Managing the Integration of Technology into the Product Development Pipeline

by

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in Partial Fulfillment of the Requirements for the Degree of

Master of Science in Engineering and Management

at the

Massachusetts Institute of Technology

January 2005
(FEBRUARY 2005)

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Abstract:

Managing the integration of technology is a complex task in any industry, but especially so in the highly competitive automotive industry. Automakers seek to develop plans to integrate technology into their products such that they deliver significant value to the customer. These plans and their implementation are critical to achieving success in the marketplace.

This thesis proposes a framework for developing and implementing technology integration plans using the systematic application of specific "building blocks". The "building blocks" are developed through specific technology integration case studies at an automotive manufacturer, and further validated by studying other auto manufacturers. While the current technology integration process at the main automotive manufacturer studied is somewhat structured, the process seems inadequate, as significant issues with the strategy and implementation diminish its effectiveness. There are many building blocks that can help define and implement a strategy for technology integration, but which ones to focus on and how to apply them is not well defined.

The proposed solution for developing a comprehensive technology integration process and applying it systematically, focuses on five key building blocks. Each of the building blocks is applied through a holistic lens, and is designed to enhance the technology integration process. The proposed methodology can be a complement to an existing process, or can be used to create a new technology integration process. The methodology combines known system engineering and change management frameworks and principles.

Analyzing the current technology integration processes at a few automotive manufacturers and contrasting them with the proposed technology integration approach leads to several conclusions. The technology integration framework provides a valuable and comprehensive method to evaluate the current technology integration process. Each step in the technology integration framework serves to strengthen the technology integration process and is aimed at making it more consistent and successful. Furthermore, the framework as a whole, contributes to alignment within the organization, helping to ensure objectives at the staff level are matched to the corporate strategy.

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Acknowledgement:

I would like to extend my gratitude to all those that contributed to this thesis and supported me throughout my MIT SDM education. I would like to thank my employer and my management, Chris Brewer and Dawn Paluszny, for giving me the opportunity to participate in the MIT SDM program. Thank you also to my advisor, Professor Nightingale, for her guidance during this thesis. Her knowledge and ability to focus my efforts while encouraging new perspectives and learning reflects the high quality of teaching at MIT.

I also would like to thank my work colleagues for their support during the past two years. Balancing school, work, and personal life is a difficult proposition, and your support was very welcome. Specific appreciation is also directed toward Rob Vane and Chet Kuziemko, who contributed to this thesis by investing their time and effort to discuss and review the thesis material. Their knowledge, experience, insight, and willingness to share information were invaluable during the development of this thesis and are testimony to their commitment and passion for their work.

Most importantly, I would like to thank my wife, Leigh, for being a source of continued support throughout the MIT SDM program. Without her unconditional patience, love, and encouragement, this thesis would not have been possible. Additionally, I would like to thank my classmates, Andrew Bond and Michelle Stevens, who were willing to focus our Technology Strategy team projects on issues that were useful to my thesis.

Thank you also to all of my classmates in the MIT SDM program. Your diversity of insights, talent and knowledge sharing contributed to an amazing learning experience.

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Chapter 1 - Thesis Introduction

1.0 Introduction

In a television ad in the 1990s, Lee Iacocca, former president of Chrysler, described the three positions a company can take in the automotive industry by saying "...you can lead, follow, or get out of the way!". This statement holds true today as automotive companies struggle to develop sustainable strategies for growth, and leaders and fast followers begin to emerge from the pack. Many different aspects have been used to analyze the automotive industry and develop scenarios that lead to a path for continued growth. Technology, in the form of innovation, is a critical area that needs to be explored extensively in order to develop strategies for sustainable growth in an increasingly competitive industry.

An effective technology strategy that is able to deliver competitive advantage in the form of enhanced customer value depends upon a realistic corporate technology vision and the corporation's ability to implement it. The implementation of strategic plans is often difficult because it requires all business units and employees to be aligned and committed to the strategy. Integrating new technology into the corporation's product development process is an even more complex endeavor because it involves external entities in the form of suppliers, universities, and other Original Equipment Manufacturers (OEMs). Long-term corporate sustainability will be dictated by the corporation's ability to create and leverage competitive advantage through the delivery of value to the customer. The corporation's ability to implement its technology strategy plans and integrate technology into their products will become a key enabler to deliver value.

This thesis develops a strategic action plan and a framework to address the issues of integrating technology into the products of a large scale automotive manufacturer (hereafter referred to as OEM-A), while balancing the business and product needs in today's challenging

business climate. In this context, technology integration is defined as the process through which a corporation sets its technology vision and puts in place operational plans that are aimed at helping them achieve their vision. Technology integration, therefore, manages the capabilities and interactions of research, development, and implementation efforts using a systematic approach.

1.1 Problem To Be Addressed

There are key gaps present in OEM-A's current technology vision, strategy and practices. These gaps are causing OEM-A to lag other OEMs with respect to product technology, and this positioning is only deteriorating. The risks of not developing, implementing, and defending technology and associated intellectual property are significant and growing. These gaps need to be addressed if the corporation truly desires a sustainable long-term technological competitive advantage.

1.2 Current Technology Integration Process

The Advanced Engineering group at OEM-A leads the technology integration process with input from both within and outside of their division, namely the Technology Strategy Office, the Automotive Strategy Office, and the Program Business Groups. Advanced Engineering is the group responsible for forward-looking research projects whose objectives are to develop innovations that will propagate into the company's mainstream products within three to ten years. The Technology Strategy Office is a group within Advanced Engineering that works somewhat independently. This group is responsible for running the business operations of Advanced Engineering and managing the technology portfolio plans. The Automotive Strategy group focuses on long-term planning and strategy issues more closely related to the business and products rather than technology. Finally, the Program Business groups (PBGs) are responsible

for all aspects of delivering a vehicle platform, including costs, timing, functionality, reliability and quality.

Three main phases, or gates, represent the bulk of the current technology integration process at OEM-A: the project selection phase, the project development phase, and the implementation phase (see Figure 1.0). Most of the efforts of the Advanced Engineering group are spent on the project selection and project development phases, while the PBGs are responsible for the implementation phase. The project selection phase begins by gathering information and trends from suppliers and from OEM-A internal areas. Once these innovations have been identified, an internal technology board of directors (members on this board are the directors of the OEM-A brands as well as Advanced Engineering, Core Engineering, Marketing, and Purchasing) is engaged to prioritize the technologies or innovations based on the perceived benefit to the corporation. In addition to prioritizing the innovations, this technology board of directors is also responsible for reviewing the due diligence process (which is carried out by Advanced Engineering and the PBGs), and then making recommendations to the Global Product Development Matters group. This group, whose members consist of vice-presidents of product development, has the final word on the go/no-go decisions at the end of the project selection phase.

Once the project selection phase is completed, the project development phase begins by pursuing the technical and business development of the selected technologies. At six-month intervals, the Vice-President of Advanced Engineering reviews the progress and status of the technologies. If the progress meets the pre-determined technical and financial targets and the technology is considered to be transfer-ready, it is then transferred to the lead user program. However, if the technology is not meeting targets, recommendations for next steps, which can

include canceling the project, requesting additional funds/human resources, etc., are presented to the Global Product Development Matters group to decide a course of action.

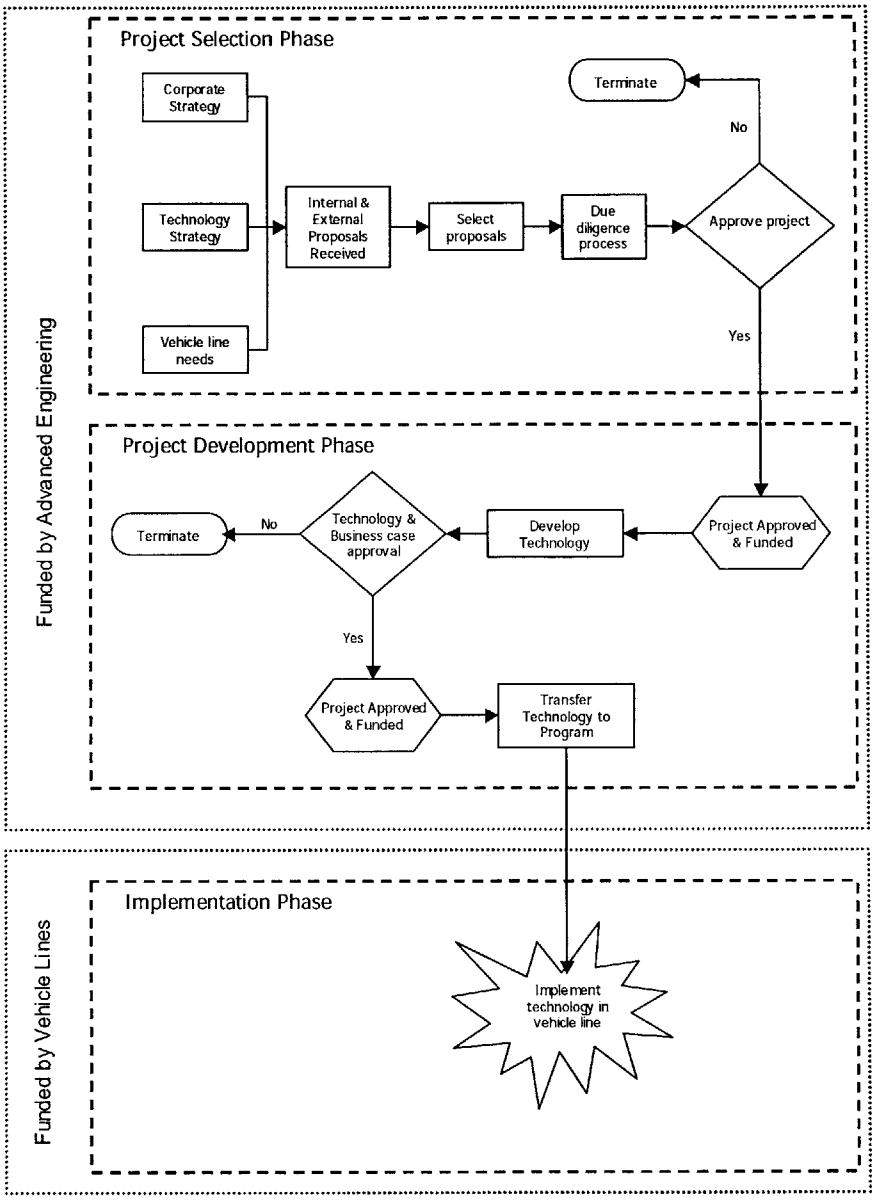


Figure 1.0 - Overview of Technology Strategy & Integration Process

The implementation phase begins when the technology is transferred to the lead user program. The program is then responsible for completing the final development, design and release of the technology into the vehicle line. The program business group is also accountable

for developing a migration strategy for the technology, which means they have to decide which subsequent programs (from any of the program groups or brands) could or should use this technology in their vehicle lines.

1.3 Gaps In The Technology Integration Process

Each one of the groups mentioned in the previous section works independently of one another in the day-to-day operations of the company. The management chain and reporting structures of these groups are completely separate from each other up to the Vice-President level. Each one of these business units acts and operates as a silo, focusing only on their core responsibilities except when they are required by management to work together on a specific project. The current technology integration process at OEM-A is organized in such a fashion that it requires these groups to interact in a cross-functional and cross-organizational manner. However, there is very little centralized control or guidance to oversee the process through completion, which translates into a poorly managed process. Furthermore, this lack of control over the process dilutes the corporation's ability to focus on and successfully integrate new technologies into its products.

Some of the organizational issues of the current technology integration process stem from the technology vision of being a "technology leader" without further definition of what this means or how to prioritize potential new technologies. It is clear that the financial and human resources required to be a leader in *all* technologies used by the industry makes this vision unattainable. It is impossible to be the leader in all areas, but it is unclear who defines which areas are most important. Therefore, the technology integration process is ill equipped to filter ideas and focus on a select few. As noted in an IBM development efficiency study, over-commitment of resources leads to lower employee productivity such that project delays become

commonplace (Henderson, 2004). Indeed, instead of a technology leader, OEM-A has become a technology follower having implemented only approximately 7% of all technology projects initiated by the Advanced Engineering group between 2001 and 2003.

Beyond the technology vision, there are also issues with the governance of the technology integration process. Although there are two distinct governance activities managing this process in its early stages, there is no centralized activity that has the authority to control the process from idea generation to implementation in a vehicle line. Once new technologies are transferred to a program, the burden of incorporating the technologies in the vehicles lies on the program's shoulders and there is no activity that has an oversight role in this part of the process. Since the programs act as independent business units, they are responsible for managing their budget and balancing it with their functional targets and customer needs. These constraints oftentimes preclude a program from implementing new technologies.

In most cases, the involvement of the programs in the early phases of technology selection is minimal at best, which means they have not necessarily bought into the perceived benefits of the technology. The situation is almost like receiving an unwanted gift and then being told that you have to use it. On top of this, the lead user program is still required to pay for most of the development costs, as the new "gift" is usually only a working model and requires further development of functionality and scalability (so it can be adapted by subsequent vehicle programs). Unless the technology is a major breakthrough that can be achieved at a reasonable cost, it is highly unlikely that the program will actually carry it through to implementation unless forced to by senior management.

In addition to the issues identified above, another major deterrent to the success of the technology integration process is linked to suppliers and their participation in the technology

integration process through the submission of innovation ideas. The lack of a centralized governance board with authority over the entire process from idea generation to implementation, as discussed above, leads to a relatively low implementation rate. This discourages suppliers from submitting ideas and/or new or emergent technologies into the innovation funnel because based on the historic low implementation rate, the suppliers have low confidence that the technology they are proposing will be used in a vehicle line. Compared to other automotive manufacturers, OEM-A prevents early supplier sourcing (to keep the doors open to other, potentially more capable, or lower-cost suppliers), and provides very little co-development support to suppliers for developing new technologies. This further discourages supplier involvement and erodes trust between the suppliers and OEM-A.

1.4 Approach To Address The Problem

OEM-A has recognized some of the issues with their current process and is working on developing a revised technology strategy and integration process. Through the course of assessing their competitiveness with other OEMs, OEM-A has identified a few key areas where improvements are necessary in order to achieve the level of competitive advantage it desires. This thesis will focus on addressing potential issues in these areas by developing a roadmap and framework for technology integration.

A case study approach is used to identify the critical factors contributing to ambiguity and misalignment in the current technology integration process. A total of three case studies are explored to understand the obstacles that OEM-A faces when attempting to implement new technologies. In addition to the case studies, a questionnaire was also developed to understand OEM-A's corporate perception of how well the current technology integration process works. The lessons learned from the case studies and from the questionnaire are then used along with

change management, organizational, and technology strategy tools and principles to develop actionable steps supporting the strategic plan. This approach is shown in flowchart form in Figure 1.1 below. The deliverables for this thesis are the following:

1. Specific recommendations for technology integration at OEM-A (strategy & actionable steps).
2. A framework that can be used to assess and analyze the technology integration process at any firm.
3. A general technology integration roadmap applicable to any firm.

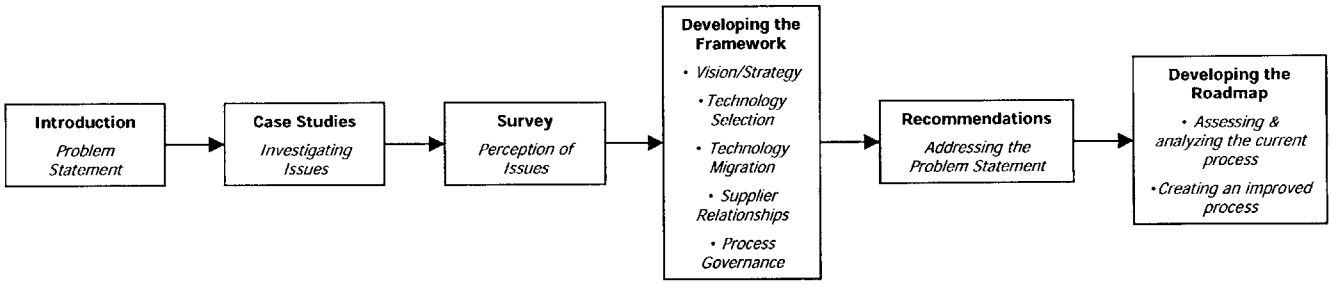


Figure 1.1 – Thesis approach

1.5 Subsequent Chapters

Chapter 2 leads into a discussion about the case studies and the corporate perceptions of strengths and weaknesses in OEM-A's technology integration process. Chapter 3 delves into the issues around developing a corporate vision for technology, and the creation of a strategy for technology that the corporation can use to align its efforts. Technology selection issues along with a proposed technology selection process are discussed in Chapter 4. The need for supplier integration is studied in Chapter 5, along with some insights into how to implement it. Chapter 6 investigates the technology migration planning process and discusses the requirements and implications of this process. Chapter 7 discusses the technology governance process and outlines a method for improved communication and efficiency. Chapter 8 introduces a framework and

roadmap for technology integration that can be used by any corporation looking to improve their technology integration process. This chapter also outlines recommendations for OEM-A to improve the rate and quality of technology integration.

Chapter 2 - Technology Integration

2.0 Overview

This chapter investigates how OEM-A deals with integrating new technologies into its products and provides some insight into the gaps between the desired and actual process flows. Three case studies are presented to illustrate some of the critical factors leading to successful or less than successful technology integration. The case studies encompass some of OEM-A's attempts at integrating new technologies and they discuss specific issues that have helped or hindered the success of each project. The technologies explored in the case studies represent new ideas for safety, fuel economy, and comfort improvements.

Beyond the case studies, it is also valuable to understand OEM-A's perceptions about how well the technology integration process works. To shed some light on this and gain further insights into senior management's assessment of the strengths and weaknesses of the current technology integration process, a questionnaire was developed based on some of the lessons learned through the case studies. The results of this questionnaire also serve as a tool to confirm whether the issues uncovered in the case studies are isolated cases or represent signs of more systemic problems.

2.1 Case Study 1 – Safety Technology (SFT)

Project background

This case study focuses on a technology (hereafter called SFT) developed to enhance a vehicle's stability in adverse conditions. SFT was a spin-off from a safety technology that was first introduced in the 1999MY of one of OEM-A's vehicles. The technology that was present in this 1999MY vehicle formed the basis for SFT technology. Most of the team that developed SFT

also had worked on the "baseline" technology introduced in 1999, and were very familiar with the strengths and weaknesses of the system. SFT began as a "bottoms-up" project when engineers working on the "baseline" technology began developing SFT on their own, purely out of curiosity. Once the engineers realized the potential benefit of SFT, they communicated the idea to their manager and showed a concept model of the system. This concept model of SFT was enough to convince the engineers' manager to authorize them to proceed. Following this approval, a prototype was developed to prove out the concept; the prototype was crude and cheap, but was enough to show the functionality and benefits of SFT.

An engineering VP was one of the first senior management supporters of this technology. As such, he approved funds for purchasing data acquisition equipment that was needed for developing the first working prototype of the SFT system. To convince the senior management team at OEM-A to buy-in to SFT, a video was produced that showed how a vehicle reacted with and without SFT. This video was then circulated amongst management as a means to "sell" the technology. When the engineering group VP saw the video, his reaction was "I want this system, and I want it now!" The core engineering VP became the executive champion sponsoring this technology and maintained regularly scheduled progress meetings (every 2-3 months) with the team developing SFT.

Project Team

The team developing SFT consisted of engineers from OEM-A and the supplier - however, all the "hats" were left at the door; while working on SFT there was no "OEM-A" guy, or "supplier" guy, everyone was part of the same team. The team was co-located and dedicated to deliver the project.

Supplier Relationship

The relationship with the supplier pre-dated the development of SFT. OEM-A and the supplier had already worked together to develop the "baseline" technology from which SFT spun-off. However, OEM-A did 95% of the development work for SFT, and established a position of authority by defining the interfaces between the OEM-A algorithms and the supplier hardware and algorithms.

There was a joint development agreement created with the supplier, which outlined specific performance targets, objective targets, and responsibilities of both parties. Intellectual property discussions were key to establishing boundaries for responsibilities between OEM-A and the supplier. One of the keys to the successful development of SFT was that the hardware and software interfaces were defined and agreed upon early in the project. Since the software yields the highest profit margins, the supplier wanted to keep this part of the business as proprietary.

In the beginning of the project, it was agreed that the supplier owned their background technology, OEM-A owned their background technology, and both owned joint technology. However, later in the project, as OEM-A contributed 99% of the invention and 90% of the resources, the agreement was changed so that the supplier could not use the joint technology without a license from OEM-A. The supplier wanted to keep SFT as their business. OEM-A had to force them to do it. OEM-A's position was "We want to be responsible for the algorithms, if you don't want these terms let us know now". There was some resistance at the management level at the supplier to implement SFT, but not at the working level. To obtain buy-in from the supplier to pursue SFT, OEM-A managers personally met with the president of the supplier. OEM-A's position was "We are going to do this (SFT). We want to do it with you, and we are

starting right away". OEM-A also requested personnel support from the supplier to be part of a co-located team to develop SFT.

The supplier agreed to work with OEM-A to develop SFT, but it still took about three months before they were able to provide dedicated resources co-located with the core team developing SFT. The relationship developed between OEM-A and the supplier during the development of SFT has led to successful cooperation in two other vehicle programs.

Push for Technology

Management push for this technology was based on an increasing awareness by customers of the need for this type of safety technology. OEM-A's brand X marketing group found out about this technology and was convinced that they had to have it. This provided a big push for SFT. Brand X's perspective was that SFT was a much-needed complement to their portfolio of safety related technologies. The marketing groups from OEM-A's other brands were more skeptical about the business case for SFT – they were concerned that customers would not be willing to pay for something they couldn't tell was there. Brand X obtained senior management support to become the first program to use SFT.

Brand X thought they were going to get a turnkey package, but as it turned out SFT still needed a lot of development work. The Global Core group thought the technology was implementation ready, but in reality, it was not. This caused a 6-month delay in the introduction of the first vehicle with SFT.

Organization at the supplier

The supplier's operations near OEM-A's headquarters were responsible for SFT, while the supplier's headquarters in Europe were responsible for other functions and were only involved as observers at first. The supplier's headquarters in Europe was reluctant to implement

SFT, and it was only after the supplier's operations in the US and Europe merged in the spring of 2002, that the supplier agreed to help develop and implement SFT. This helped OEM-A tremendously as it allowed OEM-A to interface with a single team.

Organization at OEM-A

A few years ago Advanced Engineering used to be a separate department, and as such when it developed a technology to the point of transfer readiness, nobody in the implementation group knew about it. There was no acceptance from the engineers that were supposed to implement the technology. Additionally, Advanced Engineering was not aware of cost and timing constraints from the programs. Since then, Advanced Engineering and the implementation groups have been organized into one single group, so the same engineers that develop the technology are also responsible for implementing it.

Other Key points

Senior management at OEM-A required the team to have a migration plan in place that showed how the technology would be used in one million vehicles. Without this plan in place, the team was not allowed to continue developing SFT. Additionally, the team obtained a signed agreement from the vehicle line director that said if SFT was delivered, they would guarantee that it would be implemented in a program. This agreement provided the SFT development team a strong incentive to get the technology implementation ready.

SFT Case Study Summary

The development and implementation of SFT did not happen without obstacles. After the technology was "sold" to management at OEM-A, they still had to convince the supplier to allocate the necessary resources to help co-develop the technology. Intellectual property issues also led to delays in the implementation of the technology. Although there were issues with the

implementation of SFT, overall this is considered a successful example of technology implementation at OEM-A. Today, SFT is a technology that is being used in multiple vehicle programs at OEM-A, and other OEMs have developed similar technologies in light of its benefits and customer's desire to have it.

2.2 Case Study 2 – Comfort Technology (NES)

Project Background

This case study focuses on a technology (hereafter called NES) designed to suppress engine noise via the use of an electronic controller, microphones and speakers. NES was a project initiated by a supplier. The supplier came to OEM-A with a technology demonstrator project and asked if OEM-A was interested in it. At the time, OEM-A was not interested in noise suppression; instead, OEM-A was looking for something that could modify engine noise, specifically to enhance noise quality. However, since NES did exhibit potential to help with noise quality (by suppressing unwanted frequencies), OEM-A decided to pursue the technology.

The supplier predicted significant noise reductions at a cost of $10 per vehicle. This figure later proved to be based on unrealistic expectations. Technically the project was a success; the sound quality group was very happy with it. However, the costs were out of control. OEM-A could not understand the supplier's costs and it was difficult for OEM-A to get any cost information from the supplier.

Project Team

The supplier carried out development of the NES technology, with general supervision from OEM-A. The early agreements between OEM-A and the supplier stated that OEM-A owned the installation and tuning of the NES system, but the supplier owned the intellectual property that formed the basis of NES. The team developing NES consisted of personnel from the supplier and from OEM-A. In the early phases of the project, the team was not co-located

even though the supplier was located within one hour of OEM-A's headquarters. The lack of a co-located team hampered the development of NES. It was only after the teams were co-located that significant progress was observed.

Supplier Relationship

The first phases of the project, including target development and the establishment of deliverables and timing worked out smoothly. Cooperation and communication between the supplier's development team and OEM-A's implementation team was excellent. Morale and *esprit de corps* was high. Program reviews were intermingled with social events that served as team-building opportunities. However, the situation was not always rosy. Although the supplier's intellectual property was protected through non-disclosure agreements, they were very secretive about the technology. The supplier's reluctance to divulge information about the intricacies of NES to OEM-A, sowed the initial seeds of mistrust between the two companies. OEM-A needed to know enough about the technology to have confidence that ultimately it would work in the robust environment of a production vehicle, however they did not get the answers they needed. To answer their concerns, OEM-A hired a third party consultant, which in turn caused resentment at the supplier. In general, the supplier seemed to have a lack of trust towards OEM-A and was unwilling to have open discussions about NES. Once OEM-A communicated that the supplier was in danger of losing the business, they opened up and assigned their best technical people to the project. However, this was too little, too late. In addition, even at this stage, the supplier claimed they still could not meet the cost target.

The supplier seemed to have a general lack of recognition for the NES project, and as a result did not have a realistic focus on variable costs. The supplier was tasked with delivering a turnkey system that OEM-A could then fine-tune to use in any vehicle program. However, the

supplier did not show the desired progress on NES, so OEM-A brought in their own technical experts to help. The reaction from the supplier was "No thanks, this system is our secret and we don't need your help to develop it".

A vehicle drive evaluation was scheduled to highlight the NES technology to senior management at OEM-A. The supplier could not get the system to work on time for this drive and the evaluation was cancelled. In general, there are few opportunities to impress management, and they missed their chance. This did not instill confidence in OEM-A that the supplier could deliver the desired functionality at the agreed upon cost.

Push for Technology

Assuming it is possible to get economies of scale by applying this system across several vehicle programs, a system such as NES could provide OEM-A cost effective means to use noise quality as a differentiator across vehicle brands. OEM-A was particularly interested in NES because of its perceived ability to fine-tune engine noise quality. In fact, OEM-A was interested in NES's ability to "sculpt" the engine noise, but this capability was still unproven. This was a departure from what the supplier had intended the technology to be used to do. The initial presentation by the supplier emphasized NES's noise suppression capability (which had been proven) and suggested nothing about engine noise "sculpting". Despite this difference about the use of the technology, OEM-A tasked one of its brands to work with the supplier to get NES to implementation ready status.

Organization

The supplier's technical lead was hard to get a hold of, and was not dedicated to the project. Contact between the OEM-A team and the supplier technical lead happened seldom, but good information exchange did occur during these contacts. There seemed to be some internal

issues between the implementation and development teams at the supplier. These issues may have stemmed from political bickering within their organization.

Throughout the project, the supplier and OEM-A had a high turnover of personnel on the NES project. This meant that the existing team members had to take on more responsibilities, and had more opportunities and stress to deal with. Having stability and team members who stay with the project from its start to completion ensures no important facts are lost and work is not duplicated either internally or externally. Along with personnel turnover issues, later in the development phase of NES face-to-face meetings between OEM-A and the supplier stopped. Emails and telephone conference calls were used instead of face-to-face meetings, but these are poor tools at communicating urgency and the hidden factors of stress and anxiety.

Other Key points

Despite personnel turnover, direction changes, and other typical problems, after a lot of hard work NES technology was implementation ready on time. Unfortunately by the time it was ready, or at least close to ready, the costs exceeded the initial target vehicle's budget. To bring costs down OEM-A needed volume and economies of scale, but volume could not be realized until the technology had been proven in a production vehicle and deployed onto multiple platforms. However, since the costs had spiraled out of control, migrating the technology to high volume programs became impossible and the project lost its appeal.

Although there was much progress in making the technology viable from a technical standpoint, the business plan development did not fare very well. The business case, as it stood, was not robust enough to support NES. Ultimately, this led OEM-A to make the decision of not implementing the NES technology.

NES Case Study Summary

From what started as a promising technology, the development of NES was burdened with two persistent issues. The first issue was the lack of trust continuously displayed by the supplier with respect to OEM-A. This was no doubt driven by OEM-A's history of preventing early sourcing of suppliers. The supplier was reluctant to share information about how the system worked, which left OEM-A uneasy about NES's reliability given the harsh automotive environment in which it was supposed to operate. When the supplier ran into technical problems during the development of NES, OEM-A offered up some of their technical specialists to help solve the issues. The supplier, however, refused to accept any help because they did not want to divulge any parts of the inner working of NES for fear that OEM-A would copy the technology – even though it was protected by non-disclosure agreements.

The second issue was the development of the business case. From the very beginning of the project, the supplier seemed to have an unrealistic grasp on the financials related to NES. Repeated inquiries to the supplier about cost were left unanswered, which did not improve OEM-A's confidence on the ability of the supplier to deliver NES at an affordable price. The costs were never close to the initial, agreed-upon, target costs and at the end of the day the business case did not make sense. Today the NES technology is book-shelved, and OEM-A has not implemented it in any program because of its high cost. As such, NES is considered an example of unsuccessful technology implementation.

2.3 Case Study 3 – Brake Technology (BTE)

Project Background

This case study explores a brake system technology (hereafter referred to as BTE) that provides flexibility in terms of its functionality and is a key enabler for collision mitigation systems. The BTE project was initiated internally at OEM-A, by a team from the Advanced

Engineering group. The OEM-A team working on BTE created a document outlining the development responsibilities (supplier vs. OEM-A) and the system specifications. This document was circulated amongst senior management at OEM-A for concurrence. Once concurrence was obtained, the system specifications were sent to several suppliers for bidding. From the list of suppliers OEM-A had confidence in, only one was able to meet the required project timing. Therefore, in essence, the supplier selection happened by default. At the time, this supplier was also providing another OEM with a similar brake technology. However, a major part of the system designed by OEM-A was considered "core" and was protected through patents.

Project Team

The team developing BTE consisted of engineers from OEM-A and the supplier. The initial document that assigned responsibilities to the supplier and OEM-A was clear enough with regard to division of labor and deliverables that OEM-A and the supplier could work independently, with only a few meetings required to ensure the system could be integrated. OEM-A and the supplier worked closely together only when specific issues were identified, and these efforts were always very cooperative.

Supplier Relationship

The initial cost figures the supplier was forecasting to develop the BTE system designed by OEM-A were quite significant. OEM-A balked at the cost, and one of OEM-A's senior vice-presidents had to step in to arbitrate an agreement with senior management at the supplier to reduce the development costs. This was a business that the supplier did not want to lose, and OEM-A knew this. Since OEM-A had the upper hand in the discussions about cost, OEM-A's position was "We want this system, and we will pay this much for it...". The final agreed-upon costs were still too high for the budget within Advanced Engineering at OEM-A. To resolve this,

OEM-A decided to split its development costs between the Advanced Engineering group and the first vehicle program that was to use BTE.

Detailed project specifications were created early in the development of the BTE project. These specifications defined the hardware behavior and the software interfaces between what was to be developed by the supplier and what was to be developed by OEM-A. The supplier was to provide the actuator system and OEM-A would define the software architecture required to deliver the desired system functionality.

Push for Technology

The supplier was providing a technology similar to BTE to another OEM, and some brands from OEM-A were very interested in the technology. These brands felt they needed this technology to effectively compete with other OEMs. They believed that BTE was the "next big thing" in brake technology. BTE was also very desirable because it was a fuel economy enabler on hybrid vehicles, contributing approximately 30% of the fuel economy savings while its cost was equivalent to conventional braking systems with all the latest advanced features. Additionally, NES technology also provided the foundation for yet another brake technology that was looming in the horizon - collision mitigation systems.

Organization

Two brands from OEM-A were initially interested in BTE. Both brands were committed to implementing NES, but they desired further cost reductions. While cost reduction negotiations were taking place, the supplier identified some risks associated with BTE, namely 1) the reliability of the system could be worse than conventional brakes, and 2) BTE would heavily depend upon the vehicle's electric system, so if any issues existed in the electric system they could compromise the performance of BTE. This was a cause for great concern, and one of the

brands that was initially interested in BTE decided not to pursue this technology. This left only one brand and one program who were still committed to implementing BTE.

OEM-A's Advanced Engineering group continued to work with the supplier to develop BTE to the point that it was implementation ready. There were regularly scheduled project progress reviews with senior management to help guide the process and instill confidence in them that this technology would deliver the desired functionality. During one of these reviews, senior management decided that reliability was a program task – which meant that they considered BTE implementation-ready, but the vehicle program would still have to work on development of BTE to resolve the reliability issues. This decision caused OEM-A to take on significant timing and costs risks because the vehicle program did not have the necessary resources to bring BTE to a truly implementation-ready stage. The program was not able to find a good fleet in which to test BTE, so mileage accumulation took longer than expected. This eventually led to a delay in reliability confirmation.

Other Key points

The initial perception that OEM-A had with respect to BTE technology was that it was necessary to satisfy all consumer markets, from the entry-level small car all the way to full-fledged luxury vehicles. This perception proved to be incorrect, as the gap between conventional brake technology and BTE became smaller due to better than expected progress in conventional brake technology. The original business case was developed under the incorrect perceived need for BTE, and therefore had to be revised. The new business plan was much less attractive to OEM-A, but would still deliver value in special niches.

BTE Case Study Summary

The development of BTE began with the right steps. OEM-A created a detailed document with the system requirements and system architecture, and outlined a clear division of development responsibilities between themselves and the supplier. This document provided the basis for contractual negotiations with the supplier and defined the boundaries of intellectual property for both parties.

The cost negotiations did not go as smoothly. Initial quotes from the supplier far exceeded what OEM-A was willing to pay for the development of BTE. It was only after a few meetings between senior management at both companies that a final agreement was made on the development costs. Another impediment in the development of BTE was the deterioration of the business plan because of the incorrect perception of the usability of BTE. When the development of BTE first began, the implementation plan called for the use of BTE in many vehicle platforms, but the unexpected advance of conventional brakes made this decision unaffordable. In the end, BTE was successfully implemented in a vehicle program, but its application across multiple platforms is unlikely.

2.4 Lessons Learned

Through the development of the case studies, several interesting lessons emerged. Although the case studies included successful and unsuccessful examples of technology implementation, all the cases highlighted things gone right and things gone wrong. In the case of successful implementation of technology, the things gone right far outweighed the things gone wrong, and in the unsuccessful cases the opposite happened. Some of the lessons learned may seem obvious, but their importance cannot be undermined. Sometimes the simplest things are taken for granted, such as regular face-to-face communication, leading to an erosion of the quality of the deliverable.

In studying the lessons learned, it was observed that groups of lessons could be lumped together to form a "critical category". These critical categories refer to the high-level steps that will form the basis of the technology integration framework. The critical categories were identified as Strategy/Vision, Technology Selection, Technology Migration, Supplier Relationships, and Process Governance.

The Strategy/Vision category encompasses defining the strategy and desired positioning of the corporation, and setting the stretch targets that need to be achieved. Technology Selection deals with defining the requirements for technology, and selecting the best alternative to help attain the corporate vision. Technology Migration brings in the business planning aspects and defines how a given technology will be used across programs and brands in order to help achieve the strategic vision. Supplier Relationships are critical to success as the reliance on suppliers to design and develop new technologies is continually increasing due to competitive and economic forces. Finally, Process Governance encompasses the delegation of authority and governance of the technology integration process to ensure the proper steps are taken and the right stakeholders are involved.

Given this definition of the critical categories, the lessons learned from the case studies were mapped into each of these major categories. Table 2.0 below highlights the level of success achieved by the different technologies in each one of the critical categories (Note: the larger the checkmark in Table 1, the more successful the technology was with respect to the given critical category). For the full breakdown of the categories and the assessment of each sub-category, please refer to Appendix I.

	Case 1 SFT	Case 2 NES	Case 3 BTE
Strategy / Vision	✓	✓	✓
Technology Selection	✓	✓	✓
Technology Migration	✓	✓	✓
Supplier Relationships	✓	✓	✓
Process Governance	✓	✓	✓

Table 2.0 – Success level attained in each critical category

Table 2.0 provides a quick visual indication of the success (as measured by the size of the checkmark) of each of the technologies discussed in the case studies. SFT was particularly successful at both Technology Selection and Supplier Relationships, while NES only had minor successes in all categories. Based on the outcome of these cases, it is observed that to "play" the technology integration game, it is necessary to achieve at least a moderate to high level of success in each critical category.

2.5 Technology Integration – Corporate Perception

The case studies highlighted several concerns with the technology integration process at OEM-A. Were these concerns indicative of a few sporadic issues, or were the concerns just the "tip of the iceberg", indicating the lack of a systemic approach to technology integration? It was determined that a questionnaire would be the best method to obtain insight into the answer to this question. The questionnaire developed to help answer this question was based on the Lean Aerospace Initiative's Lean Enterprise Self-Assessment Tool (LESAT) v1.0. The LESAT tool was developed to aid enterprise leaders in self-assessing their organization with respect to key integrative practices by providing a means for measuring progress towards organization

behavioral changes and showing the effectiveness of comprehensive improvement strategies (LESAT guide, 2001). The questionnaire developed utilizes the concepts from the LESAT tool, but applies them in the context of a corporation's approach to managing the integration of technology. Thus, the questions force the reader to think about technology in strategic terms, and assess where the corporation is today versus where it should be in the future. For a detailed look at the questionnaire, please refer to Appendix II. Here is a look at the categories of questions asked:

Strategy:

1. **Corporate technology vision** – A clear, well-defined and realistic vision exists. The vision has been communicated to all levels and has extensive buy-in by most employees. The vision incorporates a new mental model of how the company would act and behave.

2. **Senior management commitment** – There is a consensus commitment supporting a transformation based on the technology vision. Management provides support and recognition for positive actions. Senior management are champions in transforming the actions and behaviors of the corporation.

3. **Sense of urgency** – A compelling business case for change has been developed and communicated. The implications and time scales of the technology vision have been translated for each area of the corporation. Transformational progress is integral to leadership discussions and events.

4. **Comprehensive strategic planning process for Technology Integration** – Has a suitable strategy for growth been identified? Is strategy clearly defined and does it have ""buy-in"" from all stakeholders?

Technology Selection:

5. **Technology requirements** – There is a process in place to determine clear and concise technology requirements, with acceptable ranges. The process ensures a balanced representation from all disciplines across the value chain. Structured methods are used to elicit and gather needs from the different stakeholders/customers.

6. **Technology identification** – A robust technology identification process is in place, encompassing the total enterprise, including customer, alliances/partners, employees

and suppliers. Roles and responsibilities for technology identification are clearly defined.

7. **Technology valuation** – A formal process has been established for identifying technology value. Customer value strongly influences policies, practices and behavior. The practice and language of value stream mapping is recognized as an important part of an iterative improvement process.

8. **Common tools and systems** – Policies have been established and deployed that require the use of common tools and systems throughout the Technology Selection process. Common tools and systems provide easy access and reuse of knowledge across projects. Corporate-wide use of common tools and systems provides enhanced compatibility between processes.

Supplier Relationships:

9. **Define and develop supplier networks** – The supplier network is defined and developed in line with the strategic plan to ensure efficient creation of value for all stakeholders. Supplier expertise and capabilities complement Ford's core competencies; unnecessary overlap and duplication has been removed. Supplier network is flexible and can quickly adapt to changing requirements and unanticipated disruptions.

10. **Supplier performance** – Formal processes are in place for supplier assessment and approval. Roles and responsibilities are clearly defined in contractual relationships, and risk and reward shares agreed upon.

11. **Foster innovation and knowledge-sharing throughout the supplier network** – Long-term collaborative relationships are established and maintained where possible. Processes to facilitate sharing and transfer of innovation, knowledge and technology are deployed. A mutually beneficial continuous improvement process is established throughout the supplier network over the entire product lifecycle.

12. **Supplier Relationships based on mutual trust** – Communication barriers with suppliers have been significantly reduced. Stable and cooperative relationships exist among most project stakeholders.

Technology migration:

13. **Technology migration** – A formal process has been established to identify how the corporation can best deliver value across programs. The future value stream(s) reflects new and improved ways to realize value and minimize non-value adding activities.

14. **Technology scalability** – Roles and responsibilities for driving the migration process are clearly defined. Guidelines for technology migration across brands are in place. A robust process exists that identifies compatibility and scalability of technology to be cascaded across platforms.

15. **Migration & Cycle Plan** – Technology migration plans are aligned with the corporate cycle plan. Program buy-in and migration funding decisions are determined early in the migration process.

Authority & governance:

16. **Process governance** – Authority to oversee the process from ideation to implementation is clearly defined. Guidelines exist for activities and events needed to implement technology successfully. An established process is in place to determine appropriate responsibilities and team representation.

17. **Provide capability to manage risk, cost, schedule and performance** – Programs and process reviews have a portfolio approach to achieve corporate balance. A risk management process is fully integrated across the corporation.

18. **Resource and empower program development efforts** – A process is defined and used to ensure that cross-disciplinary skills are represented on teams. Resources and skills are easily and quickly shifted or divested to balance requirements across all program development efforts.

19. **Monitoring the transformation progress** – Transformation progress is judged by the aggregate benefits, not individual or localized improvements. Leaders actively participate in monitoring implementation progress and addressing deficiencies within the transformation plan. Progress reviews are documented in a common format and disseminated.

20. **Organizational orientation** – Functional barriers have been minimized. There is extensive use of cross-functional processes across the corporation. Collaborative atmosphere is fostered with emphasis in cross-functional communication and teamwork.

21. **Performance measures** – A balanced and minimal set of performance measures are used to track progress towards the strategic direction. Performance measures used assure that project and corporate measures are aligned.

2.5.1 Target respondents

The targeted respondents of the questionnaire were people who were involved with the technology processes at OEM-A. The respondent population included supervisors, managers,

chief engineers and directors whose work is related to technology processes. The areas of expertise represented by the respondent population spanned several functions, including: vehicle engineering, electrical engineering, chassis engineering, advanced engineering, marketing, competitive intelligence, vehicle architecture, and various strategy organizations. Although the total number of respondents was less than thirty, because the respondents were very close to the technology processes at OEM-A it was decided that analysis of the data would still provide meaningful insights.

2.5.2 Questionnaire results

The questionnaire asked respondents to rate each category in terms of its current state and the desired future state (representing a 3 to 5 year outlook). All the data in the analysis represents averaged results for all respondents, using equal weightings regardless of the respondent's background. The results were analyzed in terms of the current state, the desired state and the gap between the current state and the desired state. Respondents were asked to rate each category using a 1-5 scale, with the following definitions:

1. = **Low/Poor** - Some awareness of this practice; sporadic improvement activities may be underway in a few areas.
2. = **Mid/Low** - General awareness; informal approach deployed in a few areas with varying degrees of effectiveness and sustainment.
3. = **Mid/Average** - A systematic approach/methodology deployed in varying stages across most areas; facilitated with metrics; good sustainment.
4. = **Mid/High** - On-going refinement and continuous improvement across the corporation; improvement gains are sustained.
5. = **Exceptional** - A well-defined, innovative approach is fully deployed across the corporation and its suppliers; recognized as best practice.

Current State:

An analysis of the results for the current state of the technology integration process shows that the categories with the lowest ratings are: fostering innovation and knowledge sharing, sense of urgency, monitoring the transformation process, providing capability to manage

performance, supplier relationships based on trust, performance measures, and technology scalability (see Figure 2.0). All these categories received average current-state ratings less than 2, indicating that OEM-A's practices in these areas are weak. Investigating these issues further by looking at the comments for these categories revealed that while middle-managers are concerned about the sense of urgency with respect to a robust technology process, senior managers have, in general, not expressed such concerns. Also, with respect to technology scalability, while the migration plans within brands is reasonable, this is not so across platforms.

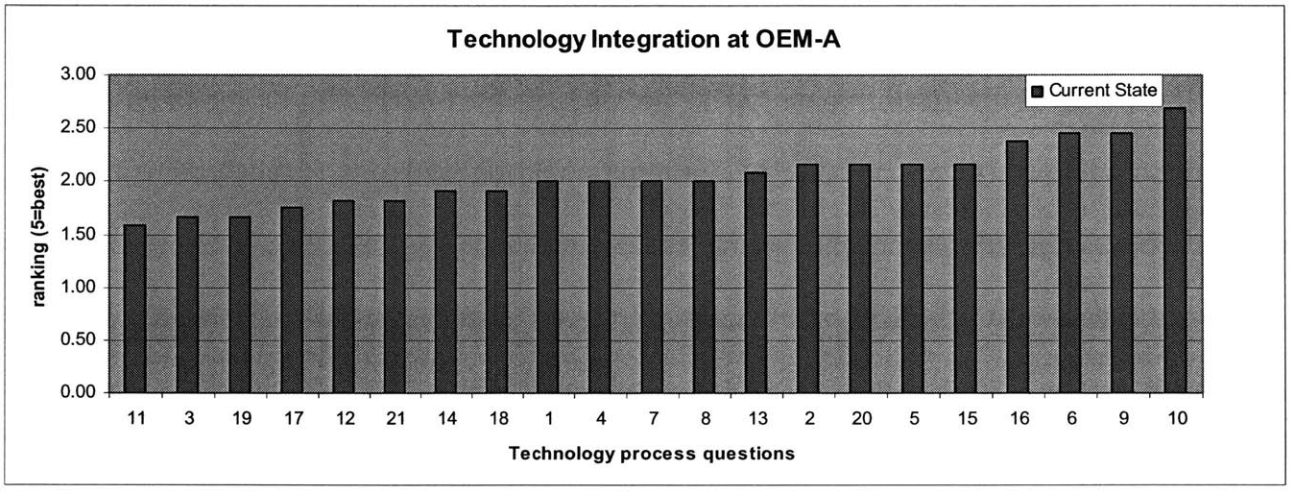


Figure 2.0 – Results ranked by current state

Desired State:

Analyzing the results for the desired state of the technology integration process shows that the categories where the best performance is desired are: authority & governance, migration & cycle plan, technology requirements, technology migration, technology vision, senior management commitment and technology identification, in this order (see Figure 2.1). All these categories obtained average ratings higher than 4 for the desired future state, indicating that these are areas perceived as critical to the successful execution of technology integration. Again, taking a look at the specific comments revealed the desire for more centralized coordination of technology integration, with more executive-level involvement. Additional respondents

mentioned the need for more control and monitoring mechanisms to enhance the quality of the technology integration process. Migration & cycle plans is a critical area to ensure technologies are implemented, and some respondents mentioned that it requires a lot of effort on the part of the corporation to make it happen.

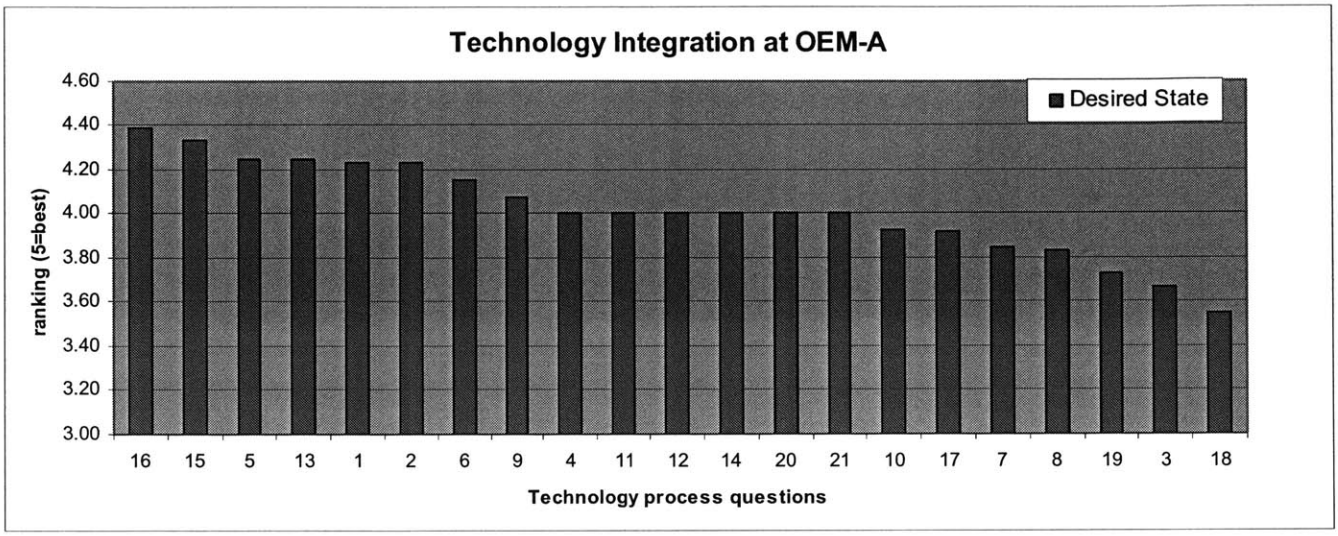


Figure 2.1 – Results ranked by desired state

Gap between current and desired states:

An investigation of the gaps between the current state and the desired future state indicates that the largest gaps are in the following categories: fostering innovation and knowledge sharing, corporate technology vision, supplier relationships, performance measures, technology migration, migration & cycle plan, and providing capability to manage performance. The gap between current state and desired state for these categories was greater than 2, indicating these categories require a significant amount of work to reach the desired levels (see Figure 2.2). Respondents indicated that migration plans are in place in some areas, but are totally lacking in others; there is no consistency in their application. Issues of complexity in both the product and corporate structure need to be reduced before successful migration can occur. The lack of a

global corporate technology vision and directive also affects the effectiveness of the technology integration process. Other respondents also mentioned that trust between OEM-A and its suppliers is a real issue.

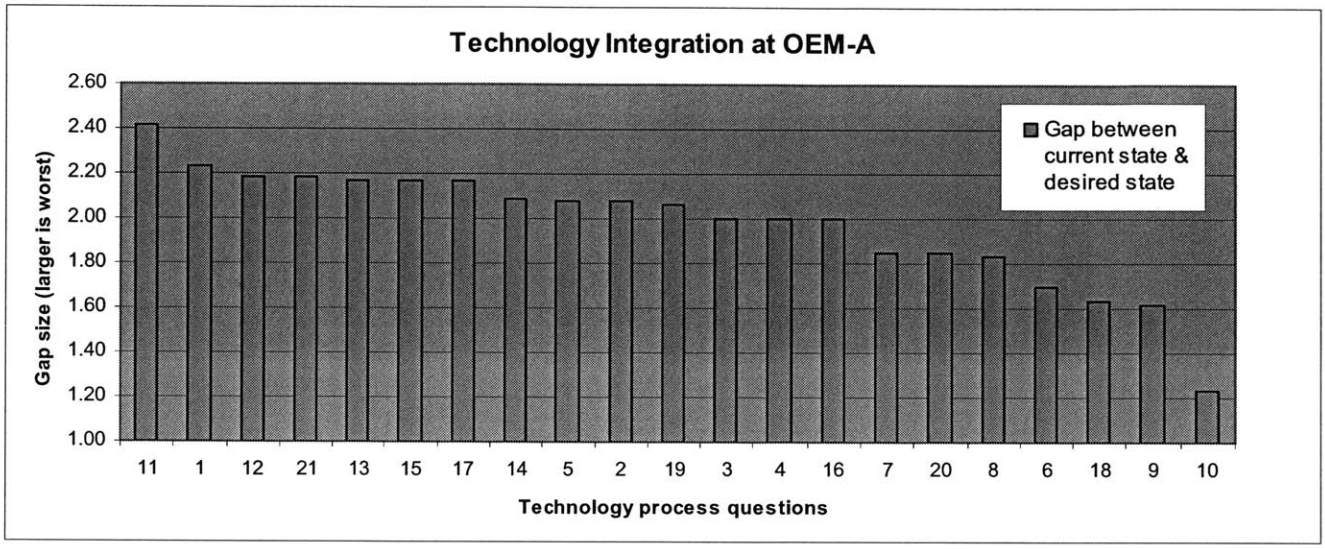


Figure 2.2 – Results ranked by gap between current and desired states

Overall, these results seem to indicate that there is in fact a lack of a systemic approach to technology integration at OEM-A, regardless of the plans and processes that are in place. Areas of particular concern highlighted through the case studies and the questionnaire are the lack of a central technology vision, lack of long-term collaborative relationships with partners and suppliers, weak technology scalability and migration plans, and the need for more centralized control of the technology integration process.

2.6 Summary

This chapter discusses OEM-A's approach to technology integration through three case studies involving technologies and people from different areas of the corporation. The case studies highlight the differences between the tasks undertaken by each of the projects and how

they were managed. Five distinct areas emerged as key contributors to the successful implementation of technology – Vision/Strategy, Technology Selection, Supplier Relations, Technology Migration, and Process Governance.

A questionnaire was developed and utilized to help determine if the concerns uncovered through the case studies were indicative of an issue with the technology integration process of OEM-A. The results of the questionnaire (albeit with a small sample size) supported the findings from the case studies. To improve its technology integration process OEM-A needs to refine how it manages the technology vision, supplier relations and integration, and technology migration. OEM-A also needs to consider having a central governing body responsible for process governance.

The next chapters build on these findings by developing building blocks that can be used to develop robust processes leading to more effective technology integration. The building blocks are based on the critical success factors identified in Table 2.0. The first and most critical building block to successful technology integration is developing a vision. The corporation needs to create a vision of where it wants to be and develop a plan to get there; this becomes the strategy. Chapter 3 discusses vision and strategy and their implication on technology integration in more detail.

Chapter 3 - Strategy & Vision

3.0 Overview

Although this chapter emphasizes the importance of developing a corporate vision and corresponding strategy to achieve it, the specific vision and strategy at each automotive OEM cannot be discussed in detail, as it is proprietary information. As such, specific strategy formulation is beyond the scope of this thesis. However, since the vision and strategy are critical elements of technology integration, it is necessary to discuss them and frame them with respect to technology integration. Therefore, the discussion around strategy presented here will be generic, and relegated to guidelines and actions a corporation can take to develop a successful foundation upon which to build their strategy and ensure it is followed through and implemented.

3.1 Strategy & Vision

Strategy is based on the corporation's vision of where it wants to be relative to the marketplace and its competitors. The vision represents a direction, or image of the corporation's goals, based on their current knowledge of the market and their perceptions about the technological outlook. It describes the corporation's goals but does not describe how it will attain them. Although the vision does not describe how to attain the goals, it needs to be specific with respect to the corporation's goals in order to drive ambiguity out of the strategy development process.

Strategy is the unique and sustainable way by which organizations create value (Kaplan, 2001). Corporations that are successful bring value to the customer by applying their efforts in a focused and effective manner. The successful corporations use strategy as a tool to identify market opportunities and act upon them. Thus, strategy encompasses a "game plan" that is

created to help deliver sustainable competitive advantage. The purpose of having a strategy can be described as follows:

Strategy…

- Challenges and stretches the organization.
- Provides a means for investing selectively to develop the capabilities for sustainable competitive advantage.
- Provides a coherent, unifying and integrative pattern of decisions.
- Identifies and coordinates tasks at the corporate and functional level.

Source: (Crawley, 2003)

3.2 Strategy Foundation

The foundation of strategy lies in how an organization chooses to differentiate their products from their competitors in such a way that they provide the customer with an attractive value proposition. This value proposition serves as the focal point around which the strategy is developed. This seems like a basic point, but the fact is that three out of four organizations do not have a clear consensus on the customer value proposition (Kaplan, 2001). The importance of the value proposition cannot be overlooked.

Opportunities to create value for the customer involve strategies that put into action the organization's intangible assets such as customer relationships, innovative products, responsive processes, and employee skills and motivation (Kaplan, 2001). Due to the renewed emphasis on customer relationships, organizations today are relying more heavily on the intangible assets created by their employees, through their knowledge and skills, to deliver competitive advantage. This requires the organization to use a holistic approach to strategy and its implementation.

3.3 Strategy Implementation

Strategy should be thought of as a comprehensive plan that describes how the entire organization works together to achieve its goals. It spans the range from the early ideation phase

to the implementation and launch phases. The development of a strategic vision is only part of the battle. Successful execution, or implementation of the strategy, is usually not emphasized enough so it is no surprise that this is where most organizations fail (Bossidy, 2002). Strategy implementation needs to be considered during the strategy ideation phase – if the corporation does not already have or cannot acquire the resources needed to execute the strategy, it will be worthless. To successfully implement a strategy, the organization needs to ensure that the business units and employees are aligned with and linked to the strategy. In addition, the corporation needs to investigate numerous scenarios involving market needs, competitors, economic forecasts, consumer trends, and internal business and product processes prior to making a final decision regarding its strategy (see Figure 3.0). Essentially, the strategy needs to become a roadmap; effectively linking operational plans and processes to people and results.

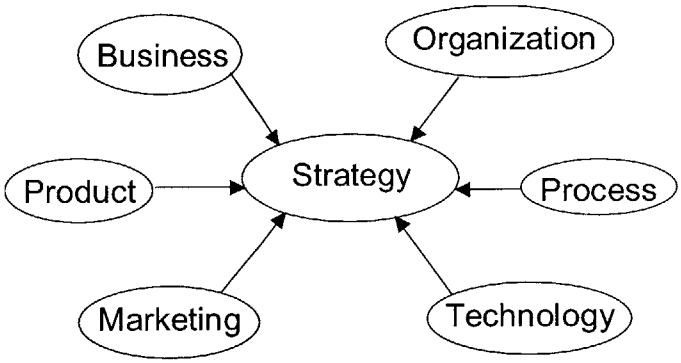


Figure 3.0 – Multi-faceted Strategy

3.4 Strategy Pitfalls

Strategy development and implementation issues are not inconsequential. There are many issues that can arise, and if they are not dealt with properly the results can be disastrous. One of the issues that can hinder strategy development and implementation is the lack of a holistic approach. Cultural, business and technical implications of the strategy need to be addressed

along with their interactions with each other. The business plan needs to be developed concurrently with technology development, or just ahead of it, to ensure that the technology will deliver value to the corporation and its customers. Culturally, the strategy needs to achieve the right balance between significant change and continuous improvement so it is not met with hostility or resentment, yet still strives for significant stretch in the corporation's goals.

Senior management commitment is another key issue for strategy development and implementation. For true change to happen, strategy development cannot be delegated to middle management; to transform the corporation and align its operational processes with the strategy requires a firm commitment from the senior leadership. There are often difficult choices and decisions that need to be made in order to align the business and technical units with the overall strategy, and senior management is the best equipped to make these choices. Senior management needs to convincingly introduce the strategy to the corporation, and be a steadfast force behind it to signal they are going to stay the course. This resolve needs to remain through to implementation of the strategy, even if the results seem less than successful at first. In fact, most projects look like failures half-way through; it is necessary to remain committed to the goals in order to deliver results.

Other pitfalls in strategy development and implementation include the lack of commonality in processes, having the right number of people involved, a process that is too short or too long, and lack of flexibility in the strategy. Commonality among processes is necessary to ensure the strategy is deployed in the same manner across the corporation, be it in business units, technical units, or others. Appropriate and comparable measures of success can then be used to depict how the rollout of the strategy is viewed across the corporation. Having the right number of people involved in both the strategy setting and implementation is also critical. When

developing a new strategy, the corporation is not looking for small changes; instead, it is looking for substantial changes. This often requires "out of the box" thinking, and it would benefit the corporation to have diverse perspectives and viewpoints to help set and refine the strategy. When putting together the team that will develop the corporation's strategy, senior management needs to keep in mind that the discussion around strategy needs to be meaningful, and the ability to reach a consensus must exist.

Strategy development will not be accomplished in one meeting, but if it is not accomplished within a few months, then there is a problem. To develop a robust strategy there needs to be a lot of sharing of ideas, planning, thinking, and re-thinking about possibilities. This requires a gestation period for the ideas to mature and be linked with other ideas to develop the corporate strategy. Although the strategy needs to be holistic in terms of systemic implications, it also needs to carry the flexibility to deal with unforeseen change. The strategy can change, but the vision must remain constant. The strategy cannot be so rigid as to prevent mid-course corrections to adapt to changing market needs, competitive pressures, or economy-led business downturns. However, to minimize the need for any mid-course corrections, it is necessary that the corporation applies the proper due diligence when developing its strategy. Instead of being set in stone, the strategy needs to be a roadmap that shows the high-to-mid-level action plans that represent the intended path to achieve the corporation's goals. The flexibility to adapt to changes comes from being able to change the detail steps that support the strategy.

3.5 Strategy Development

Strategy must become a statement of design through which the principles, processes and practices of an organization are developed (Kotelnikov, 2004). As such, the corporation needs to understand the competitive landscape and know the strengths and weaknesses of each competitor

and how they will relate to a given strategy. However, understanding the competition is not enough; corporations need to understand their own strengths and weaknesses to best position themselves such that they can successfully provide the customer with the value proposition they are seeking. What are the corporation's distinctive capabilities (those that are protected by patents or that are difficult to reproduce by another OEM), and what are its reproducible capabilities (those that could be copied by another OEM with a moderate amount of effort)? These questions need to be answered to help develop the strategy.

Another question that needs to be answered is related to the corporate culture. Does the corporation have a culture that embraces change or is resistant to change? To create a successful strategy the corporation needs to cultivate an innovation-adept culture that is focused on the vision and is results-oriented. The corporation's tacit knowledge with respect to technical and business areas needs to be explored as a potential source of sustainable competitive advantage. The internal processes that are most critical to delivering value to the customer need to be well understood. The financial background that provides the fundamental basis for the business planning becomes an enabler for strategy. The organization will be ready to deliver a strategy that achieves game-changing breakthroughs only when the customer, competitive, organizational, and financial perspectives (and their interactions) have been explored thoroughly. It is critical that the development of the strategy be linked to its implementation for the strategy to be effective.

3.6 Strategy & Organization

There are many keys to effective execution of strategy, however they all have one thing in common: they all require the discipline of having a corporation that is aligned to the strategy. The assumptions made about the business environment, customer needs, buying trends,

competitors, and financial outlook are critical to ensure that a realistic set of goals is created. The corporation's capability of achieving these goals needs to be assessed, analyzed and developed in an effort to address the new requirements as set by the corporate vision. A corporate culture that is willing to embrace change needs to be fostered, and the business and technical units need to move as a single entity towards the corporate goals. But how does a corporation achieve this?

It should start by focusing on the vision. The vision becomes the building block that will form the basis of the new, reinvigorated corporation. The vision serves as a single focal point around which the corporation can unite. It is critical that senior management convey the vision to everyone in the corporation and clearly explain the reasons behind it. This is the first step towards making everyone committed to a common, focused goal.

The vision establishes the goals the strategy, or strategic plan, will address by taking a comprehensive look at where the corporation is now and defining what it will take to achieve them. The corporate strategy needs to serve as a synchronization tool to help mesh the assumptions and goals at the business unit level, so if changes to the corporate level strategy are needed, the underlying business units can adjust seamlessly. Figure 3.1 shows a model of how this corporate alignment can take place.

According to this model, the vision becomes an enabler for the corporate strategy; the strategy then cascades to the strategic plans at the business unit level. In this scenario, the business unit strategy is linked and aligned with the corporate strategy, and the corporate strategy is linked and aligned to the corporation's vision, or goals. This alignment enables the corporation to move more quickly and efficiently towards its goals. But it does not stop there.

The strategic plan needs to be supported by an actionable operational plan that identifies resources necessary to achieve the corporate goals and assigns accountability to meet them. The

strategic plan enables the operational plan, which defines specific actions that need to be taken. The operational plan addresses how the different parts of the corporation will move together, how to deal with trade-offs, and how to build-in flexibility to adapt to unexpected changes. A strength of the operational plan is that it is developed based on realistic assumptions and realistic means of attaining the corporate goals. Knowing what actions are planned, the corporation can then allocate resources accordingly and assign the proper accountability to key groups. In this manner, the staff supports the operational plan, which supports the strategic plan, and so on.

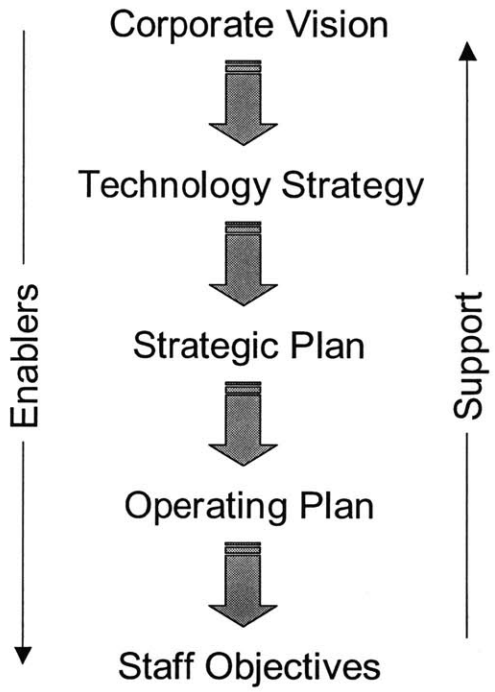


Figure 3.1 – Model for corporate alignment

This model provides a robust organizational process that links the corporate goals to results via an aligned system of strategy, operational plans, and people. This model can be applied to the technology integration process at any firm.

3.7 Summary

This chapter discusses the importance of having a vision that describes the corporation's goal, and sets the direction towards which the corporation is heading. The vision provides a hub around which senior management can get their troops to rally. Having developed and effectively cascaded the vision to the corporation, it is then necessary to develop the strategy that will be the path to achieving the vision.

The strategy needs to be multi-faceted and needs to incorporate assumptions from all the different business areas as well as perceptions and forecasts regarding the competition, economic outlook, technical capability, etc. The development of the corporate strategy needs to be led by senior management, as they should ultimately own the process to ensure the strategy is implemented as intended. Lack of commitment from senior management, lack of a holistic approach, lack of flexibility, and lack of corporate alignment are a few of the pitfalls that can lead to unsuccessful strategy deployment.

Corporate alignment is a key to successful strategy execution, and this chapter presented a model for organizational alignment that links the business units to the corporate vision through a strategic plan achieved in consensus. This model forms the organizational basis a corporation needs to effectively manage the technology integration process. Having outlined and discussed the issues around strategy and organizational alignment, the next chapter will delve into one of the first areas specific to the technology integration process, namely, the technology selection process.

Chapter 4 - Technology Selection

4.0 Overview

Technology selection can be defined as the process of identifying, assimilating, and selecting technologies that are aligned with the corporation's strategy and will deliver value to the corporation. With the proper organizational framework in place, as described in chapter 3, technology selection becomes a critical next step toward developing a robust technology integration process. The decisions made during this process can affect the corporation in a deep and far-reaching manner either positively or negatively.

The goal of this chapter is to present a systematic approach to technology selection that can maximize the corporation's opportunity to create a positive outcome from this process. This chapter will compare and contrast the current technology selection process at OEM-A with that of other OEMs from the automotive and other industries. Lessons learned from the "compare and contrast" exercise, along with insights into critical areas within technology selection, will be used to provide recommendations for the development of a robust technology selection process that can be used by any corporation.

4.1 Technology Selection At OEM-A

The technology selection process at OEM-A is shown in Figure 4.0. The process begins by soliciting technology concepts from suppliers and from across the corporation. These concepts are generally only ideas and still require considerable development effort from the Advanced Engineering group to be transformed into a functional prototype. As shown in Figure 4.0, the concepts must, at a high-level, meet the requirements and/or constraints set by the corporate strategy, the technology vision, and the customer needs (as defined by the vehicle

brands). The technology concepts that have met these requirements are then developed into project proposals that assess technical and business case issues as well as strategic issues such as implementation commitment and migration potential for the concept. The project proposals are then reviewed by an internal technology board of directors that assesses their potential value contribution to the corporation and balances them against the corporation's needs and the availability of resources (both people and money).

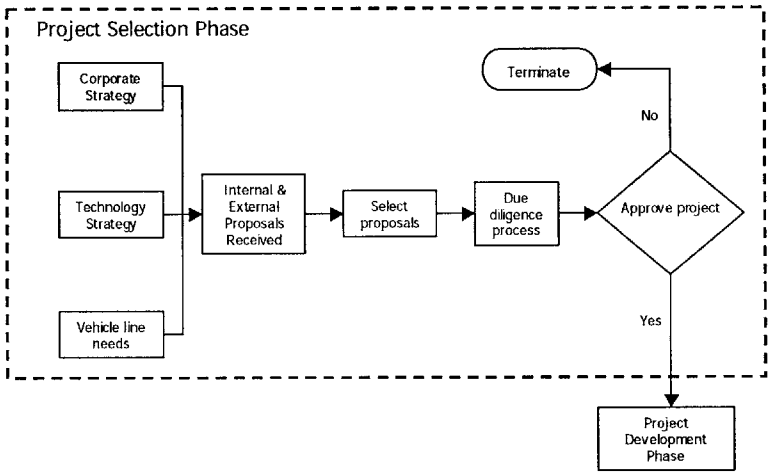


Figure 4.0 – Technology Selection Process at OEM-A

The technology board of directors' assessment of the project proposals leads to a prioritized list that encompasses the projects viewed as having the strongest positive impact to the corporation. This prioritized list is then discussed and approved at the vice-president level. Some of the key factors to project proposal approval are a positive differentiation feature for the company, strong customer pull for the technology, clearly spelled out technical development plan, and "migrationability" of the technology (ability to migrate the technology across vehicles and/or brands). Ultimately, however, the corporation has a limited amount of funds available to carry forth these technology projects; thus, the cost-to-benefit ratio is an additional key characteristic that determines project approval.

4.2 Technology Selection At Other OEMs

The technology selection process at other OEMs is similar to the one at OEM-A, although each OEM has some unique views on parts of the process. All OEMs follow the general concept of identifying, assimilating, and selecting technologies. The main differences between the OEMs lies in the details of the who and the how of this process. There are differences among the OEMs concerning organizational issues surrounding functional excellence, process governance and decision-making, in-house vs. outsourced ideas, and the handling of tacit knowledge. Although the differences may seem small, they represent the unique principles that each of these corporations bases their vision on. Here is a look at how each of four other OEMs approaches technology selection:

OEM-B:

OEM-B has a very strong, in-depth knowledge of technical areas and they understand suppliers' capabilities very well. Their in-depth technical knowledge places them in a position of authority and enables them to make confident decisions about selecting technologies. A competitive advantage they have over several other OEMs is their excellent relationship with their suppliers. This relationship emphasizes the suppliers as partners and encourages the supplier to work together with OEM-B for win-win outcomes. This is reflected onto the technology concept ideation process. With respect to technology strategy, OEM-B has a centralized group with overall strategy responsibility, which helps the organization maintain focus on its technology roadmap. In addition to these aspects, at OEM-B, Core engineering is the lead activity for technology selection, and Advanced engineering acts as an internal supplier to the Core activity. This helps ensure alignment between the technology selection phase and the technology implementation phase since the Core engineering group, in association with the

vehicle programs, will carry out a significant portion of the implementation of the technology. At OEM-B, technology is viewed as a tool to achieve cost efficiency and obtain strategic advantage.

OEM-C:

OEM-C's approach to technology selection involves determining their top research priorities through a joint board comprised of senior management and research evaluation committees. These research committees are staffed with a slew of working-level personnel – engineers, marketers, sales reps, etc. – which form a cross-functional team that is responsible for the due diligence process of identifying potential technologies. These committees have the final say on which technology "themes" the corporation should pursue. In many cases, the technology selection process is started with several themes addressing the same need. These themes are then pursued in a parallel-path manner until the committee is able to decide which theme provides the best overall solution to the customer needs. This approach forces OEM-C to look at multiple scenarios involving all aspects of the business before a final decision is made. At OEM-C, technology is viewed as an enabler to achieve their core vehicle attributes.

OEM-D:

OEM-D's most distinctive characteristic regarding their technology selection process actually has to do with the corporation's approach to functional excellence. At OEM-D, senior management understands there is a significant technological gap between themselves and the product development staff. As such, the team leaders are viewed as the highest-ranking people that are able to understand and develop the technology, and thus play a key role in technology selection. Engineers are encouraged to stay within their expertise area for a significant portion of their careers (15-25 years). This leads to the development of a deep tacit knowledge base, and provides the engineering staff with a high-level of self-confidence and a strong sense of product

responsibility. The team leaders fight for resources to adapt new technologies and improve their team's competence to stay ahead of their suppliers. The engineering teams form the backbone of technical development and are constantly asked to define technological strategies. Advanced engineering supports some of their brands, but not all, and Core engineering is responsible for implementing technologies into production. Technology is viewed as a critical strategy enabler at OEM-D.

OEM-E:

OEM-E has set its sights on technological innovation as a crucial factor on which they depend upon to stand out from the competition. This is such a deep-ingrained belief at OEM-E, that they have focused their organization and development efforts around innovations in technical fields. The activities in research and development are centered on specific strategic innovation areas (areas in which OEM-E seeks to achieve technological leadership in). As such, they have a very systematic approach to technology selection. Cross-functional and co-located teams support the technology concepts from ideation to implementation. To further broaden the spectrum of technology ideas to be evaluated, along with utilizing supplier's inputs, OEM-E also solicits input from individuals through their web site. All ideas are split into three groups – required technologies, top technologies, and breakthrough technologies. Required technologies are those that address government requirements or "entry-to-market" requirements (the minimum specifications needed to be competitive), while top technologies are perceived as offering concepts that will enhance the brand values as well as support the corporate strategy. Breakthrough technologies are characterized as those that will become the segment benchmark, or will offer outstanding customer value. Technology concepts from each of these groups are approved at a different hierarchical level within OEM-E. Breakthrough technologies require

approval at the highest levels of the corporation, while required technologies need approval at the lowest levels. At OEM-E, technology is a key strategic enabler that provides the necessary attribute differentiation to effectively compete in the industry.

4.3 Technology Selection Comparison

The technology selection process at each of the OEMs described above is similar with respect to the major activity blocks performed (identifying, assimilating, and selecting). It is, however, in the details of performing these activities that differences emerge. Each of the OEMs brings a different set of strengths, which they rely upon to select the technologies that will help them achieve their goals. Table 4.0 summarizes the strengths of each of the OEMs analyzed above.

Technology Selection Process	OEM-A	OEM-B	OEM-C	OEM-D	OEM-E
Deep technical knowledge		+		+	+
Supplier know-how		+			
Centralized strategy responsibility	+	+			
Core engineering lead, Advanced supports		+	+		+
Parallel-path technology concepts			+		
Cross-functional committees/teams	+		+		+
Focus on functional excellence		+		+	
Team leaders as decision-makers	+		+	+	
Identify top 10 / next 50 technologies					+

Table 4.0 – Summary of OEM strengths regarding Technology Selection Process

While some of the strengths identified are common to more than one OEM, there were strengths that were unique to a few OEMs. For example, OEM-B distinguished itself from other OEMs with respect to their strong partnership-type relationship with their suppliers, which provides a strong incentive for cooperation for technology identification. OEM-C is the only

OEM that uses a parallel-path approach to selecting technologies during the research/due diligence process. Although this is time and resource intensive, it forces OEM-C to analyze several different possible scenarios that involve all aspects of the business, which in turn provides them with confidence on their choice of technology. OEM-E, on the other hand, is the only OEM that in addition to the "top 10" technologies, also creates a ranking of the "top 50" technologies to be investigated and assigns them a "next-up" priority status. Thus, essentially, they have a prioritized running-list from which to select technologies for new programs. There is not one OEM that is deemed most successful regarding technology selection, as each OEM has a different set of strengths.

4.4 Setting Up The Technology Selection Process

The technology selection process begins with identifying potential technologies that can deliver value to the corporation. However, how does a corporation best identify these technologies? Many sources need to be exploited to get a comprehensive picture of what technologies may fill the voids in the corporation's strategic plan. Ideas developed internally by the Advanced engineering organization are one such source; other sources include external ideas (from individuals, and other corporations), supplier initiated ideas, and ideas from university research labs. The question becomes what is the most efficient way of gathering these ideas?

Internal idea generation:

All the OEMs undoubtedly have a significant amount of talent and creativity in their people. This can be a major source of competitive advantage, if it is used constructively. It is in the best interest of the corporation to study the ideas developed by the Advanced engineering groups in detail, as they are usually worthwhile ideas (although they do not always have strong links with the corporate strategy). Furthermore, since the individuals or groups that created these

ideas will most likely be the ones working on developing the idea to the point where it is commercially viable, these ideas will have strong support within the Advanced engineering community. To gather these ideas in a common and consistent manner, a forum needs to be created through which these types of ideas can be presented to the people leading the technology selection process, on a regular basis. This forum needs to be sponsored by senior management to ensure proper representation by cross-functional areas and to add credibility and visibility to the technology selection process.

Internal ideas not associated with Advanced engineering can also be a valuable asset. However, gathering these ideas will be more difficult as they could be coming from anywhere within the corporation. A suggested method to cope with this is to create an internal website dedicated to collecting such ideas from individuals. The purpose of the website needs to be clearly communicated to the corporation, and its use should be encouraged by senior management. The technology ideas would have to be filtered through a technology team (more on this later) that would be tasked with selecting the most promising ideas and working with the individual on developing them so they can become part of the technology selection process. The website could also be used as a tracking tool for individuals to check the progress of the idea development.

One of the issues encountered in the past with similar approaches was how to provide an incentive for individuals to submit ideas. Cash incentives do not work well because people will submit ideas that are within the scope of their jobs to earn extra cash – and if people are excluded from submitting ideas that are part of their job, then they will get their friend to submit it for them and share the cash. A better approach may be to open the idea submittal process to any ideas (related to the person's job or not), and use the quality of the ideas submitted as a

performance measure that could be used to differentiate the employee's level of contribution compared to the employee population at the same level of responsibility.

External idea generation:

The two main sources of external (non-university related) technology ideas are suppliers and individuals. Suppliers, especially those in the first tier (and full-service suppliers), have the capability to develop unique technology internally, but do not always have funding for it. These are situations where joint development of technology between an OEM and a supplier can be advantageous to both parties. The supplier gets to develop the new technology, which is partially funded by the OEM, while the OEM gets exclusive use of the technology (for a while, anyway). The supplier gets the benefit of being able to sell products that use the technology to any OEM after the "exclusive use" period has elapsed. All the details behind what each party is allowed to do have to be carefully crafted in a legally binding agreement. However, all this pre-supposes that the supplier is willing to work with the OEM.

Getting suppliers involved in the technology identification process requires the OEMs to have a good relationship with them. Suppliers that are viewed as partners (and treated that way) are more willing to share new technology concepts that have the potential of benefiting them and their OEM partner. If the relationship between an OEM and its suppliers is mediocre and issues of trust with respect to non-disclosure agreements or intellectual property have surfaced in the past, the OEM will be hard-pressed to convince its suppliers to submit proposals for joint technology development. If an OEM is in this situation, it will need to change its philosophy with respect to supplier relationships in order to gradually gain back the trust of suppliers.

To successfully work together on new technology concepts, the OEM needs to institute a process through which willing suppliers can submit project proposals for joint technology

development. The OEM needs to ensure that the suppliers are made aware of this process and have a well-defined pro-forma that outlines the technology concept, competition and market assessment, strategic impact, and financial needs along with a preliminary cost-benefit analysis. Armed with this information, the OEM and the supplier can then work together to determine if a given technology concept proposes a viable path to achieve mutual goals. The process of submitting project proposals can also begin via a dedicated website through which the ideas (at a concept level) can be submitted. After the technology team applies a filter to determine if the technology helps meet the intent of the OEM's strategic plan, the supplier should be invited to the OEM's headquarters to formally present their ideas.

As mentioned earlier, individuals outside the corporation are another source of external ideas. These ideas can also be collected via a website linked from the OEM's main webpage in a similar fashion as the internal idea collection mentioned in the previous section. The difference would be that the individual contributors would be provided a cash incentive if their ideas are carried forward by the OEM. The agreement between the OEM and the individual needs to clearly spell out that the cash given to the individual is in exchange for the rights to use the idea as the OEM sees fit. Again, a technology team would be responsible for filtering the ideas and submitting the potentially beneficial ones to the appropriate experts to determine suitability.

University research & idea generation:

Another source of technology innovation can be the research labs at universities. To take advantage of the research that is being conducted at universities, corporations need to create links with them to be constantly aware of new or emerging technologies being developed. These links can be in the form of informal networks established between Advanced engineering and the research-focused professors at key universities, or more formally through regularly scheduled

visits to the OEM where the university faculty can present new technology concepts they are working on. One drawback to this approach is that any OEM can approach the universities and discover what they are working on in their research labs. A strong connection to the universities could be a key factor in acquiring competitive advantage – for example, if OEM-A has a good relationship with university XYZ, they may become the first to learn about a potentially lucrative emerging technology and can then form agreements with XYZ about the exclusive development of this technology. Another advantage of having a healthy relationship with universities lies in the ability to leverage some of the universities' resources to help investigate a technology that was developed in-house by the OEM (of course this would have to be bound by non-disclosure type agreements) when there are no internal resources to dedicate to this.

Industry idea generation:

An additional form of idea generation that has its own merits can be achieved by looking at industry trends, both within the automotive industry and outside of it. Technology concepts within the automotive industry will show trends that OEMs are chasing, and sometimes being a fast-follower may be a requirement just to enter (or remain competitive in) a given market segment. Looking at trends in other industries is a more attractive means of identifying the next breakthrough technologies that may migrate to the automotive industry. The emerging telecommunications technologies are an example of this - today there is an increasingly larger push by customers to have OEMs integrate peripheral technology (such as PDAs, MP3 players, laptops, etc.) to the vehicle's communication network, and this trend is expected to continue. Only by keeping abreast of technology trends in other industries can the corporation be prepared for the next new thing.

4.5 Technology Team

The previous section discussed means through which the OEM can collect a comprehensive set of technology concepts from within its organization as well as from areas outside its sphere of influence. This section describes how the corporation can best manage and assess the collective ideas gathered, in order to best position itself to successfully select the critical few that will help deliver the results the corporation is looking for. To achieve this it is necessary to have a central repository of all technology concepts, or ideas, for quick and easy reference. This will help reduce the time it takes to search for a technology, and will make technology comparisons a true apples-to-apples comparison as all concepts entered into this database follow the same pro-forma.

To manage the process of gathering and assimilating ideas it is necessary to have a technology team in place. This team needs to be comprised of a dedicated administrative team, and needs to have the support of cross-functional experts from across the corporation. A senior manager champion also needs to be an integral part of this team to ensure proper representation and accountability at all technology team meetings. The dedicated administrative team's role will be to manage the websites, ensure the technology concept database is up to date and each entry contains the proper pro-forma information, scout the automotive and other industries for meaningful emergent technology, and with support from the senior manager champion, ensure the process is followed. The cross-functional experts will have to attend technology team meetings regularly, and their role will be to assess the quality and potential of technology ideas that fall within their domain of expertise. Only ideas that have been "approved" by the experts are forwarded to an overarching technology board that is responsible for selecting technologies that are aligned with the corporate strategy and are perceived to offer a significant competitive advantage. In addition to these duties, the cross-functional technology experts will be responsible

for generating a detailed assessment of technology strengths of the corporation. This assessment will help define the future technology path for the corporation. The technology team or a sub-set thereof, will be a key element of the technology foresight process.

4.6 Technology Foresight

Technology foresight can be described as the process of developing a technological perspective and outlook based on understanding the corporation's current state of technological prowess (Carlson, 2004, p.51). This process begins by analyzing in depth the technological strengths of the corporation and developing an understanding of the strategic implications of this status with respect to both the business and technology arenas.

The second step in the technology foresight process forces the corporation to use "out of the box" thinking to envision how the industry and its associated markets will embrace technology to help achieve business objectives. The cross-functional experts from the technology team will become the core members of the group that will define this future vision of technology needs that are linked to the corporation's strategy. Each expert or group of experts in a particular area becomes responsible for formulating a comprehensive look at the technological landscape that impacts their area of expertise over the next five years. All identified technologies are mapped in a Technology Interaction Matrix shown in Figure 4.1. The Technology Interaction Matrix identifies which technologies are, in effect, "drivers" or "enablers" of the technology development process. During the technology team meetings, the team will discuss the findings from each functional area's expert(s), and a combined Technology Interaction Matrix is created which contains the inputs from all areas.

- Assemble matrix of selected items (technologies, sub-systems, components, etc.) with same elements vertical and horizontal (6 or more items).
- Fill out 1st column from top down by answering the question: to what extent does the item on top drive, pace or enable the item to the left (strongly, 10 pts.; moderately, 3 pts.; not at all, 0 pts.)? Continue down the column.
- Continue with 2nd and all the remaining columns.
- Include diagonal elements by asking the question: do the results of this item drive, pace, or enable the progress of that same item? ("Exponential" technologies). Score same as above.
- Score each column and row by summing the point scores.
- Set up an X-Y plot. For each item, plot a point with X-value its column score and Y-value its row score.

	nanotech	biotech	software	medical devices	adv.materials	micro-electronics
nanotech	10	0	3	0	10	3
biotech	10	0	10	3	10	3
software	0	0	3	0	0	3
medical devices	3	10	3	0	3	3
adv. materials	3	3	3	0	3	3
micro-electronics	10	0	3	0	10	0

Figure 4.1 – Technology Interaction Matrix
Source: (Carlson, 2004)

The final step encompasses comparing the key technologies identified in the Technology Interaction Matrix to the corporation's current areas of technological strength. This comparison exercise will help focus the corporation's strategic direction by injecting a strong dose of reality into the process of highlighting the gaps between where the corporation is and where it wants to go. Thus, the technology foresight process helps to further clarify the aggregate ideas generated, and sort the ideas that have the strongest links to the strategy yet remain committed to delivering an affordable business plan.

4.7 Technology Valuation

Technology valuation is another key aspect that needs to be discussed in the context of technology selection. In general terms, technology valuation essentially has to do with the process of determining what a technology is worth to a corporation. The difficulty with technology valuation lies in the fact that new technologies are still unproven and there is no product or business history (other than possibly some similar technology examples) that can be studied to develop a forecast of the potential long-term value of the technology.

When a corporation is valuating projects, it can choose a method of measuring return on investment from several different alternatives. Some of the alternatives include the net present value (NPV), the internal rate of return (IRR), expected commercial value (ECV), and options. The shortcomings of the NPV and IRR methods are that they only provide an answer for a point in time (and the further into the future the less accurate the results are), and they do not have a means by which to quantify the effects of successful technology penetration in the marketplace. ECV and options are somewhat better alternatives because they develop improved models of the future as compared to NPV and IRR. All these valuation methods lend themselves to be applied with increasing degrees of success as a technology matures. The best predictions with these methods can be made only after the technology is in use and the market for it is well understood. Therefore, these methods alone are insufficient to create a valuation scheme for new and emerging technologies.

Intangible assets that are generated through innovation, unique organizational processes, and human resources also play a significant part in the valuation process (Sullivan, 2000). The intangible assets that contribute to the intellectual capital of the corporation complement the traditional valuation methods described above. Value, in the form of claims to future benefits, can be extracted by intellectual and human capital.

Intellectual capital is the totality of the knowledge of a corporation – the knowledge of its people and its processes, implicit or explicit – that contribute toward creating competitive advantage. A significant portion of what makes up intellectual capital is comprised of intellectual property and intellectual assets. Intellectual property consists of patents, copyrights, trade secrets and trademarks; essentially any asset the corporation owns that is legally protected. Intellectual assets, on the other hand, represent intellectual property that is not legally protected such as processes, databases, and programs.

Human capital encompasses the knowledge, experience, and capability of all the people in the corporation that are delivering value to the customer. Human capital generates value for the corporation, but is not owned by the corporation. To extract value out of its human capital a corporation needs to transform the human capital into intellectual assets that it can own and exploit. The relationship between human capital and intellectual assets is shown in Figure 4.2. But what methods can a corporation use to valuate these intangible assets?

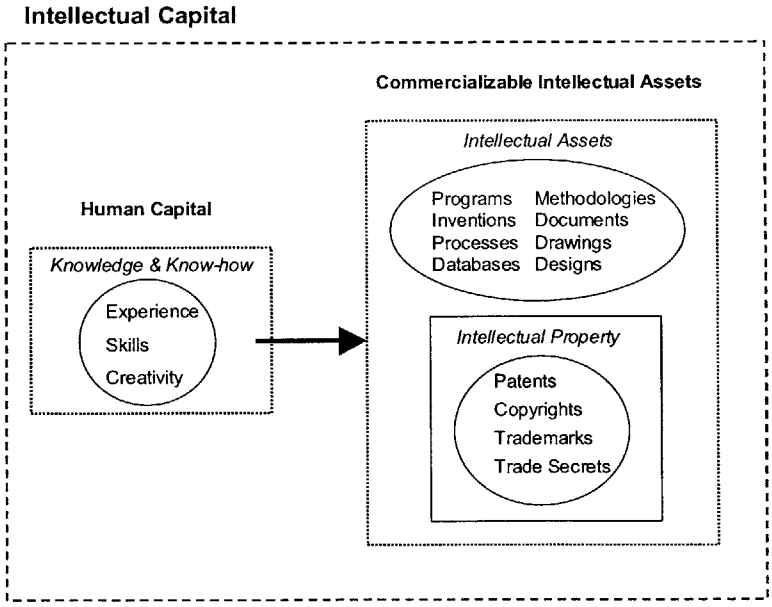


Figure 4.2 – Relationship between Intellectual Capital, Human Capital and Intellectual Assets Source: (Sullivan, 2000, p.229)

Approaches to technology valuation:

Three approaches that can be used to help with the valuation of intangible assets are Intellectual Property Management (IPM), radical innovation, and the VERDI framework. The first method, IPM, is involved with all the activities a corporation uses for commercializing and obtaining additional value from its intellectual property, with an emphasis on patented technologies (Sullivan, 1998). In the IPM method, a team of experts from across the corporation is responsible for delving into the internal processes required to commercialize a technology and extract value from these processes by means of intellectual property. With this approach to valuation, alignment between the corporation's strategy and operational plans is critical. The corporate technology strategy drives the intellectual property strategy, which in turn drives the technology portfolio management strategy, thus establishing (and maintaining) a link between patent activity and business strategy.

The Radical Innovation is another approach to valuating new technology. This approach is specifically applicable to technologies that offer unprecedented performance or very significant improvements to current features. In general, these are technologies that will revolutionize the marketplace or create entirely new markets. With new technologies that have the potential of revolutionizing an industry, there is always a high degree of uncertainty around them in both the technical and business fields. To handle this uncertainty and to be able to value the technology, *Leifer et al* propose the Radical Innovation Hub (Figure 4.3). In this model, ideas are generated through "hunters" (employees who seek ideas with business potential) and "gatherers" (employees who are on the lookout for any new ideas) and fed into a central hub where the ideas are evaluated by a team consisting of senior managers, veterans of radical innovation projects, and outside experts. The focus of the evaluations is to reduce the uncertainty

around the technology by investigating the benefits of the technology and determining whether the market is ready to accept such a change.

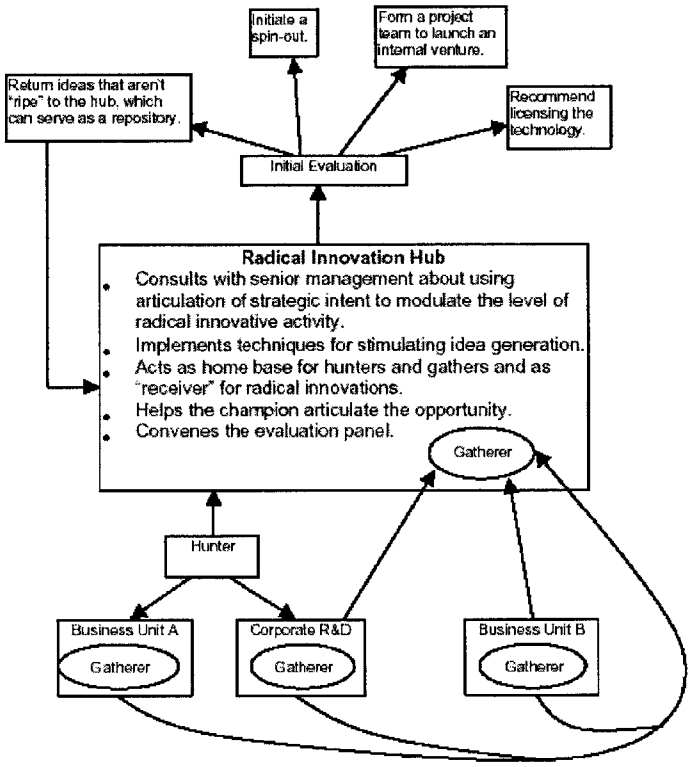


Figure 4.3 – Radical Innovation Hub Model
Source: (Leifer et al, 2000, p.51)

Although the first two approaches discussed have their merits, the most comprehensive approach is embodied in the VERDI framework proposed by *Mori & Tyson*. VERDI (**V**aluing **E**arly-Stage **R&D** **I**nvestments) is based on a resource-based view and is applicable to technologies entering or in the growth stage (growth stage is defined as the time after the technology has been proven in a research laboratory environment). The resource-based view takes into account tangible and intangible assets and is not dependent on financial methods for valuation. In addition, it provides the corporation the ability to align technologies with their business and technology strategy.

The VERDI methodology starts with a technology concept that is then filtered through the vision, mission, business and technology strategies of a corporation (Mori & Tyson, p.78). The VERDI "filtering" is shown in Figure 4.4. Only after passing through all these filters should the technology be considered for investment. The main emphasis of the VERDI approach is to leverage the corporation's strategy for intellectual property with its Research and Development portfolio to determine whether significant value can be extracted from a given technology concept.

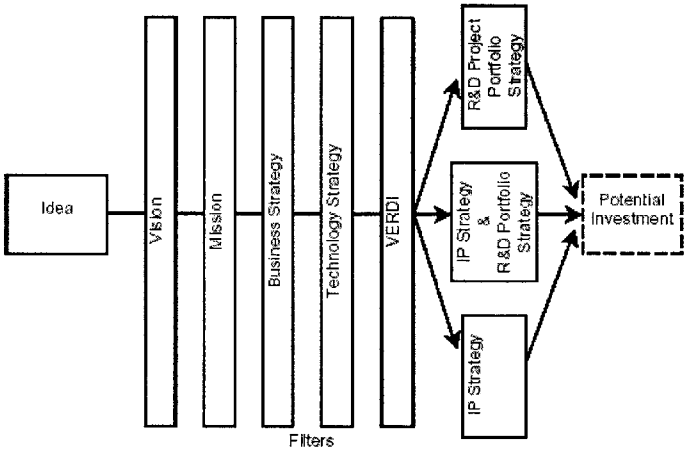


Figure 4.4 – VERDI filtering process
Source: (Mori & Tyson, 2002, p. 79)

Tools for technology valuation:

Several tools can be used in the technology valuation methods discussed in the previous section. Some of the most valuable tools are the ones that study technology and the corporation's ability to deliver it, and then overlay this information against the competition's technologies and abilities. The tools discussed here are the Corporate Decision Model, the Patent Map, and the Patent Value Model.

The Corporate Decision Model is one of the tools in IPM to help corporations value new technologies. This model compares potential opportunities based on an outlook of the

competitive landscape with respect to their core areas of expertise. Essentially this tool helps to identify niches where an exclusive technology could deliver significant value to the corporation. Figure 4.5 shows an example of a Corporate Decision Model. The ability of this model to clearly identify opportunity areas will depend heavily on the information available about competitors and their technology trends, thus it is necessary to utilize the competitive intelligence assets in detail to develop the most realistic and accurate competitive landscape view.

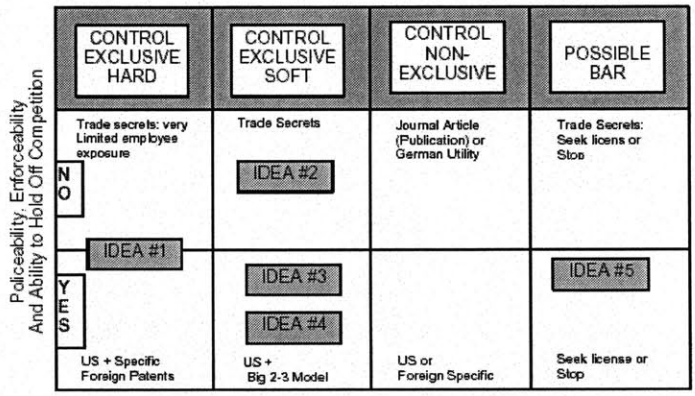


Figure 4.5 - An example of a Corporate Decision Model
Source: (Sullivan, 1998, p. 232)

The Patent Map is another tool from IPM to help the valuation of new technologies. Patent Maps take into account two parameters, technology and time. Patent Maps are divided into four quadrants that represent the interactions between technology and time, and they provide guidance with respect to the best possible use of intellectual property. The two main questions that need to be answered to determine the positioning of a given technology in the Patent Map are: What is the technology value? And what is the timing? Figure 4.6 shows an example of a Patent Map.

The Patent Value Model is another tool used to assess the value of a corporation's intellectual assets. The Patent Value Model classifies the corporation's patents and potential

patents into five "value" categories. Existing patents are categorized as Key, Base, or Spare, and potential patents are categorized as Pacing, Emerging, or Spare. The Spare category is used to classify intellectual assets that the corporation is not using but may want to use in the future. Key patents are those critical to help the corporation grow, and Pacing patents or technologies are those the corporation needs to have just to be competitive in the marketplace. Base patents are those that help protect the corporation's core competencies, while Emerging patents or technologies are those that will help the corporation positively differentiate themselves from the competition.

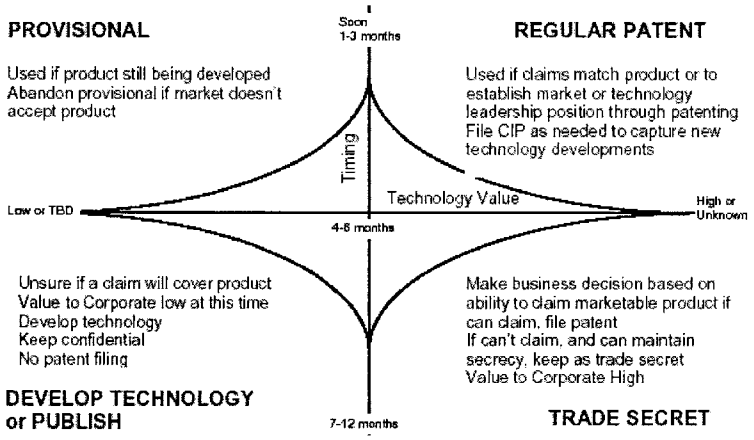


Figure 4.6 – Patent Map
Source: (Sullivan, 1998, p.233)

Once the patents or emerging technologies are classified according to the categories defined above, they are then mapped onto the business strategy through six new categories. These business strategy related categories help define whether the technology should be pursued. The categories are: Prohibited, Strategic, Commercial, Potentially Strategic, Excess, and Not Possible. The definitions of these categories are outlined below, and the Patent Value Model is shown in Figure 4.7.

- **Prohibited** - the corporation cannot take full advantage of the patent or technology because it does not wholly own it.
- **Strategic** - the technology is controlled within the corporation but is not currently being commercialized.
- **Commercial** - the technology is fully owned by the corporation and is being commercialized in the marketplace.
- **Potentially Strategic** - the corporation is still working on development of the technology or patent.
- **Excess** – the technology or patent can be sold, licensed, or abandoned.
- **Not Possible** – additional development work is still required to determine if the technology will provide value to the corporation.

By classifying the intellectual assets and balancing them with the corporation's needs, this tool helps to focus efforts in defining how to strategically utilize the intellectual assets in a manner consistent with the corporate vision.

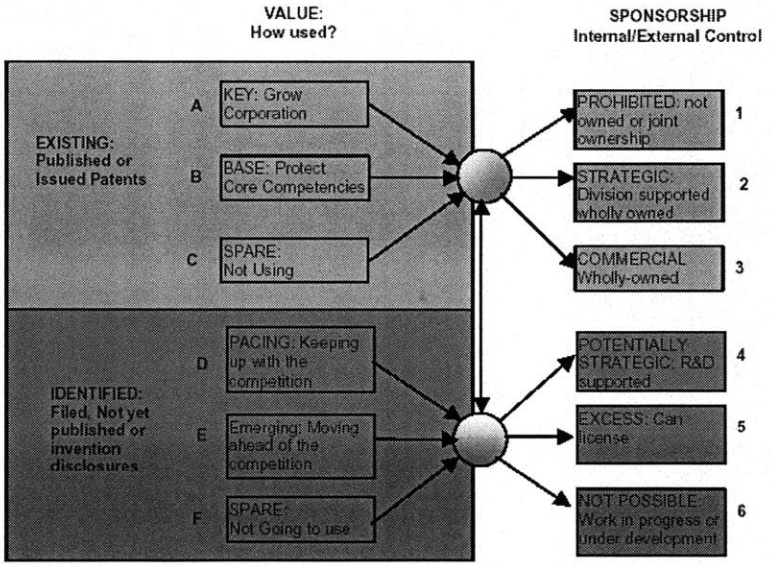


Figure 4.7 – Patent Value Model
Source: (Sullivan, 1998, p.235)

Valuation Criteria:

The resource-based view that provides the foundation of the VERDI framework also provides a basis from which to establish criteria for valuing new or emerging technologies. It also forces the corporation to look both inward and outward to understand the competitive

environment and their positioning in the market. *Mori & Tyson* have adapted the resource-based view criteria specifically to value technology. The six valuation criteria developed by *Mori & Tyson* are: 1) Inimitability, 2) Extensibility, 3) Durability, 4) Appropriability, 5) Competitiveness, and 6) Market Attractiveness. These criteria are defined by *Mori & Tyson* as described below:

1. **Inimitability** – This criterion examines how unique a technology is and how easily it can be substituted. The theory here is that unique technologies that cannot be easily substituted are inherently more valuable.
2. **Extensibility** – This criterion explores in what other industries, applications, etc. this technology may be pertinent. It is believed technologies that have multiple uses and broad applications are of greater value. The ability to identify additional potential opportunities allows the corporation to better understand the value of the idea.
3. **Durability** – This criterion examines how long the technology can endure. Durability is not just the life of the idea, i.e., if it becomes a U.S. patent it is protected for 20 years from the date of patenting or those filed prior to June 1995, 20 years or 17 years from date of issuing. It also encompasses the idea of incremental and non-incremental technologies. This test helps the corporation understand if the idea presented could be a potential disruption to a current technology.
4. **Appropriability** – This criterion poses the question of who will receive the benefits of applying the technology. Will value be extracted from the outcome of the applied technology as well as through the entire value chain? Technologies that cannot be exploited because of a weak or nonexistent value chain are in general of lower value. This criterion builds some rudimentary understanding of potential business models (e.g. vertically integrated at one extreme and licensing out at another).
5. **Competitiveness** – This criterion examines the competitiveness of the technology against alternative technologies. The information gathered in this test may also help the corporation understand if the current technology in use is hitting its natural limit, and if the new idea presented could be a disruption. Note that the competitiveness criterion is not orthogonal to the previous points i.e. the competitiveness may be tied to criteria 1-4 above.
6. **Market Attractiveness** – This criterion is used to identify where and how the technology could be used. The tests in this area could identify what markets it could be useful in, how large these markets are and how successful it could be in these markets. This criterion will help to determine if this is a market the firm should enter – i.e., identifies new market opportunities.

Furthermore, *Mori & Tyson* propose a series of questions to be used to assess the criteria for the technology concepts. The questions are designed to develop a deeper understanding of a

given technology concept with respect to its ability to deliver value. These questions could be delivered in the form of a questionnaire, a survey, or general discussion points within the technology team. The questions proposed by *Mori & Tyson* are as follows:

1. ***Inimitability***

   Unique function

   - Does it provide a unique function or, does it perform a function in a unique way?
   - If it is unique is it desirable to patent it or keep it as a trade secret?
   - Does prior art exist? Are there related patents?
   - Can the competition develop a work around?
   - Can an alternate technology be substituted for this one?

   Path dependency

   - Does this build on prior technology?
   - Is its development dependent on the core capabilities/skills of the firm?
   - Do competitors share a similar knowledge base?
   - Do we have brand loyalty in providing the solution? Would our customers expect this from us?
   - Does any competitor have greater brand loyalty associated with the solution?

   Economic deterrence

   - How much will it cost to imitate/substitute this technology? Is the magnitude large or small? Does that magnitude identity where potential competitive responses may come from?
   - Can the marketplace handle additional competitors (cannibalization, increased market share)?
   - Does the competition have or have access to the physical assets and resources required to replicate the technology?
   - Does the competition have or have access to technical skills to support development of the technology?

2. ***Durability***

   - What is the potential life of this idea? Does the technology perform its function significantly better than any competitors? Will it take a long time for competitors to catch up?
   - Can complementary assets be added to lengthen the duration in which its value will persist?
   - Do we have the complementary assets needed to lengthen its durability?
   - Does the competition have complementary assets needed to lengthen durability?
   - Will a change in market conditions deem this idea obsolete? (e.g. instant film is obsolete in the face of digital photography.

3. ***Appropriability***
   - Does a value chain exist to support exploitation of the technology?
   - Who owns those assets?
   - Do we have to partner to receive the value from the technology?
   - Does this technology rely on other technologies outside of the industry?

4. ***Extensibility***
   - Does this technology have additional uses internally? Externally?
   - Can it be used across the business?
   - Does it have application outside core industry? Do we have the skills to develop it for outside use?
   - Does extensibility factor into cost to develop the technology and if so, how?

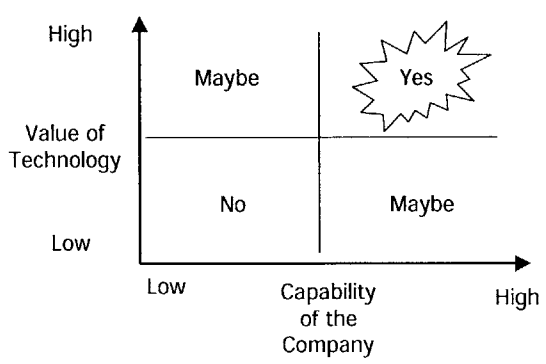
5. ***Competitiveness***
   - Is the technology superior?
   - How does this technology "compete" or "compare" against current technology performing similar functions? Both internal and external to the company.
   - How does this technology "compete" or "compare" against known future technology? Both internal and external.
   - How far out is the technology from commercialization?
   - Does the rating of competitiveness help to identify opportunities for disruption? Or is the technology incremental?

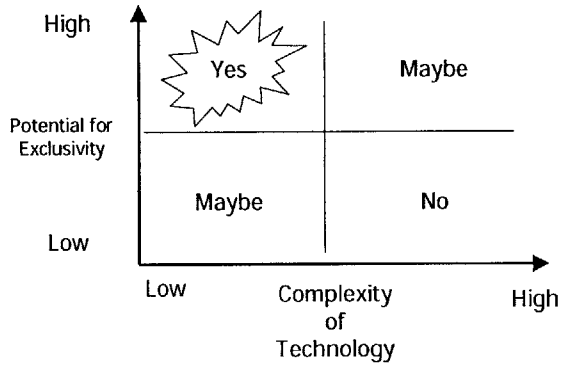
6. ***Market Attractiveness***
   - Can this technology exist in the current market or in an appreciable size market?
   - Is there potential for huge market growth?
   - Does a new market have to be created to support the technology? Can we create it? Is it accessible to us?

4.8 Portfolio Balance

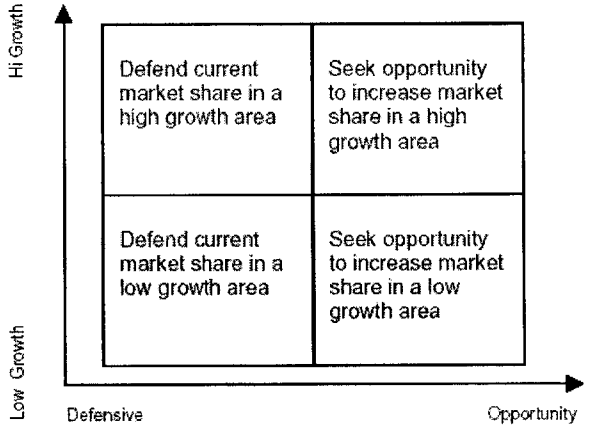
The corporation's technology selection process will undoubtedly encounter technologies that are at different stages of maturity. As such, the best option for managing technologies is through a portfolio approach to ensure that the risks and benefits of the technologies are balanced with marketplace opportunities. The portfolio approach allows a corporation to carry forth technologies that have varying levels of risk and opportunity while meeting the corporate vision. In essence, this approach enables the corporation to take a calculated risk when deciding on which technologies to add or remove from their portfolio. The goal is to invest more capital into technology concepts that can provide value with exclusivity in the marketplace. Significant

investments should be made in areas where opportunities are growing, while investments should be cut back in areas where, due to competition or other factors, the opportunities are shrinking. Figures 4.8 through 4.10 show different criteria to help determine whether a given technology should be part of the corporation's technology portfolio.





Figures 4.8 & 4.9 – Technology Investment Decisions



Figures 4.10 – Technology Portfolio Decisions
Source: (Mori & Tyson, 2003, p.73)

4.9 Framework For Technology Selection

The previous sections cover a broad spectrum of areas that are critical to successful technology selection. Technology selection can essentially be divided into three main blocks of

activities. The first block represents technology identification, the second block represents technology assimilation, and the third block encompasses the decision-making activities that lead to the final selection of which new technologies to pursue. The first two blocks are the most activity intense as they seek to collect, classify, store, analyze and contrast the new or emerging technologies and determine if there is a fit within the corporate strategic plans.

Identifying technologies begins with the process of collecting ideas or technology concepts from a variety of sources. These ideas are then stored in a central repository and analyzed and ranked in terms of their perceived value-added to the corporation. This process is led by the technology team (more specifically the administrative part of the technology team with support from the cross-functional experts), with oversight from the senior management technology champion. Key criteria to ensure the most benefit is obtained from this part of the process are:

- **Supplier relationships** – to bring forth the best ideas from the supply chain.
- **Centralized Strategy** – having one group control the corporate strategy allows for a holistic approach while maintaining the team focused on the core strategy.
- **Core engineering to lead projects** – this leads to acceptance of new technologies as the team responsible for implementing the technology is involved with it from the beginning.
- **Parallel-path early stage technologies** – using a parallel-path approach (budget permitting) may uncover uncertainties that will make the decision of one technology over another a simple one to make.
- **Cross-functional team** – ideas need to be brought forth from all areas and evaluated by all involved.
- **Team leaders with influence** – team leaders need to be given the authority to make decisions. They are in a better position to make final recommendations regarding technologies since they actually understand them.

Assimilating the identified technologies is a task the technology team takes on. However, the bulk of the responsibility for assimilating the technologies lies with the cross-functional experts, not the administrative team. They are responsible for developing the technical and

business cases for the technology using the technology foresight process. Using this process the technology team can effectively filter technologies, and recommend to the technology council (who is responsible for making final selections) only those technologies that are viable and have the potential of helping to achieve the corporate vision.

Selecting which technologies to pursue is the responsibility of the technology board (whose members are the team leaders, and senior managers from the programs, Advanced engineering, Strategy office, and Business office). This team uses the technology valuation methods and tools discussed in this chapter, along with the restrictions from the available budget, to make the final decisions on which technologies to pursue. Figure 4.11 shows the technology selection framework in a diagram format.

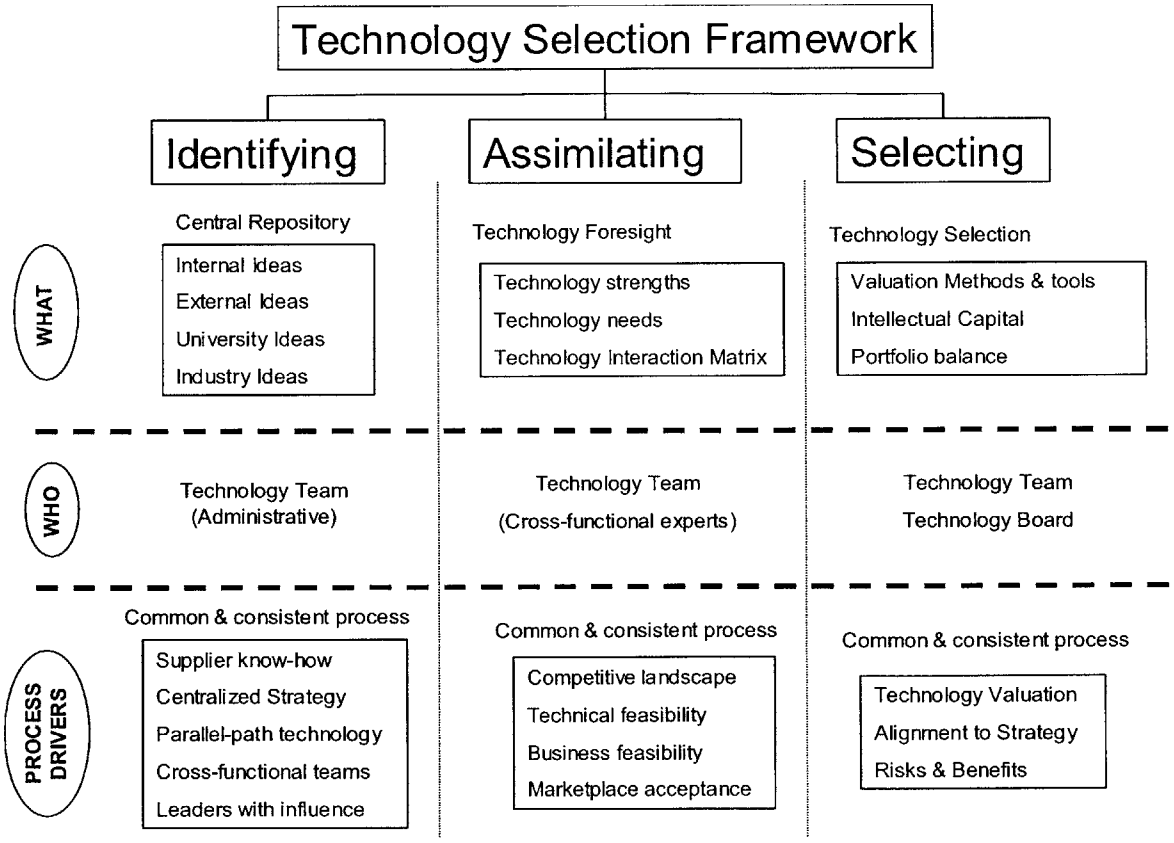


Figure 4.11 – Technology Selection Framework

4.10 Summary

This chapter begins by comparing and contrasting the technology selection process at a few OEMs. This exercise leads to some insights into specific tasks that help promote a corporation's ability to select appropriate technologies to pursue. A methodology that addresses the issues of idea generation, technology foresight, technology valuation, and technology portfolio balance is also developed to attack the technology selection problem. This methodology is then extended to present a framework for technology selection based on the insights and lessons learned from studying the technology selection process at a few OEMs.

One of the critical aspects of technology selection involves suppliers and their capacity of delivering innovative ideas to its customers and developing technology. The integration of the right suppliers at the right time can be a significant factor relating to the success of technology integration. Chapter 5 leads into a discussion of how to best manage supplier integration.

Chapter 5 - Supplier Relationships

5.0 Overview

Increasing competitive pressures and rapidly changing consumer trends are forcing corporations to constantly push the innovation envelope while maintaining, or even improving, the quality of their products. Suppliers can play an active role in contributing to an OEM's competitive edge by helping them develop innovations that address the consumer wants and needs. The relationship between an OEM and its suppliers can significantly affect the OEM's technology integration effectiveness, as suppliers often hold the key to uncovering new value streams through technology. While some OEMs take an adversarial approach to their relationship with suppliers, others approach the supplier relationship as a partnership.

This chapter begins by comparing and contrasting the current state of supplier relations at a few OEMs to illustrate the diverse approaches with respect to supplier relations. However, rather than discuss the pitfalls of using an adversarial approach to supplier relationships, the goal of this chapter is to present a framework to help integrate suppliers into the OEM's technology integration process so the OEMs can develop product innovations more quickly and efficiently.

5.1 Supplier Relations – US vs. Japanese OEMs

The quality of supplier relations varies widely across the automotive industry. In general, the largest differences between the working relationship of an OEM and its suppliers can be seen by studying US and Asian OEMs. The OEM-Tier 1 Supplier Working Relations Study conducted by Planning Perspectives Inc. highlights some of the differences between US and Asian OEMs:

- Suppliers are shifting resources (capital and R&D expenditures, service and support) to Japanese OEMs, while reducing these for US OEMs.
- Suppliers are increasing product quality at a greater rate for the Japanese, while merely maintaining quality levels for US OEMs.

- Suppliers, by a wide margin, prefer working with Japanese OEMs, and would even like to drop the US OEMs if they could.

Source: (Panchak, 2004)

Furthermore, the reasons given by the suppliers to explain why they are favoring the Japanese OEMs do not bode well for US OEMs. Some of the reasons include: the Japanese OEMs instill a higher level of trust in their suppliers, they maintain more honest relations, they treat the suppliers trade secrets with care, and they make fewer late engineering changes (Chappell, 2004).

With the influx of Japanese OEM's manufacturing facilities in the US, a barrage of new suppliers are needed to handle the introduction of the many new vehicles the OEMs manufacture. To provide the necessary systems for these vehicles, the Japanese OEMs are bringing new suppliers from overseas and are asking existing suppliers to do things differently. This creates a huge potential for US suppliers to decide whether they will continue to do things as they always have (dealing with US OEMs), or if they should look into doing things differently working with Japanese OEMs. This is a big threat to the US OEMs, and should be a clear sign that change in supplier relations is necessary. Here is a look at the supplier relations at a few OEMs:

OEM-A:

OEM-A's supplier relations are lacking compared to other OEMs. This is generally reflective of the short-term, cost-centric policies that OEM-A utilizes. While senior management recognizes this as an issue and has repeatedly called for using trust, consistency, facts, and value over price when dealing with suppliers, OEM-A's record with respect to applying these criteria is still uneven. The new technology implementation rate at OEM-A is low, which discourages suppliers to come forth with new ideas as the likelihood of having those ideas implemented is poor. The amount of co-development support provided by OEM-A to its suppliers lags the industry, which prevents smaller, less financially able suppliers from sharing ideas with OEM-A since they will not obtain the financial means to develop the idea. Sourcing commitments only

happen about midway through a program, which hinders the suppliers' desire to work with OEM-A from the early stages for fear of not gaining the contract later on. Although senior management at OEM-A has changed its views with respect to supplier relations, it seems this view has not filtered down to the daily practices of the buyers and engineers at the working level.

OEM-B

The supplier relations between OEM-B and its suppliers are very well regarded throughout the industry. OEM-B is driven by the idea that collaborative relations with suppliers can provide a means of improving their own performance. With this notion in mind, OEM-B created a supplier development program that is targeted at select suppliers. This program revolves around a core family of suppliers and focuses on improving quality to create a win-win outcome for both OEM-B and its suppliers. Key items that are critical to the success of this program (and the relations between the OEM and the suppliers), are measuring and monitoring performance, experiential learning, and long-term supply commitments. Measuring and monitoring performance means that the supplier is working towards agreed-upon quality and cost targets, and OEM-B is there to help them achieve the targets. Experiential learning means learning by doing; OEM-B provides the suppliers with human and technical resources to help achieve their targets and trains the suppliers' employees on how to manage the necessary processes. Finally, long-term supply commitments give the suppliers confidence and justification to commit more resources to the products they are building for OEM-B.

OEM-C:

OEM-C has a philosophy of open, frank communications with its suppliers and emphasizes cooperation and collaboration. A cost-modeling approach used by OEM-C dissects the costs for each part based on a target profit level, and then cascades this practice throughout its

supply-chain. A dedicated cost research group works in collaboration with OEM-C's suppliers to define the part costs. The cost-model takes into consideration sales, manufacturing, design, and purchasing, while maintaining the customer as the focal point. OEM-C's supplier development programs are robust because of the time and money invested in building and sustaining supplier relationships. To hasten implementation of the supplier development program, OEM-C takes ideas from the supplier's employees and puts them in place immediately. This way the supplier employees see their ideas in action right away and become strong proponents of change because they have a vested interest since it was their idea. OEM-C also has a strong focus on performance metrics and seeks targeted improvements while being committed to continuous supplier improvement. Constant, on-going communications with suppliers are also the norm, and helps maintain direction with respect to productivity and quality. OEM-C's motivation for doing these things is not altruistic; when suppliers are kept for the long-term, benefits are reaped by both the OEM and the supplier.

OEM-D:

OEM-D sees suppliers as co-development partners and grants long-term commitments during the early stages of a program. Renegotiation of these long-term commitments only happen if the supplier has poor performance and this performance does not improve even after coaching. OEM-D's purchasing strategy focuses on long-term relations and encourages suppliers to share technology. These long-term commitments spawn intense development partnerships with minimal confidentiality barriers leading to best achievable and/or industry-first technologies. Through early sourcing, the supplier's engineers work directly with OEM-D's program teams to design parts that are inexpensive to produce, yet deliver the desired value. Suppliers are eager to spend money to develop new technologies for OEM-D, because OEM-D almost guarantees them

long-term business. Recently OEM-D has even gone as far as having independent suppliers own and run a few of their operations at one of their assembly plants. However, OEM-D has lately shown some signs of retreating to the cost-cutting pressures of the past, presumably because of the competitiveness of the industry and the low profit margins.

OEM-E:

Not enough information available.

OEM-F:

OEM-F is looking at improving supplier relations while at the same time cutting costs. They have had quality problems related to suppliers, and it is speculated that the quality problems were driven by the intense cost pressures imposed upon the suppliers. OEM-F has realized they made mistakes in the past and are applying lessons learned to make drastic changes to their supplier relations. A joint optimization initiative is in place which seeks to achieve more cost savings, but this time in cooperation with the suppliers instead of by making suppliers compete amongst themselves on cost. The hope is that a collaborative management of the suppliers will yield higher quality while speeding up production. A key item in this new collaborative effort is the constant monitoring of suppliers to ensure they are on a path to deliver agreed-upon targets; if the suppliers are deviating from the target, OEM-F steps in to help steer them back on track. OEM-F has also added the capability to work with suppliers early on, to look at proposed technical changes in real-time through an on-line application. When deciding whether to pursue a new business case, OEM-F is becoming more open to listening to its suppliers, which is helping them regain the supplier-base's trust.

5.2 Supplier Relationship Comparison

There are essentially three stances an OEM can take towards supplier relations; they can be adversarial, collaborative, or somewhere in-between. While the OEMs discussed above represent all three of these viewpoints, the fully collaborative viewpoint seems best suited for the automotive industry, where partnerships or alliances can mean the difference between being in business or not. In fact, partnerships and alliances with suppliers have been identified as an increasingly important strategy for corporations to maintain and develop competitive advantage (Bozdogan, 1998). Table 5.0 below summarizes the strengths of each of the OEMs analyzed above.

Supplier Relationships	**OEM-A**	**OEM-B**	**OEM-C**	**OEM-D**	**OEM-F**
Long-term commitment		+	+	+	
Senior Management support	+	+	+	+	+
Co-development encouraged		+	+	+	+
Collaborative relations	+	+	+		+
Creating win-win outcomes		+	+	+	
Measuring & Monitoring performance	+	+	+	+	
Open communications	+	+	+		+
Comprehensive cost model			+		
Sharing of technologies		+	+	+	

+	= Major strength
+	= Minor strength

Table 5.0 – Comparison of Supplier Relations

As seen in the table above, although there is senior management commitment to improve the supplier relations at all OEMs studied, the overall outcome varies significantly from OEM to OEM. OEM-B and OEM-C have been practicing collaboration with their suppliers for some time, and this is reflected in the willingness of their suppliers to achieve tough targets because they know it will help grow their business. The other OEMs studied have shown commitment

from their senior management to change to a more collaborative relationship with their suppliers, but whether they will succeed at implementing these changes remains to be seen.

5.3 Supplier Integration

Supplier integration means more than a partnership or alliance with a single supplier; instead, it deals with aligning the corporation's suppliers to help achieve faster product development cycles, improve the use of technology, and reduce costs. Supplier integration begins to take form when an OEM and its suppliers work together with information sharing, planning, technology development, and joint problem solving; and as they perform these tasks they share the benefits (Monczka, 1996). Integration, unlike a merger, does not require any equity ownership of the suppliers, and the expectation is that the suppliers will continue to improve their competitive performance by working with other customers. Thus, supplier integration is a change in philosophy that builds on supplier partnering, but is broader in scope with regards to the information that is being shared and how close the corporation and its suppliers work together.

Research conducted by *Industry Week* indicates that a majority of companies that have made significant progress toward world-class operations use a supplier integration approach (Panchak, 2004). Research from *Clark* also suggests that a significant portion of the competitive advantage acquired by Japanese OEMs can be attributed to the quality of supplier relations and the extent of supplier involvement in product development (Clark, 1989). The evidence presented by this research suggests that the integration of suppliers into the early stages of product development can increase the technology and knowledge base required for product development. Team performance in product development is closely tied to formal supplier involvement, as shown by a study of 108 cross-functional sourcing teams conducted by *Monczka et al* (Monczka,

1997). A common theme among these studies is the fact that improved quality, technology, and productivity are some of the performance improvements achieved through supplier integration.

There are several places within the product development process where supplier integration can occur. There is, however, an ideal place for it to occur: in the beginning. While the early stages (concept definition and early design) of product development account for only a small portion of the total product development costs, they can constrain the next tasks in the product development cycle, essentially locking-in 80% of the total costs (see Figure 5.0). The decisions made during the early stages of a project can greatly influence the final results in terms of quality, cost and technology use. Therefore, in general, it is in the best interest of a corporation to utilize the most product, process and technical expertise as possible in the early stages of a project (see Figure 5.1). The exception to this is the case of simple parts or components that can be considered more of a "commodity". The case for integrating a supplier earlier or later in the product development process is shown in Figure 5.2.

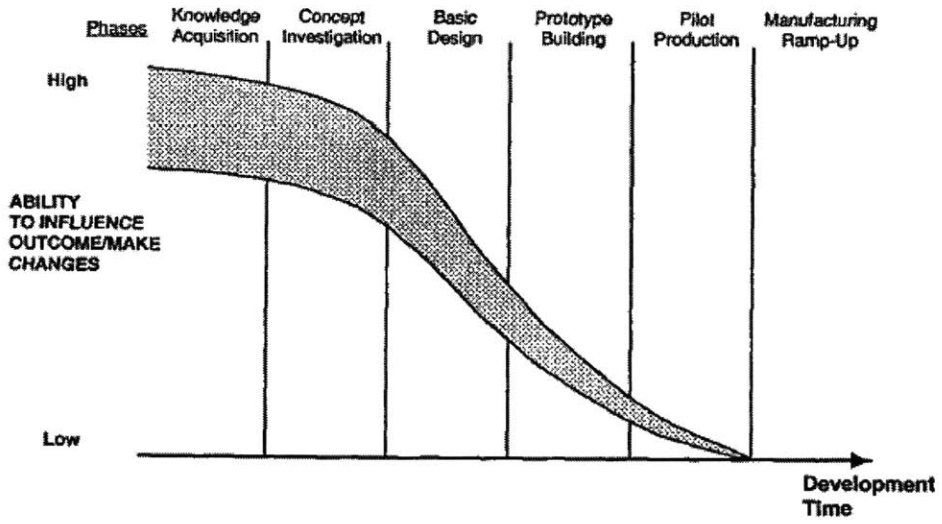


Figure 5.0 – Product Development Influence

Source: (Thomke, 2001)

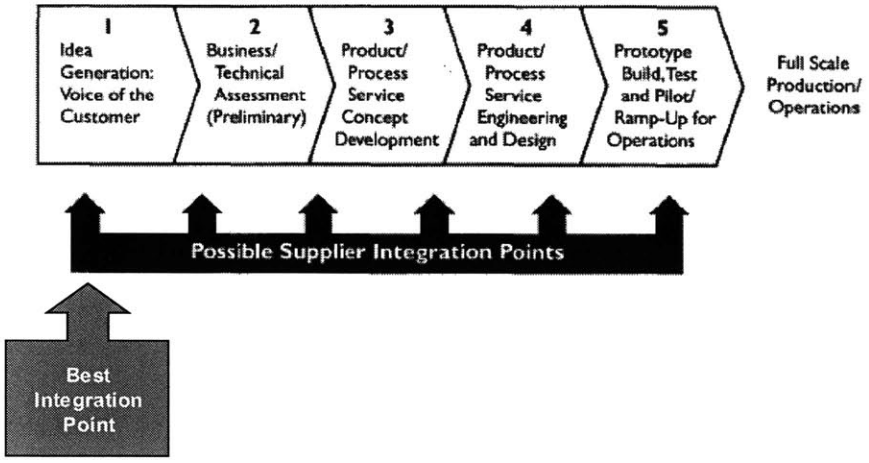


Figure 5.1 – Supplier Integration Point

Source: (Adapted from Handfield, 1999, p.62)

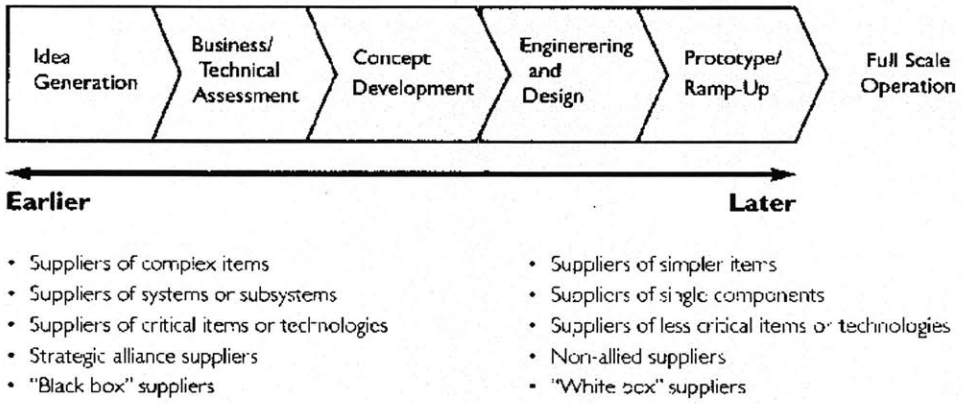


Figure 5.2 – Supplier Integration Point – Earlier/Later

Source: (Handfield, 1999, p.78)

Bozdogan et al also agree with these findings when they conclude "Perhaps the most important result derived from the research is that there exists an important opportunity for realizing significant benefits by proactively integrating key suppliers, and possibly lower-tiered suppliers as well, early in the concept exploration and definition stages of product development." (Bozdogan, 1998, p.167)

5.4 Implementing Supplier Integration

Supplier integration is in fact a strategic initiative that should be part of a corporation's technology integration process. Approaching this from a strategic perspective allows the corporation to ensure a proper balance exists between its core competencies and those of its suppliers so that it has the right capabilities with respect to technology for long-term sustainability. In order to successfully execute supplier integration, the corporation needs to use an organized approach to define their technological needs, and develop relationships with suppliers that can help fill those needs.

A review of the corporation's core competencies, capabilities and capacity with respect to technology will help identify the suppliers that best complement the in-house knowledge to achieve the corporate goals. In selecting the most apt suppliers, the corporation will need to study the suppliers' engineering capability with respect to the technology of interest, their ability to deliver projects, willingness to share information, and cultural compatibility. Once the potential suppliers have been identified, the corporation needs to focus on the process of developing or maintaining the supplier's capability as well as aligning them to the corporate goals and strategy, thus initiating the integration process. To accomplish this successfully, *Monczka et al* propose a five step execution process (Monczka, 1997):

1. **Provide suppliers an active role** – Ensure that the supplier is an active participant on projects. Open channels of communication established to provide forums through which the supplier can be kept abreast of decisions and are able to participate in decision-making that is relevant to their work.

2. **Define clear metrics and targets** – Clear, well-defined and agreed-upon targets help both the OEM and the suppliers to keep the project headed in the proper direction. Involving the suppliers in the target setting process can be valuable, as the suppliers may be more knowledgeable with respect to required trade-offs that may be involved in reaching certain goals.

3. **Sharing information openly** – This is key to effective integration, and requires significant amounts of communication between the OEM and its suppliers. Information

on requirements, cost, and technology will be needed for decision-making and problem resolution throughout any project. Mechanisms must be in place to allow direct, face-to-face communication between the supplier and the OEM. Confidentiality and non-disclosure agreements need to be settled very early in any projects to establish the boundaries for each of the parties.

4. **Involving suppliers in decision-making** – Ensure that there is appropriate supplier representation when key decisions need to be made. Suppliers often are able to speed up problem resolution during the design phases of a project due to their expertise with their own technologies. Co-location of the suppliers can also be extremely effective to help problem solving, particularly during production ramp-up.

5. **Monitoring Results and using Lessons Learned** - Constant monitoring of processes and events help ensure continuous improvement is applied to the supplier integration process. Once projects are completed, what worked well and what did not work well needs to be documented. The OEM needs to ensure these lessons learned are diffused throughout the organization so other teams can avoid the same mistakes.

This execution process provides a means by which the corporation extracts the most value from the supply-base's knowledge and capability. Key issues that need to be constantly monitored during this process are the quality of the supplier's participation and ensuring clear communications between both parties. This execution process needs to be managed carefully as it is critical to the success of the supplier integration. To ensure that the execution process is effective, the technology team needs to be engaged to help with supplier integration. The senior management champions need to set expectations for the suppliers and with the help of the technology team, identify and institute appropriate metrics by which the supplier's success will be measured. The technology team will also need to devise a common form for a feedback loop so lessons learned are disseminated to prevent issues from reoccurring.

5.5 Summary

This chapter discusses the state of supplier relations at a few different OEMs and highlights specific actions that OEMs perform that help them foster cooperative relations with

their suppliers leading to win-win situations. A relationship between an OEM and its suppliers in which there is open communication, senior management support and long-term commitments can enhance the quality of the deliverables from the supplier and encourages technology sharing. To develop such a relationship, the concept of supplier integration is introduced.

Supplier integration is an important tool to help corporations gain competitive advantage through their technology integration process. With this tool, corporations can develop a cooperative positioning for negotiations involving parts or systems that offer unique advantages in terms of brand and product differentiation. This chapter presented a framework for executing and managing supplier integration. This framework relies on the ability and desire of the suppliers to actively participate in the product development process at an OEM. Therefore, it is critical that the OEM is careful in its choice of suppliers and that it ensures clear, direct communication channels are used to keep both parties aligned to a common goal. With a strategy in place, a technology selected, and suppliers aligned with the corporation, the next step is to determine how to best manage the migration of the technology into other platforms or brands. This is the topic of the chapter 6.

Chapter 6 - Technology Migration Planning

6.0 Overview

Technology migration planning is a guaranteed method of driving performance into a corporation's technology integration process. It allows the corporation to become nimble and quick in implementing proven technologies throughout its product line. Migration planning begins through the development of a migration strategy that defines how technology will be utilized across platforms and brands. This step should be closely linked with the technology selection activity, since a technology that is not migrateable will be required to deliver outstanding value to even be considered as part of the corporation's technology portfolio.

The intricacies of a migration plan are explored in this chapter, with the goal of developing a framework for establishing an effective technology migration map that can feed the technology integration process. The chapter begins by comparing the current state of technology migration at a few OEMs, and then focuses on the attributes required to develop a comprehensive migration strategy. Critical success factors, as well as pitfalls that need to be avoided, are also presented throughout the discussion.

6.1 Current State Of Migration Planning At OEMs

Among the OEMs studied there seem to be two general approaches with respect to migration planning. There is either a strategy behind the migration efforts or the approach is ad hoc, with any given program within the OEM deciding where and what technologies to migrate. Some OEMS have established practices for migration planning with a strong decision-making process to support it, while others do not. A strong linkage to the OEM's cycle plan is also a key

contributor to successful migration planning. Here is a look at the migration planning process at a few OEMs:

OEM-A:

The migration planning process at OEM-A seems to suffer from the lack of a corporate technology migration strategy. Although there certainly is technology migration across platforms, the direction is usually set at the program level. Senior management within the programs is responsible for making the technology migration decisions, and these decisions seem to be based on cost and functionality, not strategy. The lack of a consistent approach to the migration process can dilute a brand's value since different products from the same brand may have significantly different levels of technological innovation. Also, during the technology selection process there is not enough emphasis on migrationability of the technologies being studied, which can lead to resources being allocated to a technology that will only benefit a small number of programs. OEM-A is currently working to address these issues.

OEM-B:

This OEM has an established approach to technology migration that begins with their luxury brands. The migration strategy that OEM-B has in place gives their luxury brands the lead with the introduction of new technologies. New technologies are exclusive to the luxury brand for a pre-determined number of years, after which the technologies are cascaded into the more mainstream brands. OEM-B also uses different approaches to migration depending on the technology type. For instance, technologies that have to do with electronics are planned on a two year horizon because of rapid changes in this field, while more "hardware" oriented technologies are planned over longer time-periods. Rather than performing cost/benefit analysis early on to determine migration potential, OEM-B only considers this type of analysis once the technology

has been proven with a prototype; this can be a double-edged knife since it takes longer to determine whether a technology can be migrated, but also mitigates development risks. In general, OEM-B has migration plans in place prior to the first application of a given technology. The migration decisions are made at lower levels within the organization, by people who understand the technology and its potential, but may not be aware of the corporation's technology "big picture".

OEM-C:

OEM-C's approach to migration planning takes into account the customer needs, cost, quality, and available resources. Their approach does not seem to be quite as structured as OEM-B's approach, but they have had success in the marketplace without suffering from brand dilution. Senior management is involved in the technology application decisions, and also sets the direction for how to migrate technology throughout the corporation's products. OEM-C applies financial analysis, in terms of cost/benefit, at an early stage, but cost considerations are not allowed to cancel a project until proven infeasible. The migration planning is linked to the cycle plan via a centralized budget. This helps decision-makers more clearly assign technologies to specific vehicles. As with OEM-B, the technology planning outlook varies by the purpose or objective of the technology.

OEM-D:

OEM-D does not have a clearly defined approach to technology migration, but there is evidence that shows several iteration loops between senior management, product development and marketing. Unlike other OEMs, OEM-D's migration plans are put in place concurrently with the first application of a given technology; this can be a hindrance as project decisions tend to be

drawn out because of lack of resources. It is speculated that OEM-D also has different planning horizons depending on the technology type and its perceived benefit to the corporation.

OEM-E:

OEM-E has a platform-based approach to migration planning that has proven effective in the market segments in which they compete. Managers from each program have full profit/loss accountability for a given platform, and technologies with minor, or negative, cost/benefit are reconciled during technology cycle plan reviews with senior management. Senior management reviews the migration plans and makes decisions based on recommendations from the teams involved in migration planning. Additionally, OEM-E's migration strategy requires that each new product introduced must have a minimum number of technological innovations. As with other OEMs, OEM-E's migration plans depend on the technology type. Marketing also has a strong influence on migration planning via their inputs to OEM-E's technology roadmaps.

OEM-F:

OEM-F has a well-defined migration strategy that spans platforms and brands. Established migration strategies are in place for different types of technologies, and they are consistent within brands. Individual programs do not have the authority to make migration planning decisions, instead, all migration plans and strategies are developed at the senior management level. The technology migration plans are linked to the cycle plan, and technologies are clearly assigned to specific products. The link between the migration and cycle plans also enables cascading of the technologies into different platforms and brands in a consistent manner.

6.2 Migration Planning Comparison

Having a migration plan that is based on a well-defined migration strategy can help lead to success in the marketplace through the consistent application of technology tied to specific

brands. OEM-B, OEM-E and OEM-F all have established migrations plans and have been implementing them for some time. The application of these migration plans to their different brands has been effective, particularly in the luxury or near-luxury markets, as measured by the growth in sales. The OEMs that have a weaker migration planning process in place seem to have greater difficulty projecting a clear brand image to their customers. The ad hoc approach to migration planning leads to inconsistency in what is delivered to the customer, and truly successful products are more sporadic as compared to the OEMs that have established migration plans. Table 6.0 summarizes the migration planning strengths of the different OEMS analyzed.

Migration Planning Process	**OEM-A**	**OEM-B**	**OEM-C**	**OEM-D**	**OEM-E**	**OEM-F**
Established migration approach		+		+	+	+
Cost/benefit analysis done early	+		+	+		
Decision-making at senior-level	+		+	+	+	+
Decision-making at lower levels		+				
Migration plans linked to cycle plan			+		+	+
Migration plans in place prior to 1st application		+	+	+	+	+

+	= Major strength
+	= Minor strength

Table 6.0 – OEM strengths in Migration Planning

The decisions regarding migration planning are carried out by senior management at most OEMs, but even so, the actual process of decision-making is different. While at some of the OEMs migration planning is carried out in a dictatorial manner, at other OEMs they involve the recommendations of teams at the manager level. OEM-C, OEM-E and OEM-F have strong links between their cycle plans and their migration plans. This is also a key factor to enable the consistent technology deployment throughout a brand or market segment.

6.3 Migration Strategy

The first step in the creation of a migration plan that will help strengthen the technology integration process of a corporation is the development of a migration strategy. The migration strategy needs to take into consideration the technologies available (now and in the future), the cycle plan, brand values, platform compatibility, scalability of the technology, and the competitive outlook. Because the migration strategy requires insight into technologies that will become available in the future, the migration planning needs to be tightly tied into the technology selection process.

There are several approaches a corporation can take to develop its technology migration strategy. The actual strategy selected will depend on the corporation since the product portfolio, market segments, and competition, will undoubtedly be quite varied in any industry. The next section presents a potential approach to migration strategy in the automotive industry.

Migration strategy approach:

A corporation that has a product portfolio that spans multiple platforms and brands may have difficulty in developing a technology migration strategy because of concerns about maintaining brand identity. However, those concerns could actually be mitigated through the use of a migration strategy. Part of the strategy could be to apply specific technologies to a brand to maintain or enhance its core values. Technologies that are more "transparent" to the customer could then be applied across the board to the benefit of all brands. Therefore, the first step for developing a robust migration strategy is to identify technologies that are critical to defining each brand in the product portfolio. This is a task that should be taken on by the technology team, specifically the marketing experts (to clearly define the brand values), and the engineering and administration experts (to identify technologies that would contribute to brand value). A simple tool that can help determine which technology is best suited to a particular brand is shown in

Figure 6.0. Each technology is rated by the technology team experts in terms of its impact to all the attributes that are important to the brand. It is then up to the technology team to decide what is the best attribute balance to support the brand values. Once technologies and brands have been aligned, the corporation can begin thinking about migration in terms of products and platforms. Some examples of technology migration within products and platforms are shown in Figure 6.1.

		Attribute 1	Attribute 2	Attribute 3	Attribute 4	Best suited brand ?
Technology 1	*Brand X*	-	+	+	+	X
	Brand Y	+	+	--	-	
	Brand Z	+	-	+	+	

Figure 6.0 – Selecting the best brand for a technology

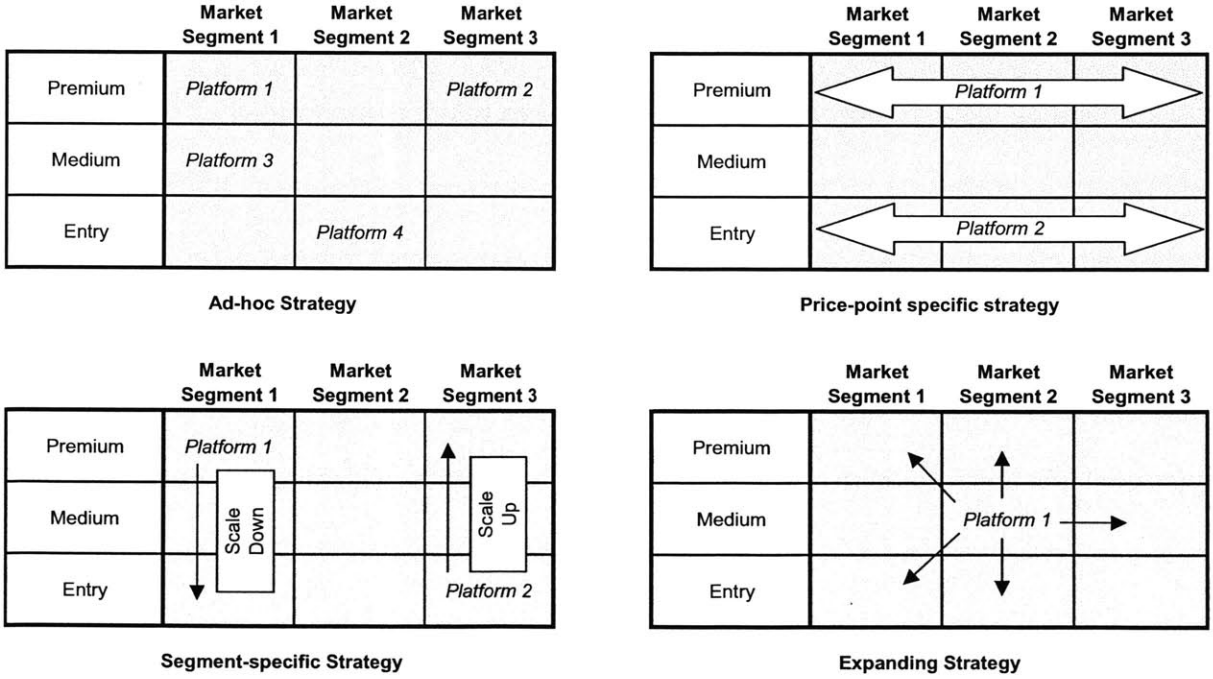


Figure 6.1 – Product & platform based migration strategies

Source: (Fricke, 2003)

While it is clear that some technologies should be aligned with a specific brand, these technologies will not be exclusive to a brand for an indefinite period of time. Customer expectations are such that the new technologies that are present in luxury vehicles today will become the mainstream technologies of tomorrow. Take for instance, the examples of power windows and navigation systems. Power windows, once only available in high-end, expensive vehicles, are now taken for granted even on the most basic, entry-level vehicles. Navigation systems which once were options on only the most exclusive automotive brands, are now making their way into more mainstream brands (at much more affordable prices). Figure 6.2 shows how technologies can migrate across brands over time. In addition to determining brand priorities for a given technology, the migration strategy should also be clear with respect to migration within a brand. The corporation needs to have a consistent approach within a brand; for example, introducing new technologies in their premium vehicles and then cascading those technologies to their more affordable vehicles over time. Although technologies will not be exclusive to a particular brand for a long time, it is important to have exclusivity in the short-term to ensure the brand identity does not become diluted. This cycle of short-term (1-2 years) exclusivity is then repeated with the introduction of new technologies.

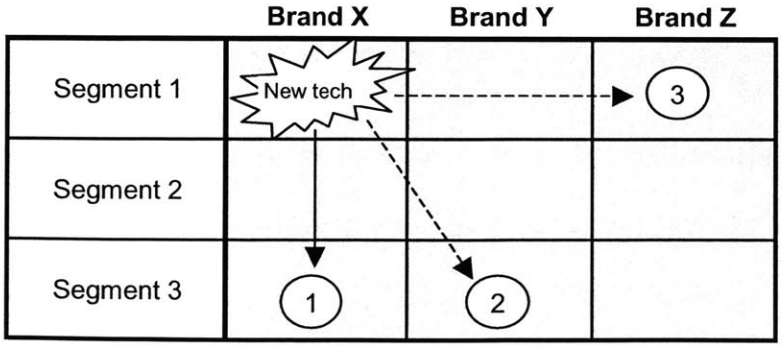


Figure 6.2 – Technologies span brands over time

However, to ensure that short-term exclusivity is possible, the migration strategy needs to be tied to the corporation's product cycle plan (which is based on the corporate strategy). This is how the migration plans will support the corporate technology goals. Overlaying the competitor's known (or expected) technology introductions onto the corporation's cycle plans helps determine where to implement a particular technology to extract the most value out of it. This exercise should be done with all the technologies available, or expected to be available, based on the technology selection process. An example of how this could be done is shown in Figure 6.3. With a migration strategy in place, the corporation can begin the migration planning process.

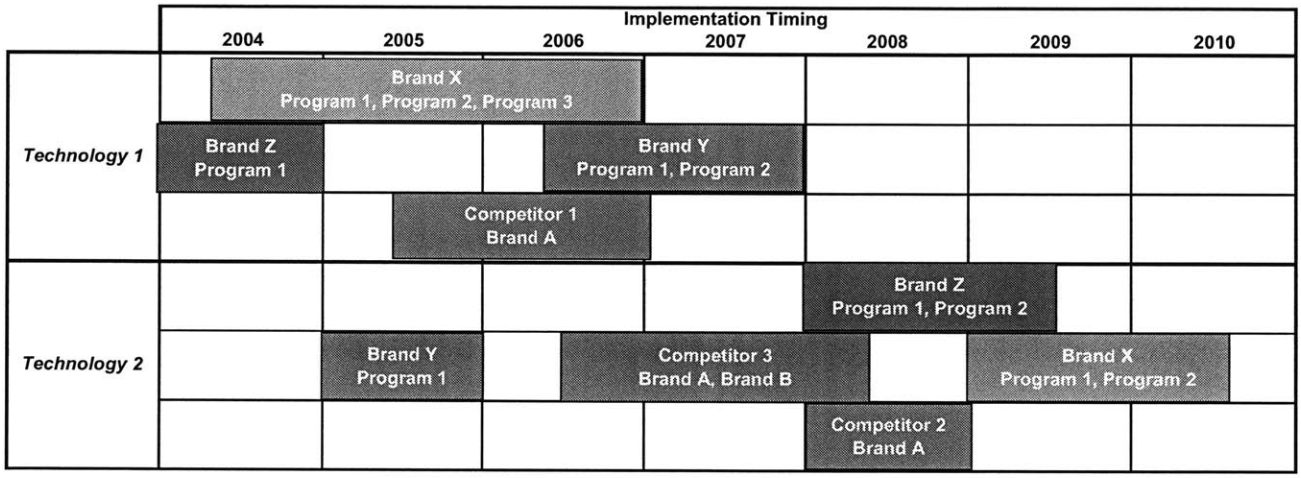


Figure 6.3 – Technology implementation and the product cycle plan

One of the pitfalls of migration strategy lies in the balance between uniformity and variety. There is an inherent risk of loss of competitiveness when too much commonality is present within the product portfolio. When a significant amount of common technology and function is present within an automaker's brand, it is quite possible that the lower-end products will cannibalize sales from the high-end products. Corporations need to be especially mindful of this when using a segment-specific strategy for technology migration.

6.4 Migration Planning

An effective migration planning process depends not only on a consistent migration strategy across platforms and brands, but also on the effectiveness of the decision-making process. Senior management commitment to migration planning is critical, as they should be the main drivers of this process. Senior management champions need to be assigned to lead the migration planning efforts. This will help ensure a consistent strategy is employed, and it takes the responsibility of migrating technologies away from program teams who do not have the right resources for it. The cross-functional technology team discussed in the technology selection chapter will have the proper representation, in the form of the attribute and functional experts, to develop the comprehensive "big picture" necessary for the migration plan. The technology team's experts along with the senior management champions, will also need to have the responsibility of developing a migration budget. Another important aspect that the technology team and senior management will need to work on is ensuring the proper leveraging of technology migration during the technology selection process. In other words, they will need to ensure that technologies that offer the potential of migrationability across platforms or brands are prioritized over technologies that can be applied only in very specific products.

When developing the migration plans, the technology team will have to be very aware of other considerations as well. The complexity of the products given the number of technologies being implemented, along with the resources required to deliver them need to be studied carefully. The implementation of new technologies needs to be somewhat staggered due to the limited financial and human resources to dedicate to them. The migration plans will also need to be adaptable due to the rapidly changing technology environment. To address adaptability the migration plans will have to take into consideration the compatibility (the multiple interrelated

systems impacted by the technology) and scalability (can the technology be moved up or down within a segment?) of technologies with respect to brands and platforms.

6.5 Summary

This chapter discusses the need of having a well-defined and consistent technology migration strategy in place to support the migration planning process. The migration strategy is the foundation for migration planning, and this chapter presents some migration strategy alternatives that a corporation can use to support the migration plans. While very important to the migration plans, the strategy is only a piece of it. The decision-making process relative to migration plans needs to have clear accountability. It is suggested that a senior management champion be appointed to lead the migration planning, along with the technology team discussed in chapter 2. A migration budget also needs to be developed to ensure the financial feasibility of implementing new technologies across the corporations' platforms and brands.

Another consideration for migration planning revolves on ensuring a strong tie-in to the technology selection process to ensure that the new technologies the corporation decides to pursue are migrationable over several vehicle programs. The complexity of the aggregate technologies assigned to a program also need to be studied to ensure that the necessary resources are available to actually deliver the program. Compatibility and scalability of technologies also need to be evaluated to ensure that there is flexibility "baked-in" to the migration plans.

The material presented in chapters 2 through 6 discusses different blocks of the technology integration process. Chapter 7 presents a possible scenario to tie these blocks together through the governance process of the technology integration.

Chapter 7 - Technology Governance Process

7.0 Overview

Implementing a technology integration process encompassing strategy, technology selection, supplier integration, and technology migration requires a methodic approach and a steadfast drive towards execution. This can only be accomplished through a set of central rules to ensure the success of the technology governance process. The technology governance process is the most critical building block of the technology integration process, as it assigns the responsibility and authority necessary to ensure alignment, within functions and individuals, with respect to the selection, development and implementation of technology. Thus, the technology governance process lays the groundwork for successful technology integration.

This chapter discusses the need for a technology governance process and develops a framework that can be used to create it. The chapter begins by contrasting the technology governance process at a few OEMs, and then leads into a discussion of critical success factors for the development of a robust technology governance process. In light of the findings, a proposed technology governance model that addresses potential shortcomings is also introduced.

7.1 Technology Governance At OEMs

The technology governance process is very different among the OEMs studied. While some OEMs have a very structured approach to technology governance, others have very loosely organized systems in place to support the governance process. It is no surprise that the OEMs that have a structured governance system in place are the most effective at actually implementing technology into their products. Other differences between the OEMs with respect to technology governance that can be significant determinants of success are the management of the linkages

between technology and brands, performance metrics and resource sharing, and the incentive system. Here is a more detailed look at the technology governance process at a few OEMs:

OEM-A:

From the different technology integration areas discussed thus far, technology governance is perhaps the weakest area for OEM-A. Unfortunately for OEM-A, the governance process is the central pillar to technology integration, essentially providing the bond that keeps the process running smoothly. The lack of a central governing body that is responsible for the technology integration process from ideation to implementation is a major obstruction to successful integration of technology at OEM-A. Without a clear-definition of a cradle-to-grave governance process, there are no concrete rules to follow regarding implementation, and the technologies tend to cater to the needs of a specific market rather than meet multiple market requirements. There is no accountability for the technology cycle plans, so the tie-in to the business plans is very informal, and in most cases is actually done at the program-level. There is also a lack of alignment between advanced engineering and core engineering with respect to technology plans, further contributing to poor technology implementation rates.

OEM-B:

Not enough information available.

OEM-C:

OEM-C is organizationally well structured between their research and development, manufacturing, and engineering groups. This facilitates and supports a clear alignment within the organization regarding decision-making. Technology evaluation committees that have representation from engineering and marketing, are empowered to make decisions about which projects to pursue, and they are supported by senior managers that are experienced with OEM-

C's research and development process. There are also no boundaries between the research group and the advanced engineering group, which assists in the seamless transfer of technology to the implementation phase. The corporate technology objectives are balanced with the program interests through a philosophy that has been consistent over time. Still, the issue of accountability is unknown, and may be deterring OEM-C's technology implementation capability.

OEM-D:

Not enough information available.

OEM-E:

OEM-E uses a very structured approach to technology governance, and it is ingrained in the corporate culture. Technology commercialization is measured and tracked, which helps ensure the actual technology implementation matches the planned implementation rate. The engineers that work on developing a technology are also the ones responsible for implementing it, which helps drive the implementation success rate. OEM-E's products are engineered to meet the requirements of multiple markets, leading to greater technology leverage. The governance process is led by innovation managers who are responsible for creating a comprehensive technology plan which is then reviewed by a technology board for concurrence. The technology board is ultimately responsible for the technology decisions and creates a technology plan with a ten-year outlook, indicating which technologies will be used in which products. The requirements put forth in the front-end of the process are driven by the programs and advanced technology centers (consisting of personnel from OEM-E as well as suppliers), thus there is a vested interest in the part of the programs to ensure there is cooperation in the transfer and implementation of technology once the plans are approved.

OEM-F:

OEM-F's technology governance approach is not as well structured as OEM-E's, but it has proven itself effective nonetheless. OEM-F employs a technology committee to provide high-level direction and decision-making with respect to technologies being developed by the engineering groups. Based on the input from the technology committee, approved technologies are passed on to the technology team composed of program personnel and vehicle system experts. The technology team is responsible for aligning technologies to specific vehicles based on the corporate migration strategy, and developing the overall technology plan for OEM-F. Because this process is less structured than that of OEM-E, it is actually dependent on having strong individuals in the development teams, the technology committee, and the technology teams in order to drive the process and ensure technologies are implemented according to the plan.

7.2 Contrasting The Technology Governance Process At OEMs

A technology governance process that is consistent across the corporation is a critical asset. The set of responsibilities and accountability established by the governance "rules" become a key enabler to the technology integration process. Without a governance process the effectiveness of a systematic application of technology integration is seriously undermined. Out of the OEMs studied, it seems that OEM-E and OEM-F are best positioned to extract significant value from their technology integration process because of their approach to technology governance. Table 7.0 provides a summary of the strengths of each OEM for which technology governance data were available.

Technology Governance Process	**OEM-A**	**OEM-C**	**OEM-E**	**OEM-F**
Alignment of decision-making	+	**+**	**+**	**+**
Committee established to manage governance		**+**	**+**	**+**
Simple/clear governing structure		**+**	**+**	
Technology cycle plans tied to business plans			**+**	**+**
Senior management support of technology roadmaps	+	**+**	**+**	**+**
Technology aligned to products	+		**+**	**+**
Implementation-oriented technology planning		**+**	**+**	**+**

+	= Major strength
+	= Minor strength

Table 7.0 – Technology governance strengths by OEM

The OEMs that are widely viewed as the technology leaders (AT Kearney, 1999) are the ones that have a well-defined approach to technology governance. These OEMs have a structured approach to managing the implementation of technology, with clear responsibilities assigned to either committees or individuals. The technology cycle plans are continuously evaluated by senior management to ensure the technology plans are strongly linked to the business plans. Having the technology planning decisions in the hands of senior management helps ensure that the technology distribution within the organization matches the corporate strategy, therefore delivering a consistent message to the customer. The bottom-line is that an implementation-oriented approach to technology planning is key to successful execution of technology integration.

7.3 Technology Governance

The technology governance process encompasses all the actions a corporation can take to ensure that technology integration occurs in a systematic manner and supports the overarching corporate goals. Beyond specific actions, technology governance also has to do with the rules, spoken and unspoken, that lead to effective technology integration. Accountability is

fundamental to success, and these rules provide accountability through the assignment of roles and responsibilities necessary to seamlessly deliver technology to the customer.

To introduce new technologies that fit within a detailed comprehensive plan and support the corporate strategy, the accountability needs to fall within one governing board. This board needs to have responsibility for the entire technology integration process, and is the best way of ensuring that the technology plans are implemented. There can certainly be sub-groups responsible for different parts of the process, but the delivery of robust technology integration needs to be the responsibility of this governing board for clear accountability. Figure 7.0 shows a proposed organization for the technology integration process.

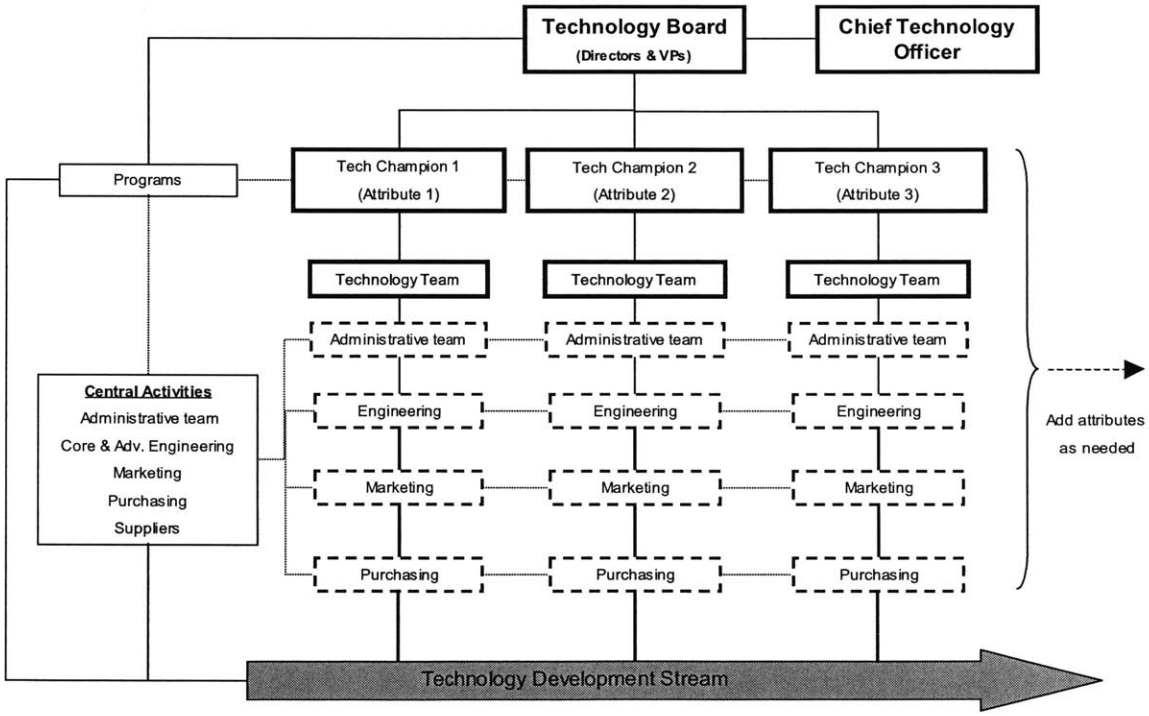


Figure 7.0 – Proposed organization for technology governance

In this proposed organizational scenario, the technology board becomes the central governing board responsible for technology integration. The technology board is accountable for oversight of the entire technology integration process from idea generation through implementation of the technology plans, and is composed of company directors and VPs,

representing an aggregate view of the corporation. Technology ideas are driven through the technology champions (senior managers responsible for a particular technological attribute, for example; Chassis, Electronics, Safety, etc.) who allocate them to specific brands or platforms based on the migration strategy devised by the technology board. The technology teams represent a cross-functional team composed of experts in engineering, marketing, and purchasing, along with members of the administrative team (whose role is to manage the flow of technology related information) to act as process "shepards". The technology team is responsible for identifying and filtering technology ideas so only feasible technologies become part of the portfolio of technologies the technology champions have to work with. The program needs are also constantly monitored via links to the technology champions and representation in the technology board.

Technology board:

Although the technology board is the central governing body for the technology governance process, it still has constraints imposed on it from the corporate level. These constraints take the form of inputs which help shape how the technology board will conduct its core business. Inputs to the technology board are the corporate strategy, the product cycle plan, the corporate platform strategy, the brand definitions and identity, the corporate budget, and available resources and staffing. The technology board needs to align itself with these inputs in order to produce the proper output for the technology integration process. The output, or deliverable, of the technology board is to primarily deliver competitive advantage through the systematic application of a comprehensive technology integration plan. There are several tasks that the technology board needs to perform in order to accomplish this. Some of the major tasks are:

- **Define the technology strategy** – The technology strategy needs to take into account the corporate goals and needs to clearly define where the corporation wants to be with regards to technology. Ambiguity should be driven out of this process by creating a vision and strategy for technology that is actionable and realistic.

- **Define the migration strategy** – The technology migration strategy needs to be aligned with the corporate view on brand values and platform strategy. It needs to build on the brand values by allocating technologies that are perceived as value-added by the core brand customers. The migration strategy also needs to consider cross-brand and cross-platform technology delivery over a long (5-10 yr) time horizon.

- **Review & concur on overall technology plan** – The technology plan needs to be developed by the technology champions for their attributes and then combined to create an aggregate technology plan. This plan needs to be reviewed for consistency in technology application and to ensure it supports the migration and technology strategies which are vital to help meet the corporate goals.

- **Ensure the technology plan is linked to business plans** – The technology plans need to have a solid business case behind them. Delivering technology for technology's sake is not a viable option. The value of delivering a given technology needs to be understood in terms of the business case.

- **Ensure implementation of technologies** – The value of a plan is only as good as its execution. The technology board is well-positioned to have the authority to drive the technology plans through to implementation because of its link to the programs. Since technology decisions now reside in the technology board, programs cannot implement any technology; it has to be tied to the technology plan.

- **Ensure commonality of technology processes** – As a central organization leading the technology integration process, the technology board needs to drive commonality into all the technology processes. From ideation to implementation, the tools and sub-processes used need to be common, and should be constantly updated based on best practices and/or lessons learned. Common tools and processes will ensure there is consistency in the ability to deliver according to the technology plan.

- **Implement incentive system** – The technology board needs to ensure alignment of objectives at all levels within the technology organization. Aligned objectives will facilitate the development of an incentive system to develop and implement new technologies . To improve the implementation capability, the incentive system needs to be tied to the corporation's record of actual implementation.

- **Drive culture change regarding technology** – The culture within an organization can be a significant obstacle with respect to change. From "change is bad" to "not invented here", there is a long way to go to turn the corporation into one that embraces change as a continuous improvement tool. The technology board can drive culture change by

leveraging the fact that the technology development team will be working together from the ideation to the implementation phases of the technology integration process.

Technology champions:

The technology champions drive technology ideas through the use of a comprehensive technology plan that indicates when a technology will be used, in what brand or platform it will be used, how long it will be used for, and how it will migrate to different products. This technology plan is the technology champions' key deliverable. Background information for this plan should contain details such as what state of development the technology is in, a history of its progression, an estimate of whether it will be ready on time, and a list of the key people working on it (including suppliers). To develop this technology plan, the technology champions are guided by input from the technology board in terms of the technology strategy, the technology migration strategy, and the available technology budget. Many tasks will be required of the technology champions in order to deliver a meaningful technology plan. Some of the critical tasks are outlined below:

- **Align technology development processes with brands/platforms** – The technology champions need to align technologies with the brands and platform in a manner reflective of the technology and migration strategies. The development of the technologies needs to be targeted to specific products so the technology team and the program teams have common and consistent goals.

- **Assess technology strengths** – Assessing the corporate technology strengths prepares the corporation to develop a technology plan that addresses both its technological strengths and weaknesses. The technology plan should exploit new technologies to enhance its positioning with respect to its strength areas, and improve its positioning in its weaker areas.

- **Technology selection** – Although the technology teams are responsible for filtering technologies to select the ones with the highest potential for competitive advantage, the technology champions still need to prioritize the technology list, which should then be reconciled at technology board review meetings.

- **Drive purchasing to leverage volume pricing** – Rather than risking quality and functionality via forced cost reductions, the technology champions need to ensure that the

right volumes are used for pricing of selected technologies. This task is linked to the migration plan, since this plan will outline the brands and platforms that are targeted to receive the technology. A robust migration plan is required in order to leverage volume pricing with the suppliers.

- **Drive technology development parallel to product development** – To ensure swift and timely integration of technology, the technology needs to be developed in parallel with product development. If the development processes are aligned in this fashion, "just-in-time" technology delivery becomes possible, and the corporation gains the ability to be first-to-market with leading technologies.

- **Drive supplier integration** – The technology champions need to drive the supplier integration process by ensuring their involvement early in the technology development phase. Information sharing and team co-location need to be encouraged, and clear success metrics need to be developed to help keep suppliers on track to help deliver the technology.

- **Focus on implementation** – The technology champions need to ensure their teams maintain focus on implementation while working on selecting and developing technologies. The involvement of program teams needs to gradually increase as the technology approaches the implementation point. This will help with continuity and ensure seamless integration of the new technology.

Technology teams:

Guided by the technology champions, the technology teams are responsible for researching consumer trends and gathering innovation ideas from within the corporation and industry, as well as from outside industries and academia. In addition to gathering ideas, the technology teams are responsible for managing the technology concept database and applying a first filter (i.e. does the technology complement the corporation's technology strategy?) to the innovations identified. Technologies that make it through the first filtering process are then evaluated regarding their potential value to the organization. This, in effect, constitutes the beginning of the due diligence process, and involves all the cross-functional experts in the team. The technology teams also need to research and evaluate the capability of suppliers and ensure that there is a well-defined innovation submission process in place through which suppliers can

contribute ideas that require co-development. Some of the critical tasks the technology teams need to perform are:

- **Identify potential technologies** – The technology teams need to scout industries and academia for emerging technologies that could add significant value to the corporation. These technologies need to be evaluated and compared (when multiple technologies serve the same need), in terms of value and exclusivity, to determine the most viable options for sustainable competitive advantage.

- **Determine funding requirements** – A technology funding game-plan needs to be developed for each of the technologies that are identified and have the potential of meeting the corporate technology strategy. In general, the technologies will be in their early development, or even in pre-development, stages. The technology team needs to identify those technologies that will require co-development funds and develop an estimate of how much funding will be required. The funding requirements will then be reconciled at the technology champion and technology board levels.

- **Develop and maintain central technology repository** – The technology concepts that are identified by the technology team need to be stored centrally so anyone in the organization can have access to them. Although a large portion of the concepts identified will likely not be pursued, they may spawn new ideas, or can be combined with other concepts to create a workable technology. The technology team needs to maintain this technology database and ensure the information is constantly updated.

- **Develop a user-friendly idea submission process** – To further encourage suppliers to come forth with their innovation ideas, a concise idea submission process needs to be developed. The process needs to be clearly defined, and updated status needs to be readily available to the idea submitters. The submitters of ideas that have merit and fit the corporation's strategic plan, need to be invited to make a formal presentation to the technology champions and technology teams. This will enable deeper discussions on potential and feasibility of the concept.

7.4 Technology Governance Process

The technology governance process needs to ensure that decisions are approached from a technology portfolio standpoint, where decisions are not based on short-term business cases, but rather on meeting the technology strategy and solidifying long-term competitive advantage. The governance process relies on having a well-defined strategy to translate brand values into supporting technology innovations, and through this strategy, the governance process needs to align program needs with technologies. Positioning each brand against a concrete competitor can

help suppliers and employees better understand the brand vision, thus enabling a more effective assignment of technologies to brands and/or platforms.

The technology governance process also needs to consider commonality, and have purchasing enforce commonality – to a certain level. Although commonality is highly desired, it has to be kept to technologies that the customer does not "see". If there is too much commonality between brands, the brand identity can be weakened, and price-premiums can therefore be eroded. The technology content needs to be managed based on brand hierarchy, and the level of sophistication of the technology needs to be dependent on the position of the brand; for example – the premium brands could receive the highest level of sophistication, while entry-level brands could apply the least sophisticated technologies. Whatever the corporate strategy may be regarding the use of technology, the strategy needs to be rolled out consistently across all brands.

Additionally, the technology governance process will also rely on unwritten rules with respect to supplier relations. These rules are not so much rules as they are intangible characteristics, such as when senior management of the corporation meets with supplier senior management to discuss technology and innovation. Figure 7.1 shows, in generic form, what the governance process looks like. The process is cyclical, and spans the timeframe from ideation to implementation of technologies. The figure shows the inputs to the technology teams, and some of their critical outputs to the technology champions. The technology plan cycles between the technology champions and the technology board until it is approved. Once approved, the technology teams work with the programs and core engineering to ensure the plan is implemented.

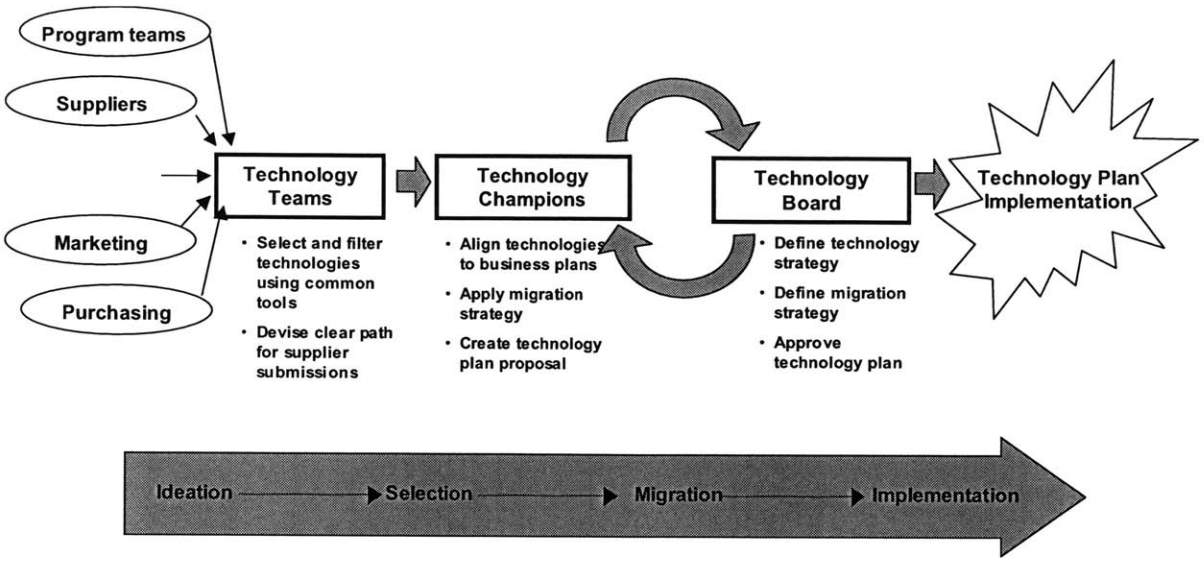


Figure 7.1 – Technology Governance Process – High-Level

7.5 Summary

The material presented in this chapter emphasizes the need for a well-structured technology governance process as a critical factor to successful technology integration. To help with effective integration, the governance process needs to have an implementation focus, as only through nimble execution will the corporation be able to extract the most value from its technology plans. However, execution can only be achieved with accountability, which is why it is critical to have a single governing body to oversee the corporation's technology strategy from ideation to implementation. This chapter proposes an organizational model for the technology governance that is comprised of three main groups: a technology board, technology champions, and several technology teams.

The technology board is responsible for the technology integration process from beginning to end, and is fully accountable for implementation of the technology plans. The technology champions lead the technology discovery and development efforts for an attribute, and are responsible for consolidating their technologies with the different brands based on the brand identities. The technology teams perform the grunt work of canvassing the automotive and

other industries for emerging technologies that meet the corporation's strategy. Each of these groups has well-defined responsibilities that will promote efficiency in the technology integration process. Chapter 8 develops a framework around the principles discussed in the preceding chapters, and argues that through the rigorous application of this framework, the corporation's technology integration process can be positively affected.

Chapter 8 - Technology Integration Framework

8.0 Overview

There are multiple challenges in the path of developing effective technology integration. These challenges are ingrained in the combination of technology novelty and complexity that need to be managed. When analyzing a new technology with respect to its ability to deliver competitive advantage, it is difficult to forecast the impact of the technology on future business because of the uncertainties surrounding the technology itself, and its interactions with other systems. Furthermore, when the benefits of the technology are well understood, processes need to be in place to ensure the corporation can extract these benefits and leverage them to differentiate themselves from the competition. Holistic thinking is required to address these points and approach technology integration from a systemic viewpoint. To create an effective technology integration process, it is necessary to consider all aspects of the technology from ideation to implementation. This chapter uses the building blocks discussed in the preceding chapters to develop an overall framework for technology integration that is designed to enhance the quality of the technology integration process and deliver competitive advantage to the corporation.

8.1 Technology Integration Framework

Due to increasing competitive pressures, many corporations fall into the so-called "death-spiral" – where lower market shares and reduced profitability lead to cost-cutting and lower investments in technology, which in turn result in less attractive products, further eroding market share and profitability (see Figure 8.0). To get out of the death spiral, or better yet, avoid it completely, the corporation needs to take a systemic view of technology integration. This view needs to be comprehensive, and along with a well-defined set of building blocks it also needs to

be inclusive of the challenge of cultural change, especially in an established organization. To be successful, the technology integration process needs to consider all steps required to bring an innovation to production. This sets the stage for the development of a technology integration framework.

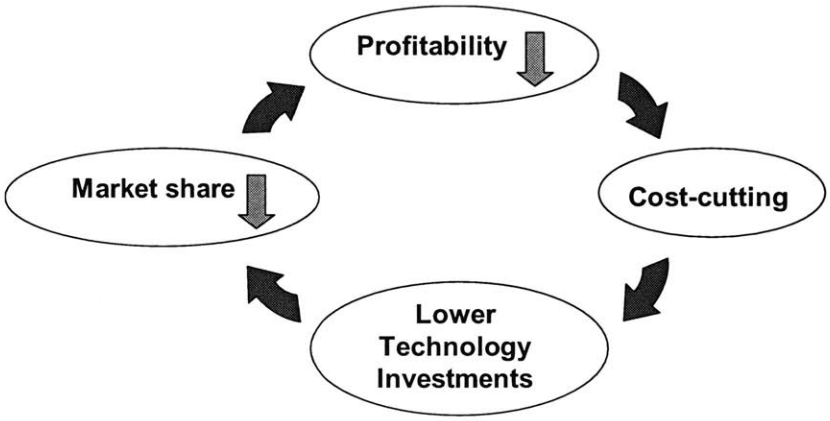
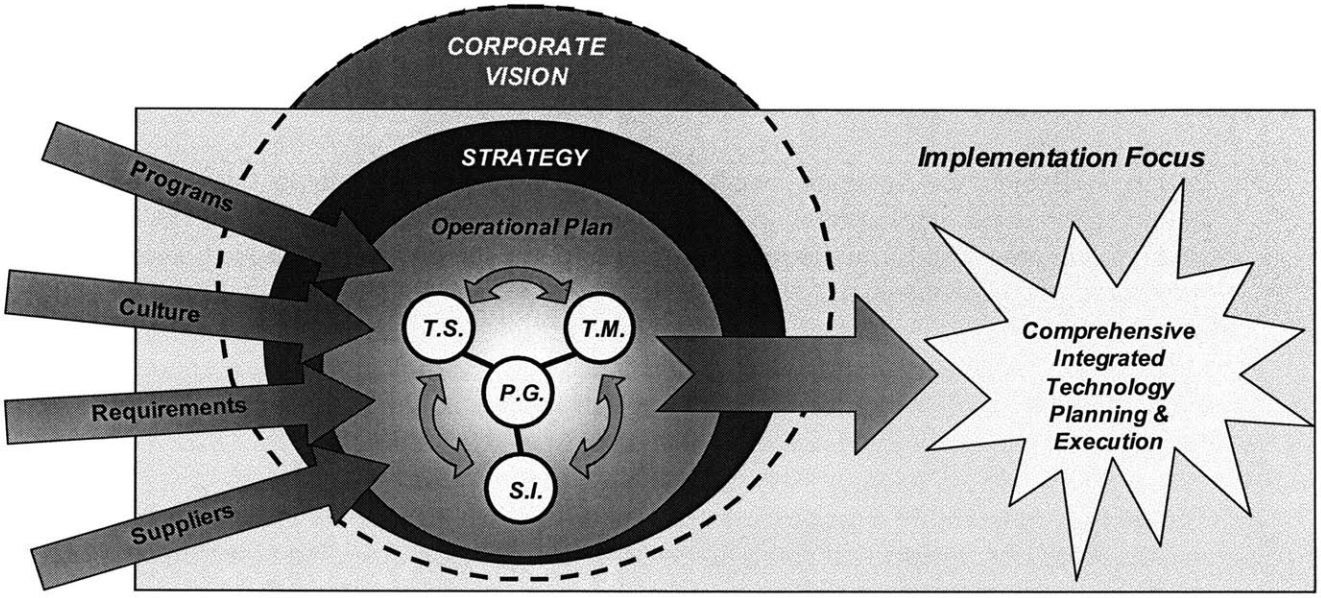


Figure 8.0 – Death Spiral

Technology integration needs to begin at the highest levels within the corporation by establishing the technology vision for the corporation and ensuring this vision is linked to the overall corporate goals. The technology vision is then used to guide the formulation of the technology strategy, which will define the underlying principles for technology integration. Critical steps after the development of the technology strategy are the technology selection, supplier integration, and technology migration processes. To link these processes in a manner that is conducive to successful integration, a structured governance process is needed. Figure 8.1 shows a diagram view of the framework proposed here. This framework requires that the operational plans be aligned with the technology strategy and the corporate technology vision. The operational plans support the strategy and vision (both of which are its key enablers) through the technology selection, supplier integration, and technology migration processes. These processes are, in turn, controlled by the central process governance, with inputs from the

program teams, suppliers, corporate & regulatory requirements, and in more intangible ways, corporate culture. The goal is to deliver comprehensive, integrated technology plans that will provide the corporation with sustained competitive advantage through its implementation of technology in the corporation's products.



T.S. = Technology Selection
T.M. = Technology Migration
S.I. = Supplier Integration
P.G. = Process Governance

Figure 8.1 – Technology Integration Framework

Along with an emphasis on the technology processes, this framework emphasizes corporate alignment as the basis for technology integration. Having a systemic view of technology integration is not enough – the corporation needs to ensure that the technology integration process has the proper authority and influence to ensure that the technology decisions made are actually implemented. Even the most formidable plans will fail without proper execution, thus it is imperative that the corporation develops and maintains an execution-focused mindset. This may require significant changes to the corporate culture, and senior management must be willing to take on this challenge to make the technology integration process work.

Technology Integration Framework steps:

The corporation needs to have a feasible and effective process for translating the right technologies into the right products. The technology integration process helps achieve this by defining a technological approach given the corporation's competitive context and positioning. The major steps in developing a corporation's technological approach are highlighted in Figure 8.2. The goals of the major steps are as follows:

- **Vision** – Senior management needs to define the corporate goals with respect to technology and its deployment in the corporation's products. The vision needs to be clearly communicated throughout the corporation, and the different organizations need to become aligned to this vision.

- **Strategy** – The strategy should also be developed by senior management. It encompasses the methods through which the corporation will engage in carrying on their business to ensure that the technology vision is achieved.

- **Technology Selection** – This process needs to ensure that all feasible ideas are examined, and the ideas or concepts that can deliver the most value are ranked and prioritized. Final technology selection should be determined through the capability of the corporation to deliver the technology with the proper quality/function/cost relationship.

- **Supplier Integration** – Should be performed as early as possible in the product development timeline. May require a corporate culture change to encourage suppliers to participate and bring forth improvement ideas.

- **Technology Migration** – This step encompasses how the corporation will use technologies across is product line. This process needs to be strongly tied to the technology selection process and the corporation's product cycle plan to map technologies into products while maintaining brand identities and increasing brand value.

- **Process Governance** – This step entails the process of monitoring and managing technology integration, from the point of concept generation through production. This process ensures that the technology decisions made by the corporation are implemented according to plan, thus supporting the corporate strategy and vision.

Figure 8.2 – Technology Integration steps

8.2 Implementing The Technology Integration Framework

In most cases, the framework outlined in this chapter will require significant changes to the way a corporation approaches technology integration. It is unreasonable to expect that all these changes will happen overnight – instead, this framework can set the foundation for gradually changing a corporation's processes. To implement the technology integration process gradually, one can begin by using the "Change-Wheel" (see Figure 8.3), a change initiative framework developed by Professor Kanter at Harvard Business School (Kanter, 2004).

The first step to implement technology integration effectively involves senior management of the corporation defining the technology vision & strategy and cascading it throughout the corporation. Senior managers need to actively participate in cascading the vision and strategy to show they are indeed committed to this initiative. To avoid repercussion of another "flavor of the month" initiative, the alignment of functional and staff objectives to the strategy needs to occur quickly. This will indicate that management is serious about the initiative, and will sow the seeds of organizational alignment, which is critical for the success of technology integration. The need for this new process needs to be clearly communicated, and a sense of urgency to meet the new corporate technology vision needs to be instilled in the corporation. At this time the technology board representation and the technology champions need to be introduced to the corporation. These steps should be completed within a few weeks or a few months (but not more than 3 months), depending on the size of the organization

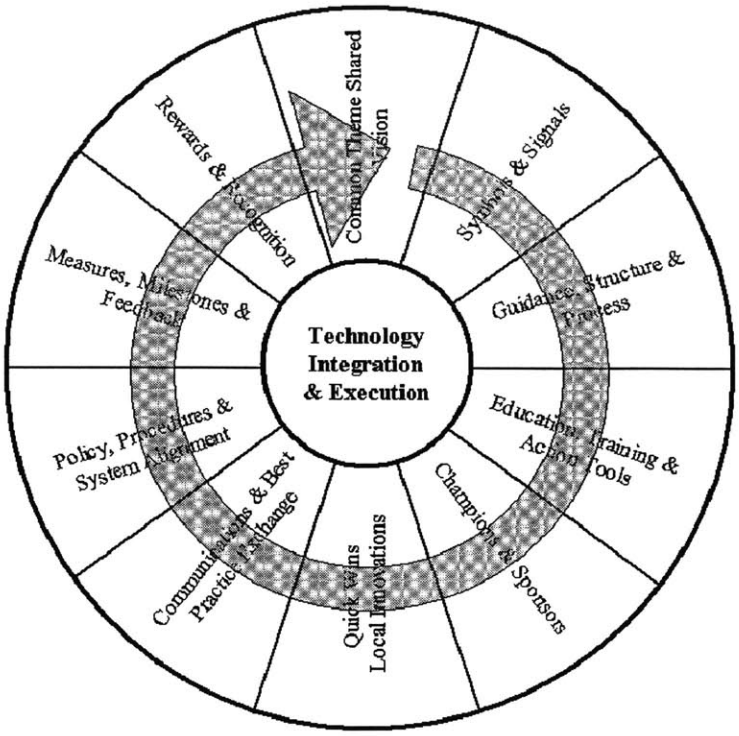


Figure 8.3 – Change Wheel for Technology Integration & Execution

The new organizational model should take place gradually, and as this happens there should be training sessions for the employees, aimed at teaching the new process as well as beginning to shift the cultural mindset towards execution. These training sessions should begin shortly after the new process is cascaded. To gain further support, it is recommended that the technology integration process begin as a pilot project, focusing on high-profile technologies that are close to the implementation point (not more than one year away from production freeze). Executing the effective integration of these technologies in a few products will go a long way towards garnering support from within and from outside the corporation (suppliers or potential suppliers). Feedback and lessons learned need to be used concurrently with the technology integration process to enhance its quality and increase its effectiveness. The technology board should establish milestones with clearly defined objectives, and the technology champions need to track the progress of technologies to these milestones. Furthermore, a method to recognize and

reward teams for meeting and/or exceeding their objectives should be developed to further strengthen technology integration execution. To enhance corporate morale, it is also recommended that this reward & recognition method be implemented prior to the first technology application using the new process.

8.3 Technology Integration Roadmap

The capability of a corporation to effectively manage technology integration will be reflected in its products by how well the technologies match the customer environment. Technology integration has to do with organizational integration as much as it has to do with technology processes. And, as described by Iansiti, "the characteristics of the organizational process of technology integration needs to be associated with the quality of the match between technology and context in the product" (Iansiti, 1998, p.76)

A technology integration roadmap was developed to help guide the technology integration process from both an organizational and a technical standpoint. Figure 8.4 shows the technology integration roadmap. The roadmap begins with the corporation's decision to capitalize on the value that technology can provide when it is used in the proper context and application. Once senior management is committed to improving its technology integration process, the first step is establishing a vision of what the corporation would like to achieve and then cascading it through the corporation. With the vision in place, an appropriate technology strategy needs to be crafted focusing on both the corporate goals and the ability of the corporation to implement the strategy. The technology strategy provides the foundation for the technology governance process, which has oversight of the technology process and drives accountability into the system, with emphasis on implementation. Technology selection, supplier integration, and technology migration are focused on the technologies required to support the corporate strategy. The main

tasks here are selecting the appropriate technologies and mapping them onto the corporation's products along with creating a development plan that takes into account the corporation and the supplier's capabilities and resources. The governance process needs to ensure the technology plans delivered are supportive of the corporate technology strategy and address the implementation of technology using a holistic point of view.

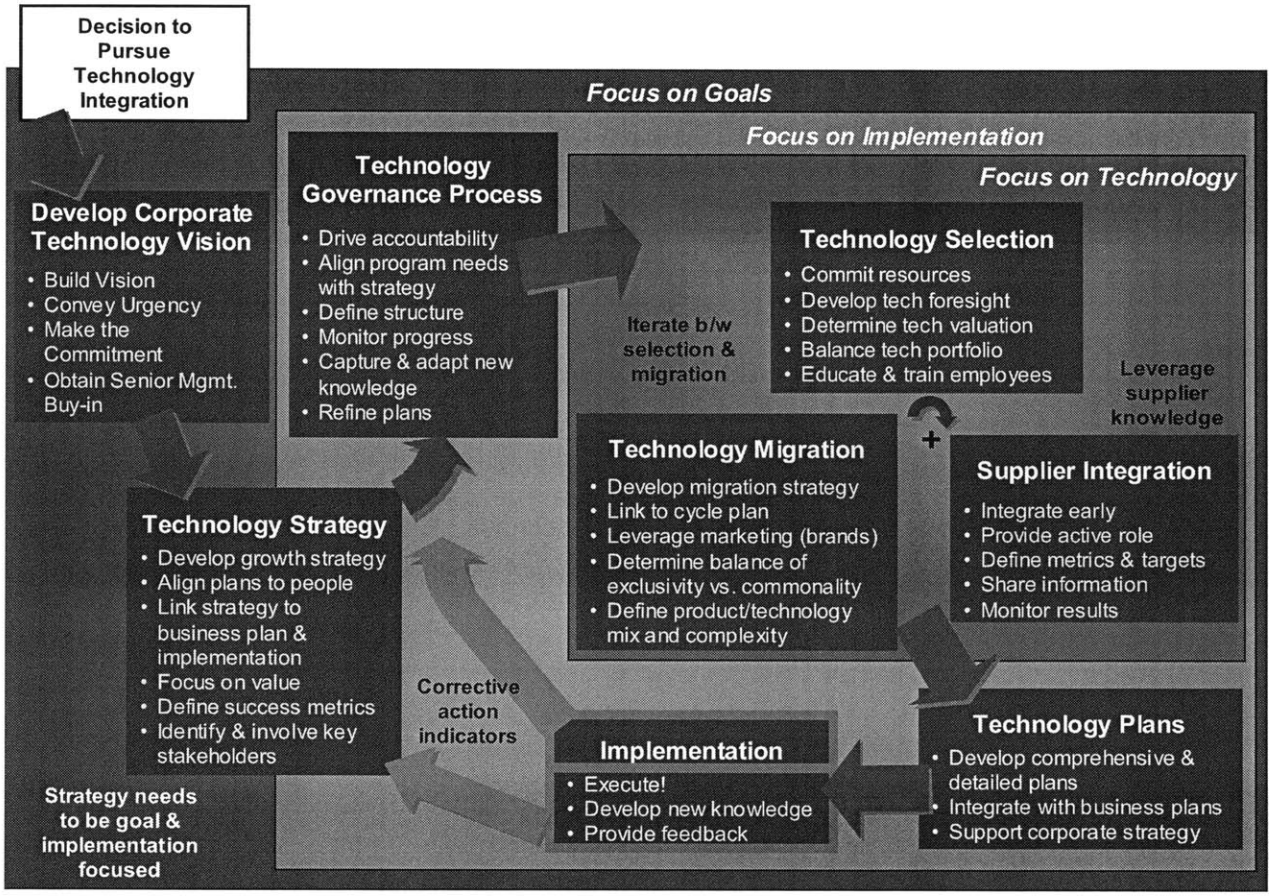


Figure 8.4 – Technology Integration Roadmap

8.4 Recommendations For OEM-A

While OEM-A has pockets of strength throughout the technology integration process, the entire process lacks cohesiveness, which contributes to the ad hoc implementation of technology. OEM-A needs to focus on better integrating what they do well, improving what they do not do well, and ensuring the process is centered on execution. Reflecting on the results from the

questionnaire introduced in Chapter 4, OEM-A needs to focus on a few critical parts of the technology integration process: development of a corporate technology vision, ingraining an innovation-focused mindset in the corporation, active management of the technology migration process, improvement of supplier integration, and enhancement of the technology governance process. Table 8.0 discusses each of these parts in more detail.

Corporate Technology Vision	• Development of a long-term vision for technology • Communication of this vision throughout organization • Alignment of organization structure to vision
Innovation Mindset	• Gradually change the corporate culture to embrace innovation • Drive innovation mindset through senior management examples
Technology Migration	• Define a migration strategy for brands and platforms • Leverage global marketing knowledge to extract the most value from brands • Link migration planning to product cycle plans
Supplier Integration	• Develop early sourcing commitments • Create and implement a budget for technology co-development • Develop comprehensive cost models that can be used across platforms • Share technology development information
Process Governance	• Create a central governing body with accountability over the entire process • Create strong links between technology plans and business plans • Drive implementation-oriented culture

Table 8.0 – Technology Integration Roadmap

To develop a more integrative and cohesive technology integration process it is recommended that in addition to addressing the items listed above, OEM-A also follow the steps outlined in the Technology Integration Roadmap introduced in the previous section. The benefits of this approach will be multiplied by the brands, creating a renewed value stream that will contribute to sustainable competitive advantage.

8.5 Conclusions

An effective technology integration process is a key enabler to help a corporation deliver the right value proposition to its customers. Corporations can extract significant competitive

advantage through the continued delivery of the right value proposition by all of its brands. The technology integration framework and roadmap introduced in this thesis are tools that can help a corporation develop and fine-tune their technology integration process through the development of comprehensive and integrated technology plans.

The technology integration roadmap is designed to help guide a corporation in the implementation of a transformational plan to extract more value out of its products. The transformational plan is based on the technology framework, which is created through the systematic application of key building blocks that provide the foundation to robust technology plans. A holistic approach to the building blocks – looking at technology strategy, selection & migration, supplier integration, and process governance – and their interrelations is necessary to ensure that the technology plans are all-inclusive, and will yield tangible benefits to the corporation.

As a corporation begins to implement their technology plans, repetitive successful technology launches will help deliver brand premiums, and valued technology may win new customers to the brands. However, there is a caveat - the benefits of applying the roadmap and using the technology integration framework will not be immediate. Senior management needs to be well aware of this, as they need to remain committed to the strategy, even though the benefits will not be reaped until the corporation has proven its ability to consistently deliver their products with the right technology foundation.

8.6 Next Steps

The technology integration framework presented in this thesis encompasses a wide-ranging look at the technology integration process, however, investigating technology funding aspects and corporate alliances can further strengthen it. Technology funding will be somewhat

specific to a corporation or industry, and should focus on many facets including: the level of funding and its consistency over time (for example, funding as a percentage of engineering budget). Additional funding concerns that need to be explored are how funds are allocated between regulatory and desired technologies, the proper balance between supplier funded vs. OEM funded projects, and the creation of a method to determine appropriate co-development funding requirements.

The orchestration of corporate alliances should also be studied, especially in terms of the expected benefits versus the expected contributions. In areas where brand goals cannot be met with the technologies available to the corporation, it may be useful to form a partnership or alliance with another OEM to develop a new technology that both parties can exploit. An alliance as such can also help mitigate the risks associated with intellectual property as it can then be shared with the partner corporation.

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APPENDIX I

Breakdown of Success Level Attained in each Critical category and subcategories:

		Case 1 SFT	Case 2 NES	Case 3 BTE
STRATEGY/VISION				
		✓		
		✓		✓
TECHNOLOGY SELECTION		✓		
		✓	✓	✓
		✓		✓
		✓	✓	✓
		✓		✓
TECHNOLOGY MIGRATION		✓		
		✓		✓
		✓		
SUPPLIER RELATIONSHIP		✓	✓	✓
		✓	✓	✓
		✓		✓
		✓		✓
		✓		
		✓	✓	✓
PROCESS GOVERNANCE		✓	✓	✓
		✓	✓	
		✓		✓
		✓		✓
		✓		
		✓		✓
		✓		✓

APPENDIX II

Questionnaire for technology integration assessment (part 1 of 2):

Please use the rankings below to rate each category for its current state and its desired future state (3 to 5 year vision):

Level 1 = Low/Poor - Some awareness of this practice; sporadic improvement activities may be underway in a few areas.
Level 2 = Mid/Low - General awareness; informal approach deployed in a few areas with varying degrees of effectiveness and sustainment.
Level 3 = Mid/Average - A systematic approach/methodology deployed in varying stages across most areas; facilitated with metrics; good sustainment.
Level 4 = Mid/High - On-going refinement and continuous improvement across the corporation; improvement gains are sustained.
Level 5 = Exceptional - A well-defined, innovative approach is fully deployed across the corporation and its suppliers; recognized as best practice.
NA = Not applicable - Not enough experience with this practice to be able to give it a rating.

	Company Practice	State	Example only	Your Ratings	Comments
Strategy	**1. Corporate Technology Vision** *A clear, well-defined and realistic vision exists. The vision has been communicated to all levels and has extensive buy-in by most employees. The vision incorporates a new mental model of how the company would act and behave.*	Current State	3		
		Desired Future State	4		
	2. Senior management commitment *There is a consensus commitment supporting a transformation based on the technology vision. Management provides support and recognition for positive actions. Senior management are champions in transforming the actions and behaviors of the corporation.*	Current State	1		
		Desired Future State	3		
	3. Sense of urgency *A compelling business case for change has been developed and communicated. The implications and time scales of the technology vision have been translated for each area of the corporation. Transformational progress is integral to leadership discussions and events.*	Current State	2		
		Desired Future State	4		
	4. Comprehensive strategic planning process for Technology Integration *Has a suitable strategy for growth been identified? Is strategy clearly defined and does it have "buy-in" from all stakeholders?*	Current State	2		
		Desired Future State	4		
Technology Selection	**5. Technology requirements** *There is a process in place to determine clear and concise technology requirements, with acceptable ranges. The process ensures a balanced representation from all disciplines across the value chain. Structured methods are used to elicit and gather needs from the different stakeholders/customers.*	Current State	2		
		Desired Future State	3		
	6. Technology Identification *A robust technology identification process is in place, encompassing the total enterprise, including customer, alliances/partners, employees and suppliers. Roles and responsibilities for technology identification are clearly defined.*	Current State	1		
		Desired Future State	3		
	7. Technology valuation *A formal process has been established for identifying technology value. Customer value strongly influences policies, practices and behavior. The practice and language of value stream mapping is recognized as an important part of an iterative improvement process.*	Current State	1		
		Desired Future State	3		
	8. Common tools and systems *Policies have been established and deployed that require the use of common tools and systems throughout the Technology Selection process. Common tools and systems provide easy access and reuse of knowledge across projects. Corporate-wide use of common tools and systems provides enhanced compatibility between processes.*	Current State	2		
		Desired Future State	2		

APPENDIX II

Questionnaire for technology integration assessment (part 2 of 2):

Supplier Relationships	**9. Define and develop supplier network** *The supplier network is defined and developed in line with the strategic plan to ensure efficient creation of value for all stakeholders. Supplier expertise and capabilities complement Ford's core competencies; unnecessary overlap and duplication has been removed. Supplier network is flexible and can quickly adapt to changing requirements and unanticipated disruptions.*	Current State	3		
		Desired Future State	3		
	10. Supplier performance *Formal processes are in place for supplier assessment and approval. Roles and responsibilities are clearly defined in contractual relationships, and risk and reward shares agreed upon.*	Current State	4		
		Desired Future State	4		
	11. Foster innovation and knowledge-sharing throughout the supplier network *Long-term collaborative relationships are established and maintained where possible. Processes to facilitate sharing and transfer of innovation, knowledge and technology are deployed. A mutually beneficial continuous improvement process is established throughout the supplier network over the entire product lifecycle.*	Current State	2		
		Desired Future State	5		
	12. Supplier Relationships based on mutual trust *Communication barriers with suppliers have been significantly reduced. Stable and cooperative relationships exist among most project stakeholders.*	Current State	2		
		Desired Future State	5		
Technology Migration	**13. Technology migration** *A formal process has been established to identify how the corporation can best deliver value across programs. The future value stream(s) reflects new and improved ways to realize value and minimize non-value adding activities.*	Current State	1		
		Desired Future State	5		
	14. Technology scalability *Roles and responsibilities for driving the migration process are clearly defined. Guidelines for technology migration across brands are in place. A robust process exists that identifies compatibility and scalability of technology to be cascaded across platforms.*	Current State	1		
		Desired Future State	5		
	15. Migration & Cycle Plan *Technology migration plans are aligned with the corporate cycle plan. Program buy-in and migration funding decisions are determined early in the migration process.*	Current State	1		
		Desired Future State	5		
Authority & Governance	**16. Process Governance** *Authority to oversee the process from ideation to implementation is clearly defined. Guidelines exist for activities and events needed to implement technology successfully. An established process is in place to determine appropriate responsibilities and team representation.*	Current State	3		
		Desired Future State	5		
	17. Provide capability to manage risk, cost, schedule and performance *Programs and process reviews have a portfolio approach to achieve corporate balance. A risk management process is fully integrated across the corporation.*	Current State	1		
		Desired Future State	3		
	18. Resource and empower program development efforts *A process is defined and used to ensure that cross-disciplinary skills are represented on teams. Resources and skills are easily and quickly shifted or divested to balance requirements across all program development efforts.*	Current State	1		
		Desired Future State	3		
	19. Monitoring the transformation progress *Transformation progress is judged by the aggregate benefits, not individual or localized improvements. Leaders actively participate in monitoring implementation progress and addressing deficiencies within the transformation plan. Progress reviews are documented in a common format and disseminated.*	Current State	4		
		Desired Future State	4		
	20. Organizational orientation *Functional barriers have been minimized. There is extensive use of cross-functional processes across the corporation. Collaborative atmosphere is fostered with emphasis in cross-functional communication and teamwork.*	Current State	2		
		Desired Future State	3		

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