that the New Product Development cycle has its own lifecycle curve, pre the inception stage of the corporate or business lifecycle curve noted above. What we have recognised is that there are two distinct lifecycles for NPD, these are:

- Research and Development lifecycle
- Product Development and Interaction Lifecycle

Both must work in unison if a new product is to make it into the market and the gap represented in TRL 4 needs to be expertly bridged. Figure 3.0 Illustrates the Double Death Valley of New Product Introduction and Product Lifecycle Management and overlays the Technology Readiness Levels from the NASA processes (NASA, 2017).

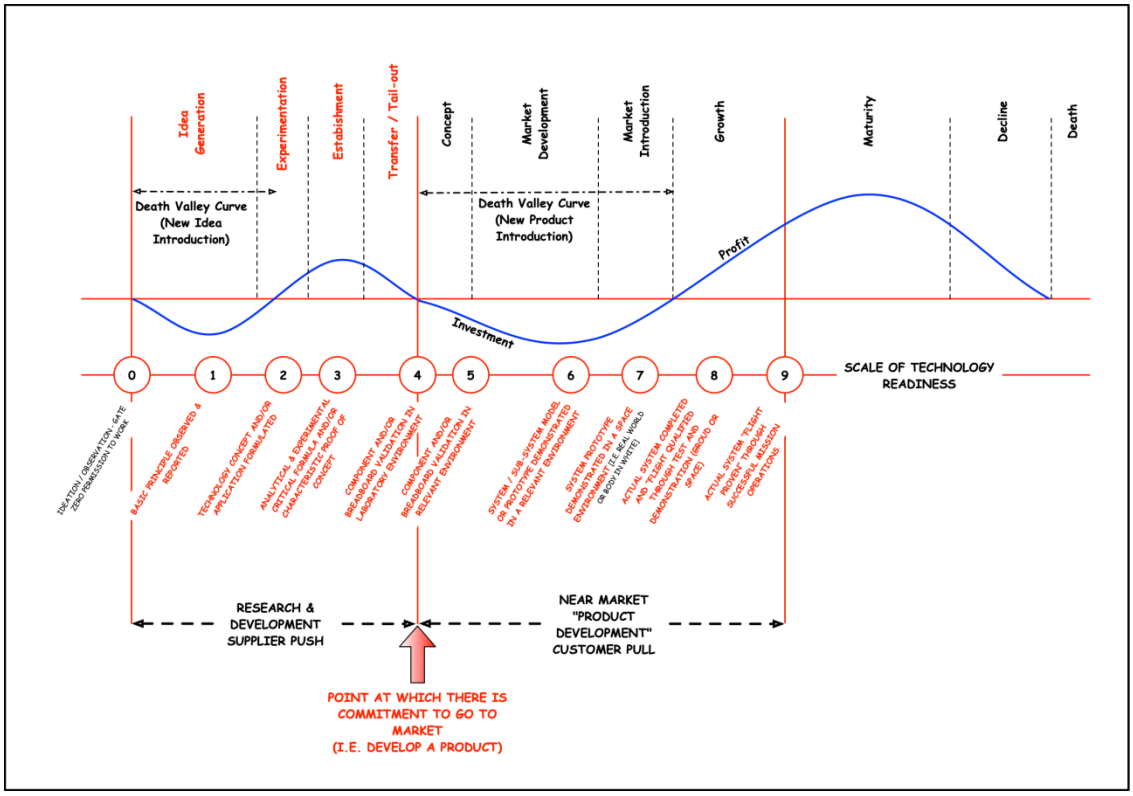

Figure 3.0 - Illustration of the Double Death Valley of New Product Introduction and Product Lifecycle Management and an Overlay of the Technology Readiness Level

Although there are many documents written on ideation, and for example; Design Thinking (Wattanasupachoke, 2012; Johansson et al., 2013; Elsbach & Stigliani, 2018; Kahn, 2018; Liedtka 2018) is typically associated with activities low down the scale of risk and functional product generation for commercial gain. Indeed, these elements are best described as sub-sets of a greater product development process and better associated with concepts of Total Design (Pugh, 1995) or Quality Function Deployment (ISO 16355) that take into account elements of both customer centricity and the regulatory frameworks of industry sectors. Without a holistic New Product Development framework such as Total Design or Quality Function Deployment, there is a low probability that products will successfully make it past TRL4 and the "handover" from research into the commercial demands of near market development. Figure 4.0 Illustrates the Double Death Valley of New Product Introduction and Product Lifecycle Management and overlays the positioning of both ideation type activities and commercialisation activities and thereby highlights the commercialisation gap at TRL4.

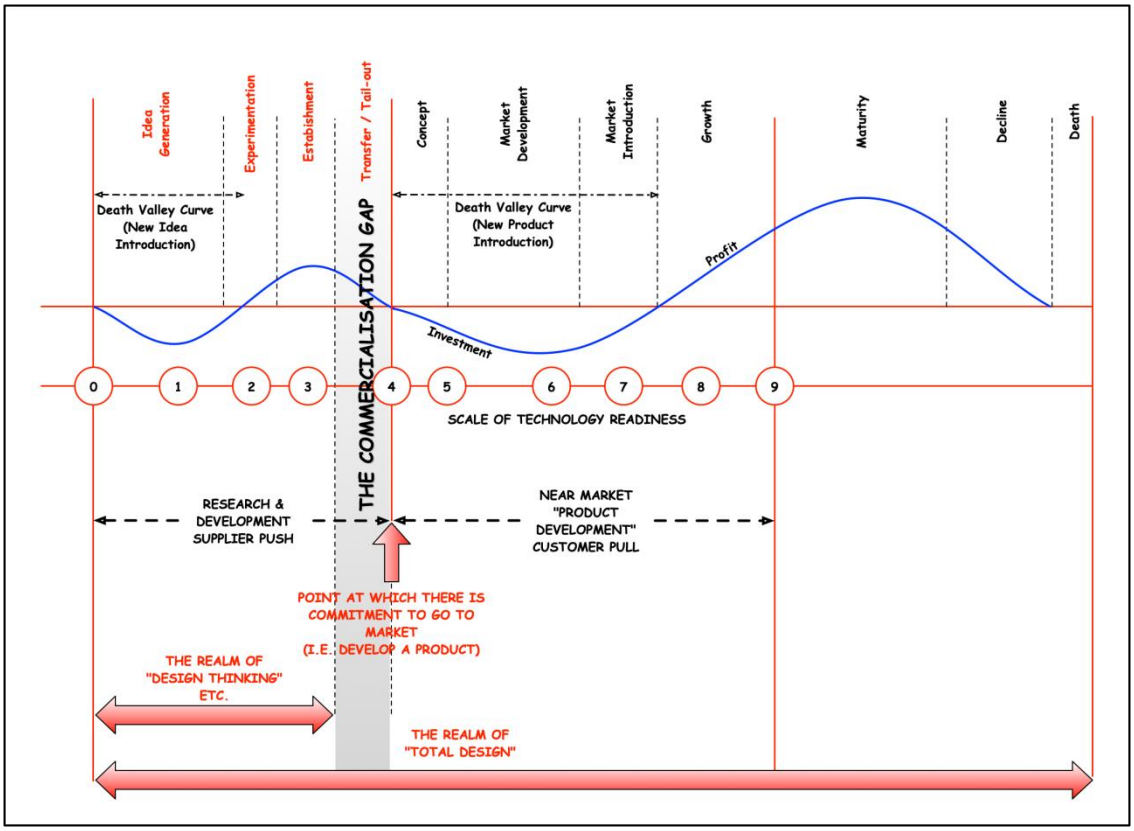

Figure 4.0 - An Illustration of the Double Death Valley of New Product Introduction and Product Lifecycle Management and an Overlays the Positioning of both Ideation and Commercialisation Activities Highlighting the Commercialisation Gap at TRL4.

The significance of the TRL process is in its holistic end-to-end configuration of the management, stage gating and "end game focus" of what is a very complex and high-risk process for any organisation. Taking into account the whole of the New Product Development process including both Death Valleys, the TRL process recognises the cyclic and symbiotic relationship between functions and subject matter experts throughout the process and overlays a transparent audit process that fits well with regulated industries and processes. Importantly, TRL does not encourage or indeed permit acts of "managerial fluidity" or scope drift by the players during the New Product Development process and thereby offers a more LEAN and agile method for driving creative (i.e. research and development) opportunities forward to a commercial outcome.

The Significance of Halfway Houses as an Innovation Hub

The most critical and yet most difficult technology level for any organisation to bridge is TRL 4. This is usually down to the siloing of New Product Development activities both within departments, where for example early stage research is defined as "back room / laboratory" activity whereas product "commercialisation" (i.e. the productionising, introduction and ramp-up fit for customer) is a process or operations activity. As such, the ability to work on both sides of the institutional divide and champion a single and holistic vision of new product are rare and conflicting within traditional supply chain systems. This might also be the reason why there is such a high failure rate of start up ventures and products.

A proven model in bridging the TLR4 gap is a "Halfway House" or collaborative research and development centre. These centres are typically housed in university campuses and are a partnership between industry and academia. There are many exemplars of collaborative centres between academia and industry, such as the Fraunhofer-Gesellschaft in Germany or the Warwick Manufacturing Group in the UK. Typically a thematic network is built around core exisiting competencies and innovative and disruptive businesses, their product lifecycle and carrier technologies associated with their sector. As the Halfway House's capability grows in one sector such as medical device technology, other "advancing" industries such as aerospace, green-tech and defence would likely come alongside to create similar thematic networks around the carrier technologies to form "super networks".

The concept of the Halfway House base on collaborative research is not new, however, true and significant collaborative hubs are, where the hub draws on appropriate and best talent from both the university and industry partners (i.e. focal node and suppliers), and brings them together, to work side-by-side on an actual, live, real world project for that business. These projects are typically near to market and of shorter time frames than more conceptual or exploratory research, however, invariably includes higher degree research integration.

An Integrated Graduate Development Scheme (IGDS) masters program also coexists with many of the Halfway Houses and typically consists of elements of both technical and enterprise relevant course material coupled with a real (i.e. brought in by the student from their organisation) project that needs solving during the duration of the program. IGDS is therefore not necessarily a "quick in quick out" or churn type masters, but fosters long-term organisational and personal relationships (student to staff / institution to industry) where continuation

of projects and future projects are continuously "sold" into the partners of the hub by all the partners of the hub. When working well, it is often difficult to distinguish the industry player from the university player within Halfway House exemplars.

IGDS integration is based on the concept of building strength in thematic networks and carrier Technologies by creating integrated product champions that take the output of the research back into the organisations who have sponsored the development and the individual. Because the individual has worked on a specific industrial technological challenge, expertise is developed more widely into the supply chain system and a thematic network develops. The thematic network draws upon carrier technologies of interest. These carrier technologies may, of themselves, not be specific to the thematic network (i.e. 3D printing, structural composites, performance super alloys, self learning systems, coatings, nano carbon tubes and super-conductors), but they build a demonstrable expertise in the collaborators, and subsequently draw in other thematic networks, for example if the hub was initially focused around med-tech, the it would eventually cross-pollinate ideas and technology into non competing sectors such as aerospace, green-tech and defence. This not only grows the collaborative potential of the IGDS collaborative hub, but it also offers significant potential for cross network collaboration, technology transfer between non-competing industries, thereby increasing engagement, impact and revenue generation potential of the output of the research.

Conclusion

Our work has indicated that organisations operating in regulated sectors confound the norm and are highly innovative and have increased successful output driven from their own sophisticated New Product Development platform strategy. Working within a regime of technological standards, these organisations have managed to bridge the TRL4 (commercialisation) gap, usually by active participation of a Halfway House arrangement, where super networks of industry players develop a suite of carrier technologies and thematic networks that act as multipliers for commercial output and gain.

A Halfway House catalyses a culture of continuous technological and managerial leadership within an environment where it is difficult to tell the industrialist from the academic, form the organisations "position" within the supply chain system (i.e. focal node or tier player). Greatest impact appears to come from higher regulated frameworks that organisations operate within and as a result, a confounding dynamic occurs where, we would typically expect regulation to reduce innovation whereas our study has suggested that: *"regulation drives innovation".*

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