Integrating Technology and strategy: A General Management Perspective

Strategic managers must understand technology and innovation. Since technology is a central resource for achieving and maintaining sustainable competitive advantage, managers should build and evolve capabilities, competencies and a capacity for innovation.

By understanding core concepts of innovation, technology can be better aligned with strategy. Discoveries and inventions provide access to previously unknown and previously non-existent resources. Technological innovations can be based on, or achieved through new technology. They can be incremental improvements on existing products or services, radical innovations in completely new products or services, or architectural innovations that reconfigure core components. Through entrepreneurial objectives and innovation-focused administrative capabilities, new configurations of resources can achieve outcomes through experimental R&D activities. These resources and capabilities combine to achieve innovations and sustainable competitive advantage.

In order to integrate technology into corporate strategic objectives, managers must consider the role of technology within their interpretations of strategy. The positive view of strategy suggests that goals demonstrate management beliefs about present and historical performance in the form of core competencies, values, products and objectives and their interrelations. These capabilities and competencies are derived from combined learning of an organisation. However, complacency, tradition and changing priorities can lead to divergence between strategic intent and strategic action. The product-market view of strategy addresses competition through products and services, whilst the resource-based view considers strategy as a tool for securing competitive advantage. From this view, strategy maps building sustainable competitive advantage by capitalising on competencies and capabilities with organisational resources. Porter's five competitive forces and generic strategies provide a framework for interpreting resources within an industry. These resource-based perspectives on strategy highlight the role of technology as a core factor in building competitive strategy. Therefore, executives must understand technologies affecting competitive positioning and frame business strategy questions in terms of technological resources and capabilities.

Porter considered four generic strategies through which a company can achieve a competitive stance. Technology can be used to achieve competitive advantage through either product or process innovation in any generic strategy. Product innovation provides advantage to firms using cost leadership and focused cost leadership strategies by reducing costs in materials and simplicity of manufacture, whilst process innovations lead to enhanced economies of scale and manufacturing process improvements reduce cost infrastructure. Conversely, product innovation drives differentiation and focused differentiation by enhancing quality and features, whilst process innovation improves reliability, lead times, and quality control. Moreover, Porter highlights the importance of technology throughout the value chain. At any stage in the value chain, technology influences cost structure or differentiation, impacting on competitive advantage. To retain competitive positioning, a manager must be aware of the potential changes and developments that occur in technology potential throughout the value chain.

A firm's technological capabilities and business portfolio can be assessed to derive strategic understanding. Plotting the importance of a specific technology for competitive advantage compared to technology position of a firm relative to competitors helps develop technologically aware strategies. Depending on relative positioning, different strategic actions are recommended. The key factor is that changes in the technological environment, such as diminishing importance of particular technologies, should lead to changes in resource allocation and strategic objectives. Furthermore, mapping industry attractiveness by competitive position alongside technology importance and position offers insights into influence of capabilities on competitive positioning of products and differentiation or cost reduction. These recommendations on technological resource allocations can inform strategic decision making. It is also important for a manager to be aware of the technology life-cycle, and technology develops over time. An awareness of the dynamic changes within the technological environment and systematic forecasting based on relationships between significant technological events will help retain an innovative edge.

An audit of innovative capabilities can aid understanding of a firm's potential for innovation leading to improved decisions on strategic choices on direction and resource allocation. By assessing organisational characteristics that encourage innovation, technological resources can be better developed to support strategic objectives. The auditing framework approaches the dimensions from business unit and corporate level perspectives, addressing resource availability, the technological environment, strategic management capacity, structural and cultural context and competitor's innovation strategies. Considering these factors from both historic and present perspectives informs strategy formulation.

There are pros and cons to auditing internally or externally. Internal audits can be impacted by conflicts of interest and narrow perspectives, whilst conversely having a better understanding of the firm's resources and context. However, external audits may be more realistic and objective, though they may have less understanding of internal priorities and resources.

It can be seen that there are many factors that influence appropriate integration of technology and innovation management into strategic objectives. Through use of the above tools and frameworks, organisations can be better placed to deliver innovation to achieve sustainable competitive advantage.

Design and Implementation of Technology Strategy: An Evolutionary Perspective

Technology strategy is developed from organisational learning of technological capabilities building experience feeding back into strategy and capabilities. Technological competence and capabilities are formed of the core competencies of combined tacit knowledge, skills and know-how through which an organisation develops competitive advantage. Technology strategy addresses four dimensions of strategic action; competitive strategy stance, value chain stance, resource commitment stance and organisational design. These factors are shaped and adapted by evolutionary forces within technology and the environment, and the experience that the firm gains through that.

The competitive strategy stance involves making decisions on technological ways to build, enhance or sustain a competitive advantage in differentiation or cost leadership. One factor is technology choice; the decision on which components or architectures to use. Due to the high capital investment costs and potential costs involved in reversing decisions means that these decisions can be significant, and are often influenced by architectural “dominant designs” driving infrastructure formation. Another factor is technology leadership which leads to building ranges of competencies over time which develop advantages transcending simple differentiation or cost leadership. Technology leadership can involve “pioneering” first mover advantage, but there are also disadvantages to being first to market. It is necessary for a first mover to be in a position to defend their technological lead through “appropriability regimes”, including patents, know-how and trade secrets, and to have access to necessary complementary assets which may impose high capital costs. Sometimes, it is preferable to license the technology to maximise R&D spend, if the cost of capitalising on the innovation is too high, or if there are other limiting factors.

Another dimension of technology strategy is the value chain stance. Technological strategy impacts throughout the value chain and determines decisions as to the scope of the technology strategy. Due to resource constraints, a firm must assess their distinctive competencies to determine which technologies to lead or follow in, and which will impact on their competitive advantage. The two other dimensions of technology strategy are resource commitment stance, which addresses amounts of resources applied to technology and R&D, and the management stance which addresses the need for a consistent approach to their priorities related to the other technology strategy dimensions.

Technology strategy develops and changes based on several evolutionary forces. Evolutionary processes consider the interrelation between history, tradition and inertia with individual and social learning processes. Technology strategy is shaped by the generative forces of strategic action and technology evolution and the integrative forces of industry context and organisational context. Technology evolution occurs through changes in the environment, process and product technology development and the emergence of new technologies which can influence the competencies of existing firms. Strategic action is based around organisational learning based on historic and present success, and how firms are able to adapt to changes in the environment that are out of the scope of strategy and competencies. Industry context and structure can be determined on the basis of Porter’s 5 forces, along with appropriability regimes, complementary assets, dominant designs and industry standards. The organisational context exerts internal selection forces through the capability to exploit opportunities in alignment with current strategies and opportunities that occur outside of the strategic objectives, and can be seen as the products and culture develop over time and influence context.

Technology strategy performance and experience allows development and feedback on quality of the firm’s competencies and the effectiveness of the strategy. Through this feedback, the firm can develop technology strategy, capabilities or both. Actual technology strategy performance is achieved through key technological tasks. One such task is internal or external technology sourcing, both of which have impacts on technology performance. It is beyond the resource capabilities of most firms to fund scientific R&D that leads to new technologies. Most firms work on applied R&D to develop existing technologies. The level of internal R&D capability is also a determinant of how effectively the firm will be able to absorb and assimilate external technologies. External sourcing is chosen when the technological needs are beyond the scope or reach of the internal resources. Technology strategy controls decisions that impact on whether to make technological acquisitions or work in strategic alliances, how to develop technological capabilities through those alliances, and how best to capitalise on the learning achieved. Another task is deployment of technology in product and process development. Technology driven product and process development can yield improvements in market position, resource utilisation and organisational renewal, however, few firms have a specific development framework that integrates technology strategy and product-market strategy. The final technological task is technical support, which provides a communications channel between technology and users. In some markets, innovations often come from recommendations from users, so the experiences in the field contribute to the development of capabilities of the firm.

On the basis of these factors, technology strategy should be both comprehensive and integrated, approaching acquisition, development and technical support consistently across the technology strategy dimensions and tasks.

Patterns of Industrial Innovation

The path and route to innovation is dependent on the maturity of the organisation. Innovations occur along a continuum of product innovation in small technological start-ups and process innovation in volume manufacturers. As organisations, products and markets develop, the characteristics and specifications of the product are better understood, so that competitive advantage is achieved through reduced cost base. This is often achieved through high volume, low cost, highly efficient and specialised production technologies.

A large percentage of cost reduction comes from incremental, gradual process innovations and minor systems and process enhancements rather than formal projects. Standard design features allow increased specialisation of the processes building greater economies of scale leading to reduced flexibility in the productive unit. The highly specific nature of the process technologies leads to higher capital requirements and vulnerability to changing demand and technological obsolescence.

Major new products disrupt this pattern of incremental change. They require reorientation of corporate goals to adapt to new drivers of competitive advantage which tend to be superior performance, rather than the lower unit cost of incremental innovations. Due to the new technology being in its infancy, the true drivers of product performance are uncertain, often requiring user input on specific needs. Rapidly changing requirements mean economies of scale based bespoke production technology are quickly obsolete, so smaller, more flexible and adaptable organisations are likely to out-compete more established firms.

It can be seen that there are two main types of innovation; radical and evolutionary. Evolutionary innovation trends towards rigid, highly efficient production systems for specific, standardised products, whilst radical innovation trends towards flexible characteristics. However, the types of companies which become based on evolutionary process innovations are often at first driven by radical innovations. Initially, new firms with radical innovations offering improved performance disrupt incumbents who tend to react by emphasising process enhancements. The incumbents are slowly squeezed out of the market by more effective performance and features. However, as products approach maturity, dominant design and heightened price competition pushes focus towards reduced costs and process enhancements to drive economies of scale. This pattern of shifting from radical to evolutionary innovation is a common thread across development and can be identified in microprocessors, aircraft, light bulbs and the automobile industry.

Managerial priorities and competitive strategies are influenced by the organisation's position in its innovation life-cycle. The key drivers of competitive advantage for volume producers are to encourage development of well-articulated design objectives and to push for standardisation and economies of scale. For small, fluid entrepreneurial firms with new product innovations, performance requirements and design criteria are difficult to enumerate and the relative importance of these requirements is unstable. The tooling is likely to be general purpose and labour and expertise intensive. User contributions towards performance requirements and opportunities in components and process equipment are more likely. However, since specifications are rapidly changing and there will be both target and technical uncertainty meaning that R&D programs are high risk. As the market matures, but before cost competition drives down margins, uncertainty is reduced and investment in R&D offers maximum benefits, justifying greater R&D spends. At this "middle stage" between fluid and specific companies, there is a clear benefit to investment in R&D to deliver process innovation and functional improvements. Over time, these companies work to improve their process-equipment from generic tooling to increasingly specific highly integrated systems. By reaching this level of specificity, major process innovations will most likely be delivered by product innovations of external firms.

Suppliers of production-process innovation also face changing priorities. Due to early issues in task uncertainty, processing of information vertically and laterally is important. As the product develops and becomes more clearly defined, suppliers must adapt their organisational structure to respond to these needs. By the time the product is fully mature and standardised the manufacturer will be able to reduce their reliance on information systems. As the organisation matures, its structure will also develop in order to address greater requirements for formality and more rigid authority.

It can be seen from this that depending on the stage of evolution, different stimuli will encourage innovation. Fluid units face barriers to progression in factors impeding standardisation and market aggregation. Static units face barriers in terms of uncertainty in governmental regulation and vulnerability of obsolescence of existing production investments. This model suggests that sustained competitive advantage can be achieved through management taking a consistent approach to addressing the needs of their status on the spectrum; fluid, transitional or specific.

The Core Competence of the Corporation

Sustainable growth in an increasingly dynamic world is delivered through development of core competencies. By conceptualising the corporation in terms of core competencies which build into core products, competitive advantage can be achieved. Companies whose strategic intent focuses resources on strengthening, acquiring and internalising core competencies tend to succeed in the long run.

Traditional thinking focuses around a corporation as a portfolio of businesses, but long term competitive advantage is achieved by corporations that build their portfolio of competencies at a lower cost and quicker than competition. Rather than perceive the corporation in traditional, static Western managerial budgetary terms, which tie competencies within strategic business units (SBU), it is preferable to consolidate technologies and competencies to empower individual businesses to adapt. Thus, the diversified corporation can be thought of as a tree with the core competencies at the roots, providing nourishment for the core products from which business units are formed. In this way, competencies are the collective learning of an organisation, and are embodied in competency-carrying experts. Thus, rather than through SBU as competing cost centres, leading to dependence on external suppliers for critical components, core competencies can only be leveraged efficiently through cross-boundary communication and involvement to achieve cross-pollination between SBU,.

Competencies are not about end-products, but are about skills, knowledge, know-how, shared understanding and alliances that build knowledge capital at the lowest cost. They are about recognising the distinction between competitive strategy at business and entire corporation level.

A core competency offers access to a wide variety of markets, makes a significant contribution to customer benefits and is difficult to imitate. Competencies are often integrations of complex technologies, by their nature difficult to imitate. Whilst technologies can be acquired, harmonisation cannot. Companies which consider their competitiveness in terms of products, price and performance without addressing the competencies underlying them risk making strategic alliances and sourcing decisions based on reducing cost centres rather than leveraging internal resources. Divestments of unattractive industries can lead to loss of core competencies with unpredictable effects on long term competitiveness.

Core products are the central components that add value to an end product. Competitiveness in brand share in end products and manufacturing share in core products require different competencies. Developing global leadership is achieved by different rules for each of core competencies, core products and end products. Increasing numbers of external and internal customers for core products leads to greater returns and improved market feedback supporting development and enhancement of core competencies. Outsourcing core products leads to decreasing competitiveness and increasing reliance on external suppliers. These suppliers can develop their own competencies and through this push their brand forwards. Economies of scale mean that with more applications for core products, more time and resources can be effectively invested with less risk leading to quicker development cycles.

Western management styles split the corporation up into SBUs and cost centres, leading to poor development of core competencies. Western models address competitiveness based on performance of products, without considering the competencies underneath. This leads to decentralisation rather than cross-boundary cross-pollination strategies. As a portfolio of SBU, corporations under-invest in competencies since no one has responsibility for corporate development. Competency carriers are also often locked into particular SBU due to their effectiveness within that role, but full leverage of competitive resources is necessary for global leadership. Also, without cross-pollination of ideas, innovation will be locked into easily attainable rather than hybrid opportunities based on a range of competencies.

The strategic architecture of the corporation should be clearly formed around competence building. Incentives, career paths, rewards and communication and information systems should be brought into alignment with building core competencies. Strategic alliances, technology acquisitions, resource allocations and product and market diversification should have clear priorities based on competency development. The strategic architecture should lead to an organisational infrastructure and management culture formed on change, long term thinking and resource sharing.

The velocity of competency carrier movements through the corporation determines the rate at which competencies can be deployed. Competitiveness will be enhanced by redeployment of competency carriers in strategic roles. Middle-managers must be aware that core competencies are a corporate resource and must be allocated on the basis of best return for investment of skills. Reward systems should be formed around cross-boundary competencies rather than SBU competition, and team playing SBU should be compensated for their loss of resources and factored into performance appraisals. By emphasising these priorities, transfers will be less political. People rotations in early and mid-careers cross-divisions can help transfer core competencies and release the ties of specific SBU on carriers. Human resources should ensure that carriers careers are tracked and brought together regularly for transfer of ideas. Ultimately, loyalty should be to the core competency, not the business unit.

New business development built from core competencies should be at the centre of corporate strategy formation. A corporation should be conceived of as a hierarchy of core competencies, core products and market-focused businesses in order to ensure focus on a strategic architecture which guides competence acquisition for competitive advantage.

Creating Project Plans to Focus

Sustainable competitive advantage depends on New Product Development (NPD) to drive financial performance and market share. Management of innovation planning requires development of an “aggregate project plan” rather than relying on annual strategic business plans. Without specific guidance on formal ways of choosing projects, there is a risk of over commitment of resources, delays, poor focus on strategic goals and redeployment on short-term issues rather than long term development. More effective NPD strategies can be achieved through planning, prioritising, sequencing and managing the development function.

The project plan covers 5 types of projects, commercial and R&D. There are different resource implications and returns for the types of projects. Commercial projects are derivative, breakthrough or platform. Derivatives are incremental development of existing products, requiring few resources, time and management. Breakthrough projects involve significant changes to core products and processes to create new products and markets, requiring greater investment of resources, longer timeframes, and potential changes in tooling and techniques. Platform projects are designed with feature enhancements for core customers, but with modularity to simply add or subtract features to meet the needs of specific segments, with a smooth migration path between iterations. Platforms allow for greater market penetration and strategic opportunities, so are core components of the project plan. R&D projects develop capabilities and technological understanding for future leverage in commercial projects. Since R&D is more risky, it must compete with commercial projects for resources. Alliances and partnerships allow access to external competencies and can be any type of project, so the resource requirements can vary considerably, but it is always necessary to monitor the project and ensure knowledge acquisition is occurring productively.

In the PreQuip case study, they were not adapting to changing customer requirements and resources were not being allocated efficiently. Through remapping the projects to customer priorities, they could design single platforms with several derivative products. By ensuring modularity and simplicity, the manufacturing quality could be higher with several derivatives on a single production line. The breakdown of types of projects was assessed based on the number of engineering months for each type of project, and allocated on the basis of the desired mix of 50% platform, 20% derivative and 10% each to breakthrough and partnerships. This led to dropping from 30 projects to 11, with considerable productivity improvements, whilst still ensuring a capacity cushion with 5 floating engineers.

By focusing on platform projects, development resources can be utilised to offer a coherent and consistent development plan. Breakthrough projects lead to platforms which spawn derivatives. Industrial progression typically comes from new markets in breakthrough products with superior features and performance, which are followed by derivative products with incremental developments from competitors. Platform projects allow products to be built in generations, reducing risk and chaos in the development process and lowering unit cost.

One way to allocate resources in a structured way is steady stream sequencing, which aligns development with management priorities and ensures cross-fertilisation of ideas and knowledge. As one project draws to a close, some of the spare developers are assigned to begin working on derivatives of the platform for a new release once every 6 months. As the derivatives are coming towards the end of the first platform, the learning and knowledge can be leveraged for the next generation of the platform. By planning to release a new platform every 2 years, releasing 2 or 3 derivatives for each, there is steady development. Also, by deploying resources with some to derivatives and some to other projects, knowledge transfer can occur amongst different projects, allowing for strong resource development.

Alternatively, with multiple product lines and more platforms, spacing between them is wider. When one platform is completed, the development team work on another product family. The product is left for a while with no derivatives, but as it ages and is becoming less competitive, the resources are brought back to release derivatives based on market feedback and competitors offerings, to rejuvenate the platform. The skills and knowledge learned from the derivatives is then used to develop the next generation. In organisations with faster feedback loops on market data, initial platforms can be followed with immediate derivatives, followed immediately by the next generation. This means building up momentum in development and offers improvements in manufacturing processes automation and resources. However a company builds their platform/derivative mix, competitive advantage is achieved by the speed in which new platforms can be introduced.

Aggregate project plans allow for the shaping and building of development capabilities of individuals and organisations. It allows training and career paths to be mapped out in alignment with strategic goals. New managers can be allocated to simpler derivative projects, whilst proven managers can be assigned the complex and critical platform projects. Moving key engineers between commercial and research ensures technology transfer between departments. It also helps identify gaps in capabilities and develop ways to fill them.

A sustainable development strategy requires active participation, involvement and support from top management to implement and develop the plan. The planning process is almost as important as the plan itself, as it links resource allocation to strategic objectives.

New Product Development (NPD) at Dell

Dell's first line of portable laptops had been unsuccessful with many recalled. In order to put together a more winning product portfolio in their next attempt, they instituted a NPD structure. They planned to differentiate their new laptop platform through new battery technology (LiOn) but Sony, their supplier, did not have a reliable product to offer them during the early phases of development. This paper addresses the decision process which they went through in order to decide how best to plan for the most profitable solution.

Through the 60s and 70s, computing was the domain of mainframes, but innovations in microprocessor technology lead to commercial consumer products and the proliferation of clone IBM PCs. Dell grew out of an entrepreneurial college venture through a low cost business model of direct sales of mail order customised clone PCs. Dell's innovative processes were focused around building a direct relationship with computer savvy customers reducing support costs through self-resolution, mass customisation, low inventories and strong supply chain management. These innovations led to faster development cycles and quicker adoption of new technologies. Although Dell's strategy was initially highly effective, in the early 90s, new competitors based on similar business models, rapid unplanned growth and a price war impacted on the success of the model. Dell had also started to move into the retail sales market which was culturally unsuitable for their Spartan style, slowing their turnover of inventory and leading to drops in projected profits. In order to move into the next stage of maturity of the company, a more experienced management team was required, along with a more structured NPD process.

The early NPD strategy was informal and did not adequately state project boundaries, or assess risks and costs of investment, but by 1993 it was clear that it was going to be necessary to update their methods. Dell formalised their approach to NPD by separating it into six clearly defined phases. The first was the Profile Phase, where the development team laid out product and market definition and specifications, along with a feature guide. Next was the Planning Phase, where a business case for the product was constructed, analysing the core assumptions and the expected financial impacts of the project. Following was the Implementation Phase, where prototypes were manufactured, instruction manuals and service plans were developed, and after successful completion of the phase, long lead time tooling was ordered representing a high level of financial commitment. The next phase was the Qualification Phase, where prototypes were distributed to key customers for feedback and sales force training. The Launch Phase followed, with end-to-end testing of the customer buying experience and initial customer shipments. Finally, the Acceptance Phase involved acquiring customer feedback for 3 months after launch to compare planned objectives with achieve performance and compiling a list of lessons learned.

Using their new NPD process, Dell planned on launching a new portable computer platform following ongoing difficulties with their previous range. The core team of planners came from a broad range of expertise, including electrical, mechanical, industrial and software engineers. From concept to product, the development phase was scheduled to take 18 months, with 14 months of development and 4-5 months of tooling. The product's lifecycle would be approximately 3 years. Based on market research suggesting that key features for customers were price, microprocessor, battery life, screen resolution, reliability, size and weight, the team found that battery life was to be the core decision.

Dell's decision lay in whether to offer the Latitude range with the new Lithium Ion (LiOn) batteries, or to use the current reliable technology. Early development data from Sony, their supplier, suggested that there would be a marked improvement over current batteries, but there was a risk as to whether Sony would be able to resolve the difficulties with the technology in time for the Latitude launch. By the end of the Profile phase, there were three available options, each with different risk and financial implications. Firstly, Dell could use existing technology, using the extra space for more components, but without competitive differentiation. Secondly, they could use the new battery, losing space, but potentially buying up all of Sony's supply for years, effectively cutting the competition out of the market for the batteries. Finally, they could defer commitment by two or three months, hoping that there would be more information available. This could be achieved by either over designing the battery space and circuitry so it was compatible with both technologies or by designing both in alignment until taking the decision. Clearly, depending on the route chosen, there would be differing risks and costs, leading to different levels of expected return. By analysing these risks, costs, and expected impact on market share, Dell was in a better position to make a strategic new product technology decision. Through analysis of Dell's NPD methodology, it can be seen that their phased strategy could also be profitably applied by other organisations.