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Managing Corporate Capabilities: *Theory and Industry Approaches*

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Abstract

This study characterizes theoretical and industry approaches to organizational capabilities management and ascertains whether there is a distinct “best practice” in this regard. We consider both *physical* capabilities, such as technical disciplines and infrastructure, and *non-physical* capabilities such as corporate culture and organizational procedures. We examine Resource-Based Theory (RBT), which is the predominant organizational management theory focused on capabilities. RBT seeks to explain the effect of capabilities on competitiveness, and thus provide a basis for investment/divestment decisions. We then analyze industry approaches described to us in interviews with representatives from Goodyear, 3M, Intel, Ford, NASA, Lockheed Martin, and Boeing. We found diversity amongst the industry capability management approaches. Although all organizations manage capabilities and consider them to some degree in their strategies, no two approaches that we observed were identical. Furthermore, we observed that theory is not a strong driver in this regard. No organization used the term “Resource-Based Theory,” nor did any organization mention any other guiding theory or practice from the organizational management literature when explaining their capabilities management approaches. As such, we concluded that there is no single best practice for capabilities management. Nevertheless, we believe that RBT and the diverse industry experiences described herein can provide useful insights to support development of capabilities management approaches.

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1. INTRODUCTION

1.1. Background and Approach

Sandia National Laboratories, like many other organizations, faces decisions on investing in (or divesting from) corporate “capabilities.” In the context of these decisions and the processes that support them, it is often asked what are the theoretical and industry approaches to capabilities management, and is there a best practice in this regard? Our study addresses these questions.

In our research, we turned to Resource-Based Theory (RBT) because it is the predominant organizational management theory focusing on capabilities (other theories focus on things such as costs, efficiencies, or control of inputs and outputs).^{*} RBT seeks to explain the effect of corporate capabilities on competitiveness and thereby provide a basis for capability investment / divestment decisions. Using a framework provided by RBT, we interviewed representatives from Goodyear, 3M, Intel, Ford, NASA, Lockheed Martin, and Boeing to understand how they manage capabilities.

1.2. Caveats

We utilize RBT in this study because it focuses on capabilities and thus can provide a uniform standard against which to compare industry approaches. Nevertheless, RBT is but one theory of corporate competitiveness. We make no attempt to assess the merits of RBT relative to other theories. Furthermore, this is not an exhaustive survey of all theoretical aspects and/or industry applications of RBT or capabilities management. Although the companies examined are leaders in industry, they were selected primarily because they have preexisting relationships with Sandia National Laboratories which afforded frank discussion of organizational management approaches. Finally, this is not an exhaustive survey across each organization. We relied on the perspectives of a few (albeit well-informed) individuals.

1.3. Resource-Based Theory in a Nutshell

Organizational resources include *physical* capabilities, such as technical disciplines (e.g., structural engineering, field testing) and infrastructure (e.g., test or manufacturing facilities), and *non-physical* capabilities such as corporate culture, organizational structure, or procedures.[†] RBT was driven by the observation that two companies can possess similar physical capabilities and financial positions, yet one company is far more successful than the other. RBT scholars attribute the preeminent company’s success to the unique harmonization of physical and non-physical capabilities that enables it to excel in meeting a particular market need.

Resource-based theory calls for organizations to:

- understand the role of physical and non-physical capabilities in competitive advantage,
- maintain the health of key resources, and
- use the understanding of unique corporate strengths as the basis for selecting markets in which to compete.

^{*} For a survey of organizational theories, see “A Historical Comparison of Resource-Based Theory and Five Schools of Thought within Industrial Organization Economics: Do We Have a New Theory of the Firm?”, Kathleen R. Conner, *Journal of Management*, Vol. 17, No. 1, pp. 121-154, 1991.

[†] Shortly, we will introduce more specific terms for different types of capabilities.

2. RBT CONCEPTS AND TERMINOLOGY

Inconsistent terminology is a shortcoming of resource-based theory. Terms such as “capability” and “core competency” are used broadly throughout the literature and corporate thinking. Yet, these terms often have different meanings to different authors or organizations, with some authors/organizations using the same terms to describe physical capabilities that other authors/organizations use to describe non-physical ones. Nevertheless, once the terminology barrier is overcome, the RBT literature is fairly consistent on the interplay and role of different types of capabilities in organizational competitiveness. In this section we define the terms we will use for different types of capabilities and delineate how RBT posits they combine to provide competitive advantage. Given RBT’s diverse terminology, our terms are not necessarily those used throughout the literature or the industry conversations.

2.1. Skills - What the Organization Does

Skills are what the organization must do, and the tools the organization must use, to produce its end products (they are not the end products themselves). Thus, skills are *physical* capabilities and include technical competencies (e.g., engineering, quality control, system integration) and the infrastructure to support them (e.g., test and production facilities, specialized research equipment). For example, Toyota’s skills include automotive engineering, heavy machining, quality control, and marketing.

Organizations will likely have tens of skills, and few will be unique when compared to those of similar organizations (like Toyota, Ford Motor also has automotive engineering and heavy machining skills). Nevertheless, a skill’s lack of uniqueness does not necessarily diminish its importance to the organization. The importance of an individual skill must be assessed based on the competitive ramifications of the organization losing that skill. Furthermore, if an organization has a diverse set of products, it will probably have skills that do not support *all* products. Finally, an organization might have skills that met a bygone need, and have been retained even though they no longer support any products.

There are some notable exceptions where organizations have skills that are clearly superior to those of their competitors. Intel’s ability to quickly and exactly reproduce highly complex production “fabs” around the globe is one such instance. Although fabs are not its end product, Intel’s skill in this area affords it one of its critical competitive advantages.

2.2. Distinctive Organizational Behaviors – the “How and Why”

Distinctive organizational behaviors is the term we apply to the *how* and *why* the organization does what it does. Distinctive organizational behaviors are *non-physical* capabilities that can be thought of as the ethos that imbues uniqueness to how an organization employs its skills in producing its end products.

Organizational behaviors are often the manifestation of culture and practices that arise to meet specific challenges (e.g., the unique culture that evolved at Los Alamos during the Manhattan Project). Behaviors might evolve over time and become irrelevant, inadequate, or unsustainable as the external environment changes and/or as the organization grows. The expedience of the Manhattan Project gave way to a more constrained environment with the advent of the Cold War. Similarly, the tight-knit team environment prevalent in many start-up companies often disappears as these companies grow to the point where each employee no longer knows everyone else. Nevertheless, organizations can take deliberate steps to nurture distinctive organizational

behaviors (e.g., Goodyear's establishment of innovation hubs described later in this report). Deliberately fostering behaviors is the essence of what Kaplan describes as establishing "learning and growth" characteristics in his thesis on strategy maps.*

As is the case with skills, not all distinctive organizational behaviors necessarily come into play for all products or processes. If an organization has diverse products, it probably also has organizational behaviors that contribute to some product types, but that do not come into play for others. Similarly, some distinctive organizational behaviors might feed *only part* of the product cycle (which is exemplified in the R&D/production dichotomy that we discuss later in this report).

The literature asserts that, because distinctive organizational behaviors are often subtle, some organizations actually have difficulty identifying them. The list below, drawn from articles by Ulrich and Smallwood and by Stalk, *et al.*, is a compendium of characteristics that tend to be prevalent in successful organizations. Often, distinctive organizational behaviors stem from a combination of these characteristics. Efforts to identify organizational behaviors can include assessing the degree to which these characteristics are present in an organization and their role in providing value to customers. Note that it would not be expected that any one organization would possess all of these characteristics because some will invariably be irrelevant to a given organization's particular mission.

- Talent – technically excellent performance
- Speed – quickly responding to customer or market demands and/or quickly incorporating new ideas and technologies into products
- Accountability – linking performance to rewards
- Collaboration – partnering across corporate boundaries
- Corporate learning – adapting corporate practices in light of accumulated experience
- Corporate leadership – effectively articulating and implementing strategy
- Customer connectivity – building enduring trust relationships with targeted customers
- Strategic unity – pursuing a shared strategic vision
- Coherent corporate identity – possessing a common mindset
- Innovation – generating new ideas and combining existing elements to create new sources of value
- Efficiency – cost effectively delivering products
- Consistency – producing products that unfailingly satisfy customer expectations
- Acuity – seeing the competitive environment clearly and anticipating customers' evolving needs
- Agility – simultaneously adapting to different business environments

* Kaplan, R. S. and Norton, D. P., Having Trouble with Your Strategy? Then Map It, in *Harvard Business Review*, September / October 2000.

The literature points out that it is often difficult for organizations to reach consensus in this regard, leading one author to suggest incorporating a consensus-building step into efforts to identify distinctive organizational behaviors.

Back to our Toyota example – its distinctive organizational behaviors include a holistic development approach that integrates design and production to yield products that can be manufactured in a cost-effective manner, a defect minimization mindset that enhances product reliability, and market acuity that links consumer desires to innovative directions.

2.3. Market Differentiators – What the Organization Does Best

Market differentiators are what the organization does best relative to its competitors. Specifically, market differentiators are the harmonization of a set of skills through application of distinctive organizational behaviors to meet a market need.

Prahalad and Hamel observed that market differentiators^{*}

- provide potential access to a wide variety of markets,
- make a significant contribution to the customer value of the end product, and
- are difficult for competitors to imitate.

Given these constraints, resource-based theory points out that most companies will have *only a few* market differentiators.

While organizational behaviors and skills tend to be internally driven, by definition, market differentiators can exist *only* in the context of external market drivers. Prahalad and Hamel's criteria highlight that these drivers include customer value and competitors' abilities. As such, assessing market differentiators must include gathering and analyzing market intelligence on these external drivers.

Returning to our earlier example, taken in concert, Toyota's organizational behaviors and skills yield a Toyota market differentiator – producing automobiles characterized by competitive price, high reliability, and innovative features.

In his book *Good To Great*, Jim Collins provides a simple yet elegant diagram explaining his "Hedgehog Concept," which is largely a recasting of RBT. Inspired by Collins, we have constructed the diagram shown in Figure 1 to graphically represent RBT's thesis that market differentiators arise from the intersection of skills, distinctive organizational behaviors, and market needs.

^{*} Prahalad and Hamel use the term "core competency" to refer to market differentiators. They also use this term to refer to distinctive organizational behaviors. For consistency and clarity, we have substituted our terminology.

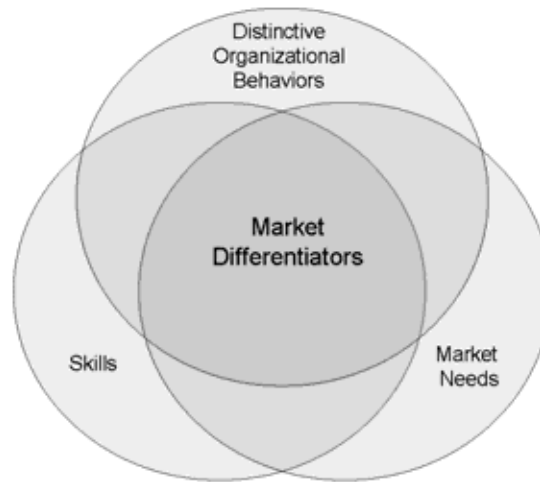


Figure 1. Market Differentiators - harmonization of skills through application of distinctive organizational behaviors to meet a market need

2.4. Industry Partners Through the RBT Lens

In this section, we assess the competitive attributes of Goodyear, Intel, Ford, 3M, NASA, Lockheed Martin, and Boeing using RBT. This approach allows us to make “apples-to-apples” comparisons when organizations use different terminology for similar types of resources. It also allows us to highlight different types of resources and their role in an RBT context – even if the organizations themselves did not portray the resources this way. Nevertheless, we stress that *a posteriori* assessment of organizations using RBT (or any organizational theory) can inadvertently create the impression that the organizations used RBT *a priori* in their planning – which may not be the case! In fact, no organization that we examined used the term “Resource-Based Theory,” nor did any organization mention any other guiding theory or practice from the organizational management literature when explaining their approaches to capabilities management. That said, the examples from the industry interviews presented in the remainder of this report show that, although the organizations do not follow named or published capabilities management approaches, they all engage in deliberate capabilities management activities, many of which are consistent with RBT.

Goodyear’s market differentiator is cutting-edge, distinctive tire concepts. Notable among Goodyear’s skills is computer modeling that serves to both enhance the engineers’ understanding of fundamental tire behavior and reduce tire development time. Innovation is one of Goodyear’s distinctive organizational behaviors. All seven points of CEO Keegan’s vision, “Seven Reasons to Believe,” include the word “innovation,” and Goodyear is taking steps to institutionalize innovation.

Intel’s market differentiator is the ability to quickly bring to market large volumes of new-generation micro-chips. Underlying this strength are skills in producing silicon semi-conductors, running supply lines, and building and operating “fabs.” Intel’s distinctive organizational behaviors include structured risk taking, failure analysis, problem solving, process control, and

acuity – the last being highlighted by the interviewee’s comment that, to stay ahead, Intel must “read the customer’s mind.”

Ford subscribes to the concept of market differentiators. In their Power Train group, the market differentiator is engine engineering, which is built upon a foundation of skills referred to as “the Five Cs” (cylinder head, cylinder block, etc.). Ford has collocated product engineering and manufacturing engineering to support its distinctive organizational behavior of cross-disciplinary synergy and interaction.

3M’s market differentiator of multi-application technologies derives from its roughly 35 skills. These include materials (adhesives, abrasives, ceramics, etc.) and processes (electronic packaging, molding, polymer melt processing, etc.). 3M’s distinctive organizational behaviors include innovation, process development, and market focus. 3M leverages its skills across its diverse market-focused business areas.* For example, the ability of both the Industrial and Health Care Businesses to develop market-focused specialty adhesive products ties back to the underlying corporate adhesives skill.

The NASA interviewee noted that they firmly believe in the concept of market differentiators. Each NASA center[†] has a small list (~3-4) of market differentiators that all must have proven track records. Most market differentiators are expressed in a “one line” description. Interestingly, NASA does not disclose its list of market differentiators, as it is viewed as proprietary (a notional example is: “rapid development, prototyping, and demonstration of payload delivery vehicles”). A competitive behavior underlying NASA’s market differentiators is project management (where “project” refers to efforts on the order of hundreds of millions of dollars). NASA has a distinct career path for project managers wherein they do not supervise personnel. Instead, they focus on project execution and cross-NASA integration of the market differentiators to bring them to bear on a variety of problems.

Because of its diversity, Lockheed Martin has several market differentiators that typically do not overlap. As such, each market differentiator is usually supported by specific skills and behaviors. Furthermore, individual Lockheed Martin companies manage their own skills and behaviors. That said, Lockheed Martin is attempting to establish a corporate list. The tendency at Lockheed Martin is to focus on market driven skills and the resulting market differentiators. Although there is little conscious focus on organizational behaviors, there is an awareness that they exist. For example, Lockheed Martin Aeronautics’ Skunk Works is known for flexibility and problem solving ability.

Boeing Commercial Airplane Systems is differentiated by designing and integrating large, customer-focused aircraft systems. Customer focus is a Boeing distinctive behavior and is exemplified by Boeing’s strategy of tailoring the internal aircraft configuration to the individual airline’s needs. Boeing takes the “customer” concept beyond the airlines to the travelers. The carrying capacity and runway compatibility requirements of Boeing’s most recent venture, the 787, are based on Boeing’s perceptions of traveler habits and desires. Specifically, Boeing holds that the rival Airbus 380 concept of a super-jumbo aircraft will be unpopular with travelers

* 3M is divided into 5 large businesses (e.g. Industrial, Optical, Displays and Graphics, Health Care). Each large business is broken into divisions (e.g., Healthcare includes Dental, Pharmaceutical, Drug Dispensing, Orthodontics, etc.).

[†] NASA has ~10 centers, including Johnson Space Center, Kennedy Space Center, etc.

because it will lead to long aircraft loading/unloading times and because it will force travelers to fly to a limited number of hubs (whose runways can handle such a large aircraft) and then catch connecting flights to final destinations. In contrast, the smaller 787 can land on a larger percentage of existing runways and can therefore reach more final destinations.

Boeing's skills include Lean manufacturing and large system integration (LSI). Boeing holds that it adds the most value in its role as the aircraft system designer and integrator. Boeing integrates thousands of aircraft sub-systems produced by a host of suppliers. Boeing has even gone so far as to outsource fuselage production for its 737 aircraft. Boeing's investment in Lean Manufacturing over the past several years has revolutionized final aircraft assembly, with Boeing introducing the first-ever moving assembly line for large commercial aircraft.

2.5. Capabilities Management – a Diversity of Approaches

In this section we highlight the diversity in the capabilities management approaches taken by the organizations we studied.* This diversity led us to conclude that there is no single best practice regarding capabilities management.

None of the organizations differentiated between distinctive behaviors, skills, and market differentiators, with most organizations referring to all of them as “core competencies” or “capabilities.”† For example, corporate literature listed Boeing's core competencies as customer knowledge and focus, Lean enterprise, and LSI. RBT holds that one is a distinctive behavior, and the other two are skills. Furthermore, most interviewees did not make a clear distinction between physical and non-physical resources. Nevertheless, they could usually provide insights into non-physical resources when they were asked specifically about culture. Furthermore, all organizations understood how their distinctive behaviors provided an advantage in their markets.

The companies tended to blend practices that the theoretical literature considers mutually exclusive (notably blending market-based and resource-based approaches). For example, some interviewees reported that, for them, the first step in identifying differentiators was to look at an organizational chart, with the assumption that the organization is probably already aligned with its differentiators. This is contrary to the approach advocated by RBT wherein differentiators are separated from activities and /or business areas.

Virtually all of the companies we examined have a relatively narrow and static market focus such as tires or commercial aircraft. Thus, they tended to develop resources to meet market needs (i.e., market-back strategy) instead of seeking markets in which their existing resources would give them an advantage (as advocated by RBT). For example, at the corporate level 3M looks for “mega-trends” (e.g., nano-technology) and selects associated markets in which to compete. 3M either seeks the technology to compete in these markets in-house, or acquires it (e.g., 3M acquired the leading preventative dental care company as part of their expansion into that area).

* Our interview outline is presented in Appendix A, and our interview notes are in Appendix B.

† We realize that, in some cases the respondents' terminology might have reflected how the questions were posed. We made the distinctions herein based on context and our understanding of RBT elements.

3. NURTURING BEHAVIORS AND SKILLS

3.1. The Role of the Corporate Leadership

The RBT literature highlights the role of corporate leadership in managing and maintaining skills and distinctive behaviors. Theorists Prahalad and Hamel hold that successful corporations are portfolios of behaviors and skills rather than of businesses. The key to these corporations' success is how they manage their distinctive behaviors and skills. Furthermore, the literature holds that distinctive organizational behaviors and skills are *corporate* resources that should be managed by the CEO. Prahalad and Hamel contend that the independent business unit construct tends to blur corporate focus on behaviors and skills. Typically, no one executive controls the behaviors or skills that happen to cross internal corporate boundaries. To address this problem, Stalk, *et al.* suggest that building behaviors and skills should be the primary agenda of the CEO, stressing that skills building cannot be treated as an operating matter and left to corporate staff or Strategic Business Unit (SBU) heads. They argue, that "only the CEO can focus the entire company's attention on creating behaviors and skills that serve customers. Only the CEO can identify and authorize the infrastructure investments on which strategic skills depend."* They add that in many instances, senior managers must undergo a fundamental philosophical shift that allows them to see their corporate strategy in terms of behaviors and skills.

Often, existing business practices cannot support a capability-based view of the corporation. Leveraging capabilities requires a host of strategic investments across SBUs. Furthermore, investment in non-physical organizational behaviors can be difficult to justify using traditional cost-benefit metrics.

3.2. Fostering Distinctive Organizational Behaviors

Organizational culture was a recurring theme in our interviews, with most of the companies we interviewed describing deliberate steps to foster distinctive organizational behaviors.

Historically, Goodyear has been able to successfully "innovate on demand" in response to crises. Yet, the interviewees lamented that, in stable times, innovation tends to give way to conservatism. Thus, fostering a culture of innovation can, at times, be a tough sell. To ensure the vitality of innovation, Goodyear is working to implement mechanisms to bring the elements of innovation together. Goodyear holds that a *combined* awareness of both market needs and of available technologies and possible solutions is a key to innovation. Thus, informal cross-functional information exchange involving people with diverse perspectives is fundamental to the innovation process. Accordingly, Goodyear formed an "innovation hub." The hub has sponsored forums for information exchange, electronic idea submission, and even exercises to make "linear-minded" technical people comfortable with the often non-linear elements of innovative thinking.

Intel has a unique culture that it instills in its employees via courses and rewards. Topics covered include guidance on how to run a meeting, and even how to conduct a technical argument (both of which support the failure analysis/problem-solving behaviors that are vital to ensuring that Intel can keep processes on track). Intel reinforces its values through its rewards system.

* Stalk, G., Evans, P., and Shulman, L. E., Competing on Capabilities: The New Rules of corporate Strategy, in *Harvard Business Review*, March-April, 1992.

When a Ford engineer joins the Power Train group (PT), he/she begins a 2-year mentor-guided training process that includes classes on the fundamentals of power train engineering, a series of rotations in different parts of the group, and on-the-job training. The culture and rewards in PT are team oriented and production directed. The Ford interviewee noted that when he did a stint with PT in Europe, he encountered virtually the same organizational culture he was familiar with here in the US. Interestingly, the same interviewee described experiencing greater culture shock when he transferred to the research-focused Product Development group here in the US, than he did when he went to PT in Germany.

3.3. Culture: The R&D – Production Dichotomy

Most companies we examined exhibited a dichotomy between their R&D cultures and their engineering and manufacturing cultures – with the two sometimes being in conflict. The interviewees described how they addressed this dichotomy in an effort to ensure the health of often mutually exclusive behaviors.

Goodyear found that, although important for manufacturing or compliance, the structured, “linear” mindset associated with operational excellence tools such as Lean or Six Sigma tend to militate against innovation. To address this dichotomy, Goodyear is encouraging different cultures in different parts of the organization, with the innovating parts being given more freedom. Notably, the culture becomes more constrained further down the product cycle. The Goodyear R&D budget is broken into two main pieces: fundamental and applied. Fundamental funding covers anticipated needs whereas applied funding is directed at short-term (often production-related) goals. The aforementioned innovation hub is funded via fundamental R&D.

3M decouples technology development from product development through what it refers to as the NTI (New Technology Initiative) and NPI (New Product Initiative) processes, allowing a more innovative culture in the former, and more structure in the latter. NTI is early stage development, with broad potential applicability. NPI is market-need-driven applied development, and typically occurs only after basic technological hurdles have been overcome in NTI. At 3M, R&D is done both at the corporate level and the business level. All divisions pay for corporate R&D as an overhead charge. The goal is to spin technologies off via NTI to useful NPI efforts. Thus, there is, for example, both a corporate adhesives skill and a division adhesives skill in the Dental Division. The key is communication within the skills.

At Intel, development goes from path finding (identifying new technology focus areas), to road mapping (near term needs, dates, goals), to basic R&D, and factory floor / process R&D. The culture and rewards vary along this continuum.

The R&D / manufacturing dichotomy also exists at Ford. As noted earlier, the research-focused Product Development Group rewards individual accomplishments. In contrast, the production-focused Power Train group is very team-oriented.

4. THE ROLE OF MARKET DIFFERENTIATORS IN STRATEGY

4.1. The Theoretical Approach to Strategy

RBT calls for organizations to maintain a healthy set of distinctive behaviors and skills and then identify markets in which they can become differentiators – which is in contrast to the approach of selecting markets and then attempting to develop differentiators to compete in these markets (which is referred to as “market-back” strategy). All three elements (skills, distinctive organizational behaviors, and market needs) must be present to yield a market differentiator. Thus, recalling the diagram in Figure 1, organizations must make investment or divestment decisions when they find parts of their business mapped into areas where only two elements intersect. We have constructed the following examples (and coined descriptive titles for each) to highlight the challenges an organization will face *if it remains* in an area on the diagram where one element is missing. Figure 2 shows where these challenging regions fall on the map of organizational resources and market needs.

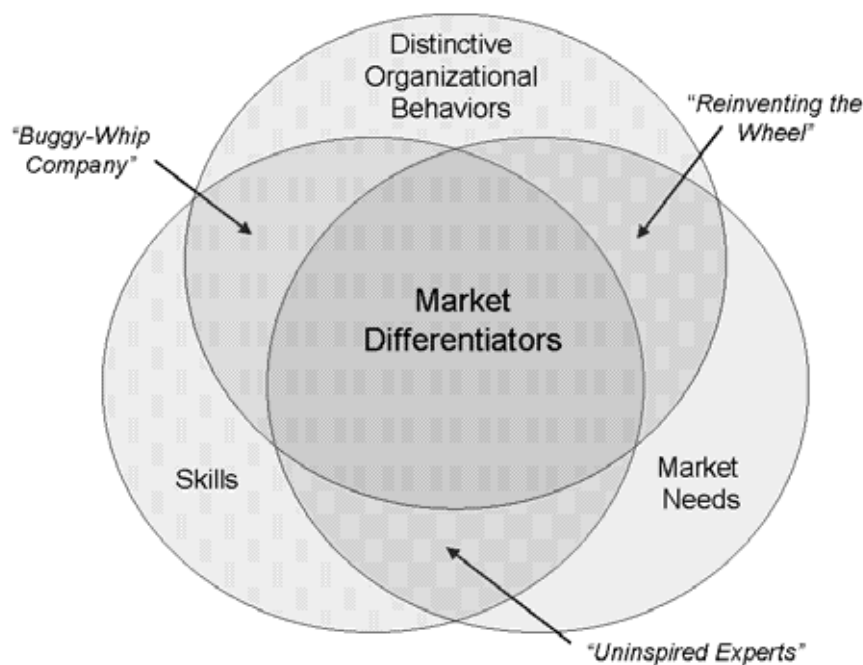


Figure 2. Using RBT to map challenges and opportunities

- *Uninspired Experts*: An organization pursues an existing market need. It has the requisite skills, but lacks supporting distinctive organizational behaviors. As a result, the organization will not do better than its competitors. Absent the advantages afforded by distinctive organizational behaviors, this effort represents only a market initiative, not a market differentiator. Such was the situation facing US automotive companies when they were challenged by Japanese competitors in the 1980s. To succeed, the organization must develop the distinctive behaviors that will set it apart from its competitors.
- *Reinventing the Wheel*: An organization pursues an existing market need. It has applicable organizational behaviors, but lacks the requisite skills. In this situation, the organization will apply its strengths to an area in which it does not possess the basic skills, making it

very hard to catch up to established competitors (imagine Intel suddenly deciding to make tires or cars). Given the challenges involved, significant effort is required to turn this type of initiative into a market differentiator. To succeed, the organization must either develop the requisite skills or partner with another organization already possessing them. Shortly, we will see examples of how Goodyear and Ford succeeded in this regard.

- *The Buggy-Whip* Company*: An organization maintains existing behaviors and skills that served a bygone market need. Yet, because these behaviors and skills have become central to the organization's culture, they continue to be valued, even though they are irrelevant. IBM had an internationally recognized R&D culture and abilities. Nevertheless, by the mid-1990s, IBM R&D was fast becoming irrelevant to the increasingly software- and service-centric demands of IBM's customers. Given the absence of market needs, this cannot be considered a market initiative. Instead, it is an internal initiative that will likely drain corporate resources. To succeed, the organization must create new markets – as epitomized by Henry Ford's seeing beyond the public's desire for a "faster horse." Needless to say, creating new markets is a challenge requiring market acuity, resources, and perseverance.

4.2. Investing, Divesting, and Outsourcing – the Industry Experience

We observed that, since most of the companies we interviewed had a relatively narrow product focus (except 3M and Lockheed Martin), they tended to have an *a priori* constraint on how far afield they would go when attempting to establish a new market differentiator. For such companies, new initiatives are typically just new applications within an existing business area (e.g., a new type of tire or a new chip or processor) as opposed to being a completely new business area. In mature markets, there tends to be fierce competition for small advantages. To combat this, 3M exploits "adjacent" markets (i.e., those that are similar). Instead of making large investments to chase minimal gains in the mature sandpaper market, the 3M Abrasives Division expanded into the adjacent specialty abrasives market. In taking this approach, 3M minimized the problems highlighted in *Uninspired Experts* and *Reinventing the Wheel* by staying close to existing organizational behaviors and skills.

Goodyear provides an excellent example of investing to develop a skill. When steel-belted tires were first introduced in the 1970s, the steel wire necessary for this application was not readily available. In order to compete against Michelin, who pioneered the steel-belted radial tire, Goodyear realized that it had to be able to produce this wire. Goodyear invested in the wire skill, and hired a spectrum of personnel from material scientists doing basic research to process experts overseeing wire manufacture. The wire skill is an example of an organization overcoming the challenges of *Reinventing the Wheel* to ultimately establish a market differentiator.

Goodyear also provides an example of how organizations often ignore irrelevant or weak areas rather than proactively managing a graceful divestment. Ironically, the Goodyear example pertains to the same wire skill that saved the company in the 1970s. Ultimately, when the wire for steel-belted radial tires became available from a variety of sources, the health of this skill suffered at Goodyear. Nevertheless, the skill and the associated personnel lingered until

* This is the situation characterized by the buggy whip analogy wherein an organization continued its efforts to sell (albeit excellent) whips for horse-drawn buggies after automobiles had made such buggies obsolete.

Goodyear faced another corporate crisis. Instead of gracefully closing down the skill in a manner that would retain talented personnel, actions were taken under duress and only “a rare few” individuals remained. The interviewees contended that a long-range vision should identify irrelevant areas and allow time for graceful divestment.

Ford provided a more positive example wherein they divested from a declining skill while simultaneously investing in a new one. About 15 years ago, electronics became much more important in automotive design. Ford was faced with either laying off large numbers of mechanical engineers, whose skill set was in less demand, and replacing them with electrical engineers, or retraining mechanical engineers to be more versatile. They chose to do the latter, partnering with Wayne State University in an onsite degree program that was very successful. The Ford interviewee stressed that “upfront, open, honest communication is key to successful transition, particularly when an organization is facing crises and cutbacks. Even if the news is uncertain or bad, Ford takes the approach that it is better to communicate (than to not).”

Until recently, Ford kept most key skills in house. Now they outsource skills that are not directly tied to the engine block and power train. Realizing that there is the potential to lose insight into products and processes when tasks are outsourced, Ford ensures that there is a Ford employee who knows *at least* as much about the product as the group that will supply it. In this way, they retain a measure of control over key skills that they no longer own.

Boeing Commercial Airplanes recently sold several manufacturing facilities, including the Wichita facility where fuselages are built, in large part because they were becoming increasingly removed from Boeing’s identified strength areas. The Wichita facility became part of a newly formed company, Spirit AeroSystems, from whom Boeing now purchases fuselages. Boeing contends that these divestments were motivated by a desire to focus on their skill in system integration.

5. SUMMARY AND CONCLUSIONS

Resource-Based Theory (RBT) explains that excelling at meeting market needs stems from the unique harmonization of an organization's physical skills and non-physical distinctive organizational behaviors. Accordingly, RBT contends that corporate leadership must understand and nurture the appropriate skills and organizational behaviors so they can target market needs that provide the greatest competitive potential. Furthermore, RBT holds that leadership must use this understanding to guide investment and divestment.

Our interviews with industry representatives showed that, although no organization used the term "Resource-Based Theory," nor did any organization mention some other guiding theory or practice from the organizational management literature, they all have objective capabilities management processes. Furthermore, elements of RBT can be identified in all of these organizations' structure and practices.

To address the questions that motivated this study, we conclude that there is no single best practice regarding resource management. Nevertheless, our benchmarking effort offers examples of capabilities management approaches, either those prescribed by RBT or those employed by industry leaders, that can stimulate thinking amongst Sandia leadership in their efforts to develop approaches that best suit Sandia's needs.

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7. APPENDIX A: INDUSTRY INTERVIEW QUESTIONS

Do you have a preferred terminology?

Does your company subscribe to the concept of core capabilities / competencies (i.e., a portfolio of competencies vs. portfolio of business areas?)

- If not, how does your company view the role of groupings of skills and activities that provide value to customers in its strategic planning?

How does your company identify core capabilities? Can you provide some examples?

In your corporate model, who owns and maintains the core capabilities?

How do you ensure that critical capabilities remain vibrant?

How do you decide to invest in and grow new capabilities? Similarly, how do you decide to divest from capabilities?

Do strategic partners fit into your capability construct? If so, how?

What role do capabilities play in your targeting of market areas?

- Do you start with a market segment and see how your capabilities might come into play therein – or do you start with capabilities and then identify market segments in which they will provide an advantage?

8. APPENDIX B: NOTES FROM INDUSTRY CONVERSATIONS

8.1. Goodyear February 23, 2006.

SNL participants: Mary Monson and Adam Slavin

Interviewees subscribe to the view of core capabilities underlying organizational competitiveness. When interviewees set out to identify core capabilities, they first looked at the organizational chart, with the assumption that it represents a “binning” of important capabilities. They then ask whether the binning is still valid and viable. They have asked other parts of their organization for insights in this regard and found that it is difficult to get feedback. Some individuals feel threatened by an assessment of capabilities. Others lack the abilities to assess and / or select important capabilities.

Interviewees hold that capabilities must be assessed in the context of a corporate strategy. Thus, attributes needed for the envisioned future state can be identified and compared with existing attributes. They contend that, without a new concept for the future by which to evaluate capabilities, the future will, by default, look like the past. Interviewees caution that people will be threatened if they do not see themselves in the future vision.

Goodyear is establishing a formal process for defining the future. Historically, Goodyear leadership defined the future in a piecemeal manner. Now, the desire is to look at the external environment and conduct road mapping in an effort to influence the future via a series of planned actions.

Innovation is a core Goodyear capability. All seven points of CEO Keegan’s vision, “Seven Reasons to Believe,” include the word “innovation.” Historically, Goodyear has been able to (successfully) “innovate on demand” in response to crises. Interviewees noted that in stable times, innovation tends to give way to conservatism. In crises, innovation is more prevalent. This pendulum swing involves constant change (and therefore conflict).

Interviewees’ current effort is an attempt to put Goodyear in the mode of continual innovation. To this end, interviewees have attempted to understand innovation. They have broken “innovation” into pieces and have found that a key feature to innovation is a combined awareness of both market needs and of availability of technologies and possible solutions. (for Goodyear, examples of market needs included smoother / quieter ride, improved snow traction, etc.). Developers understand the technology, but must be made aware of the market need so they can strive for innovative approaches for applying the technology. A key to this process is informal information exchange and dialog. Innovation is also cross-functional and requires people with diverse perspectives to be brought together.

Interviewees are attempting to ensure that there are mechanisms to bring the pieces of innovation together. To this end, they have formed an “innovation hub.” Activities associated with the hub include electronic idea submission, exercises to make logical-minded technical people comfortable with often illogical elements of innovative thinking, and forums for information exchange during idea development.

The organizational environment also must be conducive to innovation. Nevertheless, fostering a culture of innovation has been a tough sell at Goodyear. Interviewees contend that, although important in tight times, operational excellence tools such as Lean or Six Sigma tend to be structured, rigid, and linear. Thereby, these tools (and their associated mindset) militate against

innovation. To address this dichotomy, interviewees suggest encouraging different cultures in different parts of the organization, with the innovating parts being given more freedom. Notably, the culture becomes more constrained further down the product cycle. The Goodyear R&D budget is broken into two main pieces fundamental and applied. Fundamental covers anticipated needs whereas applied is directed at short-term goals. The innovation hub falls under the fundamental part. Interviewees noted that time will tell as to how the relatively new (~ few years old) innovation hub will be viewed by the larger organization.

Interviewees gave examples of more tangible capabilities at Goodyear. These include computer modeling and simulation, and the Goodyear Vehicle Systems group (GVS) , which has pursued novel efforts such as a “smart tire” with embedded electronic sensors. Notably, Goodyear grew both of these capabilities from the ground up (Sandia National Laboratories has been a strategic partner in the modeling and simulation area).

Divestment from a core capability historically has been painful and has been a response to significant threats to the company. When steel-belted tires were first introduced, the quality / quantity of steel wire that Goodyear needed were not available. To support wire production, Goodyear had to hire the gamut of personnel from R&D to manufacturing. Eventually, Goodyear divested from this capability. Interviewees observed that organizations often ignore irrelevant or weak areas. Yet, when crises occur, events tend to unfold quickly and the weak areas are slashed. In the case of the wire capability, a “rare few” individuals were retrained. The vast majority were let go. Interviewees note that a long-range vision should identify irrelevant areas and allow time for graceful divestment. People can attempt to fit into the new vision and the organization can make plans to retain people.

8.2. Intel, March 6, 2008

SNL Participants: Adam Slavin and Bob Blewer.

Recently, Intel underwent a “radical” transformation from being organized around technical areas (factory development, R&D, CPU designers) to being organized around platforms (e.g., mobile technologies, desktop technology, etc.). The transformation was driven by a desire to be more customer focused and to allow groups to be able to produce a complete platform.

Note that, because of its market value, the markup on an a complete iPod is greater than the markup on the individual components.

Historically, silicon-related activities were top priority, with transistor development being next, followed by product development. The model was driven largely by an overarching strategy to “sell CPUs to Dell.” The customers were eager to by Intel’s products and the markup was high.

Now, suppliers must “read the customer’s mind,” which is risky because the cost of miscalculation is high. Predicting customer needs is a key part of Intel’s marketing capability.

Interviewee noted that Intel subscribes to the notion of competencies, but it took him a few moments to name the competencies. He noted the following competencies: silicon semiconductor production, launching new technologies, building and operating “fabs,” running supply lines, and market-need identification.

When asked what subtle elements underlie these competencies, Interviewee noted systems orientation, structured risk taking, and failure analysis / problem solving (he also had to think

about these for a few moments). Interviewee claimed that these elements had ownership in corporate quality, and did not require much maintenance.

The reward system includes a large spread in compensation (no raise at all is possible).

Intel has done some strategic hiring to enhance capabilities in certain areas, but there are lots of in-house resources that can be tapped into.

Regarding moving into completely new areas, “silicon” is the core business and Intel has not diversified beyond this.

Intel has a unique culture that it instills in its employees via courses (e.g., how to run a meeting, how to have a technical argument). Management “open door.”

Note the Intel development path goes from path finding (identifying new technology focus areas), road mapping (near term needs, dates, goals), basic R&D, and factory floor / process R&D.

8.3. 3M, March 13, 2006

SNL Participants: Mary Monson and Adam Slavin.

3M is divided in to 5 large businesses (e.g. Industrial, Optical, Displays and Graphics, Health Care). Each large business is broken into divisions (e.g., Healthcare includes Dental, Pharmaceutical, Drug Dispensing, Orthodontics, etc.).

3M uses the NTI and NPI processes which decouple technology development from product development.

NTI is early stage development, with broad potential applicability.

NPI is market-need driven applied development and typically occurs only after basic technological hurdles have been overcome (in NTI).

3M has about 35 core technologies (e.g., micro-replication, adhesives, abrasives, advanced materials, nano-technology). A theme at 3M is multi-application elements. For example, many divisions (such as those in both the Industrial and the Health Care businesses) use adhesives. Interviewee noted that the subtle underlying elements include innovation, process development, manufacturing, marketing.

R&D is done both at the corporate level and the business level. All divisions pay for corporate R&D as an overhead charge. The goal is to spin technologies off (via NTI) to useful NPI efforts. As such there is both a corporate adhesives capability and a division capability in places like Dental. The key is for the capabilities to communicate.

Strategic planning is done both from a business and capability perspective. At the corporate level, they will look for “mega-trends” (e.g., nano-technology) and select associated markets. The technology to compete in these markets will be sought in-house, or acquired (e.g., 3M acquiring the leading preventative dental care company). There is also bottom-up strategic planning that occurs starts at the division level and works up. This planning tends to be more technology / capability focused.

Regarding investment and divestment, by definition, core technologies are so spread out that divesting from them does not seem relevant or possible.

Note that in mature markets, there is fierce competition for miniscule advantages. Such conditions suggest moving into “adjacent” markets (i.e., those that are similar). For example the abrasives division expanded from sandpaper applications to developing specialty abrasives for polishing displays.

They advised us to:

- Look at how technologies cut across businesses.
- Enhance communication of needs / technologies (this is ingrained at 3M).
- Establish a dedicated marketing group.
- Engage in meaningful strategic planning.

8.4. Ford Motor Co., March 21, 2006

SNL Participants: Mary Monson, Clint Atwood, Adam Slavin

Interviewee is a 30-year employee who has worked primarily in the power-train (PT) group. He worked for nearly five years in the Product Development (PD) group.

Interviewee noted that Ford subscribes to the concept of core capabilities. In the PT group, the core competencies are “the Five Cs” (cylinder head, cylinder block, etc.). These are the core elements of engine engineering.

Years ago, Ford did most things in house. Now they outsource things that can be readily manufactured by suppliers. Note that the focus at Ford is on manufacturing, even though they look for opportunities to outsource component manufacturing.

Interviewee conceded that there is the potential to lose insights on products / processes when tasks are outsourced. To combat this, Ford retains the system integration role. They also have a rule that, if something is to be outsourced, there must be a person / people at Ford who know *at least* as much about the product as the group that will supply it. This prevents Ford from losing its understanding of the elements that comprise their products and assure quality.

Interviewee noted that product engineering is collocated with manufacturing engineering. The physical collocation facilitates synergy / interaction.

The Five Cs are a corporate asset situated within the PT group. When an engineer joins the PT group they begin a 2-year training process wherein, under the guidance of a mentor, they take classes on the fundamentals of power train engineering, do a series of rotations in different parts of the group, and receive on the job training. The culture and rewards in PT is very team oriented and production directed. Interviewee noted that when he did a stint with the PT group in Europe, he encountered virtually the same organizational culture he was familiar with here in the US. He felt more culture shock when he joined the PD group, which is here in the US, than he did when he went to the European PT group in Germany. The PD group is far less team oriented due to their focus on individual research and development accomplishments. There is much more individual competition and the rewards in place reinforce this individual contributor mentality. Interviewee shared that Ford is working to develop more of a “team” result orientation in the PD group without losing what is good about the R&D environment. He also stated that Ford’s goal is to have seamless transition from technology development to production.

Ford does not have many significant relationships with external non-supplier organizations in R&D (e.g., R&D groups). Note that only 10 percent of the Ford workforce is R&D related. The R&D groups are also not as team focused as PT, and tend to have an individual project focus rather than a product focus. Joint ventures focused on product and supplier relationships are abundant, however.

Ford is working to bridge the cultural gap between R&D and PT, but the process is slow. They are using communication tools and slight modifications to rewards.

Interviewee shared an example of divesting from a declining capability while simultaneously investing in a new capability. Around 15 years ago, electronics became a much more important element in automotive design. Ford was faced with either laying off large numbers of mechanical engineers (MEs) whose skill set was in much less demand in the company and replacing them with electrical engineers, or retraining the MEs to be more versatile. They chose to do the latter, partnering with Wayne State University in an onsite degree program that was very successful.

Interviewee stressed that upfront, open, honest communication is key to successful transition, particularly when an organization is facing crises and cutbacks. Even if the news is uncertain or bad, Ford takes the approach that it is always better to communicate (than to not).

8.5. NASA, March 23, 2006

SNL Participants: Mary Monson and Adam Slavin

NASA firmly believes in the concept of core capabilities. Each Center (e.g., Johnson Space Center, Kennedy Space Center, etc. – NASA has ~10 Centers) has a small list of capabilities (~3-4). Each Center's capabilities must have a proven track record. NASA is "brutal" in assessing whether an area is actually a capability. Most capabilities are expressed a brief description ("one liner"). A notional example is: "Rapid development, prototyping, and demonstration of payload delivery vehicles." Notably, the interviewee was not at liberty to disclose NASA's list of capabilities, as the categorization is viewed as proprietary.

Capabilities are largely retained through a competitive model. Capabilities that starve (i.e., do not bring in sufficient external project funding) are abandoned.

NASA's horizontal structure makes it very adept at partnering both across NASA Centers and with others (e.g., SNL, USAF). The downside is that it can take NASA a long time to initiate programs.

Part of NASA's approach of maintaining capabilities is to maintain focus, and not diffuse resources. NASA's strategy for success is to horizontally integrate the capabilities from all across NASA to accomplish tasks. NASA has become a "super matrix" organization. NASA will direct efforts to the Center that owns a capability. It will not shift or replicate capabilities (a few are shared between sites, with each site having a unique focus). In addition, NASA does not accept work that does not fit under their capabilities. The interviewee provided the example of another government agency offering significant funding to do a job for which NASA had the necessary expertise. Yet, the work did not fall under any of NASA's capabilities, and was not accepted.

It could be said that one of NASA's capabilities is program management (which they refer to as program "leadership"). NASA is very agile in managing programs and can internally shut down or redirect major programs (on the order of hundreds of millions of dollars) in 120 days.

NASA has a distinct career path for project managers. These managers do not supervise personnel. Instead they focus on project execution. Project managers do a large part of the horizontal integration work. The NASA project culture encourages doing what is best for the government rather than what is best for NASA. The interviewee shared an anecdote about a project leader seeking flight test support from an external provider because their cost would be significantly less than NASA's. The project leader was able to do this without suffering recrimination at NASA.

The interviewee had some advice for Sandia regarding strategic partnerships. The interviewee commented that SNL is probably the fastest organization he has seen when it comes to development, prototype, and demonstration (note that the interviewee has interacted with SNL only as a WFO partner). He attributes the speed to the fact that all of these activities can be accomplished in a single Vice Presidency (Division). He notes that things become much more cumbersome once SNL programs cross internal organizational lines – becoming even worse as we attempt to partner with external organizations. He noted that SNL does not have a culture of partnering. We are not rewarded for horizontal thinking, and we often feel threatened by partners. He stressed that partnering is a two-way street and that we (SNL) should avoid the “vendor” mentality when attempting to establish strategic partnerships.

Projects (i.e., external funding) fund most R&D at NASA. In some instances, NASA will provide core funding for some R&D to get initiatives to the TRL-I to TRL-III levels. Then, projects must provide the rest of the funding. The interviewee contends that NASA's strengths in integration and program management tend to come into play once the initiative has reaches a higher TRL and moves into the multi-million dollar scale.

Note that NASA's mission is to advance public application of space and aeronautics. As such, all projects must ultimately tie back to this. Accordingly, it does not have much role in defense or intelligence space applications.

8.6. Boeing Plant Visit, June 21, 2006

SNL Attendee: Adam Slavin

Boeing listed its core competencies as customer knowledge and focus, Lean enterprise, and LSI (large system integration). Boeing develops cultures and values via new hire orientation (lasting 2 to 3 days to a few weeks), new hire rotations, organizational indoctrination sessions, discipline-specific training (e.g., structural analysis).

The 737 is built in Renton. Boeing purchases the 737 fuselage section but does produce the wing section. Much of the Boeing value added is in ensuring that all of the externally supplied sub-systems (avionics, seats, etc.) come together as a system that meets all requirements. Boeing does design many of these components – they design the fuselage. There are more than 300 vendors in England alone that supply parts for the 737.

Boeing sold the Wichita facility that builds fuselages to Spirit AeroSystems, a newly formed subsidiary of Onex, and now purchases fuselages from Spirit. Boeing elected to divest from this area in order to focus on their strength in LSI. Note that a Chinese company will build the 787 wings.

Boeing makes the wings and aft fuselage for the F22. F22 CDR was in 1995, low rate production started in 1998. The current production rate is ~24 per year.

Boeing was given ~ \$17m over three years to implement Lean techniques on the F22 Wing / fuselage, making the case to the DoD that so doing would save ~ \$100m. The DoD customer gave Boeing the \$17m, notifying them that they would deduct the \$100m from Boeing's fee, regardless of how much Boeing was able to save.

General Observations

- The competitive environment has forced Boeing to acknowledge failures. Leadership tends to take the lead in setting an example.
- They contend that there must be constant pressure from management to drive change.
- Quote - "leadership tends to get along well."
- Observation - Boeing management appear to take communication seriously.
- They recognize the need to link personal growth (of the employee) to change efforts and improvements. Therefore, transformation involves investment in people.
- Lean efforts had grassroots support, but they couldn't move ahead without upper management support (there was often the "frozen middle" that was oppositional).
- Change managers tend to get impatient and / or lose their drive when the going gets tough – often moving on to a new plan. This creates the "flavor of the month" perception.
- Boeing put the manufacturing engineers in the production plant.
- Boeing is a big mod-sim (modeling and simulation) user, applying a gate process wherein some gates require some mod-sim.
- Observation: the Boeing personnel talked a lot about their customers.
- Boeing refers to production personnel as "mechanics."
- A key to implementing Lean was a promise to workers that no one would be let go as a result (they might be reassigned within Boeing).
- Best work cell on the floor has no supervisor.
- "Moonshine room" stocked with parts to allow mechanics to make their own tooling to support manufacturing processes.
- Production line obtained a ~\$300k quote from the in-house tooling group. Production then procured a tool to meet their needs from an outside producer for ~\$10k.

9. DISTRIBUTION

1	MS0101	Tom Hunter	00001
1	MS0102	Joan Woodard	00002
1	MS0102	Rodney Wilson	00250
1	MS0103	Carol Yarnall	03800
1	MS0104	Tom Bickel	01200
1	MS0109	John Stichman	00003
1	MS0110	Mike Cieslak	12900
1	MS0111	Bruce Fetzer	03600
1	MS0112	Frank Figueroa	10000
1	MS0121	Gary Sanders	02800
1	MS0127	Jay Grimley	12117
1	MS0127	Anna Schauer	12117
1	MS0127	Eric Ryder	12117
1	MS0134	Dave Carlson	00200
1	MS0136	Cindy Longenbaugh	00225
1	MS0138	Paul Shoemaker	00210
1	MS0139	Art Hale	01900
1	MS0139	Paul Yarrington	01902
1	MS0141	Becky Krauss	11000
1	MS0143	Ron Detry	04000
1	MS0145	Chuck Meyers	00220
1	MS0157	Robert Blewer	10110
1	MS0185	David Goldheim	10100
1	MS0186	Kimberly Adams	03000
1	MS0308	Mike Hazen	04200
1	MS0361	J. Leonard Martinez	00003
1	MS0380	Hal Morgan	01540
1	MS0384	Art Ratzel	01500
1	MS0415	Keith Almquist	00241
1	MS0421	Ron Moya	00240
1	MS0423	Lani Miyoshi Sanders	00247
3	MS0423	Adam Slavin	00247
1	MS0423	Don Waye	00247
1	MS0425	Jon Rogers	00245
1	MS0429	Bruce Walker	02100
1	MS0431	Wendell Jones	00511

1	MS0431	Al Stroupbauer	00513
1	MS0431	Jay Vinson	00510
1	MS0453	Larry Walker	02110
1	MS0457	Steve Rottler	02000
1	MS0511	Carol Adkins	01020
1	MS0511	Wendy Cieslak	01010
1	MS0511	Randy Watkins	01010
1	MS0513	Rick Stulen	01000
1	MS0724	Pablo Garcia	06002
1	MS0724	Les Shephard	06000
1	MS0825	Carl Peterson	00003
1	MS0836	Mary Monson	10114
1	MS0839	Linda Branstetter	07000
1	MS0839	Laura McNamara	07000
1	MS0839	Lori Parrott	07000
1	MS0839	Gerry Yonas	07000
1	MS0868	Kathleen McCaughey	02700
1	MS9004	Pat Falcone	08110
1	MS1190	Keith Matzen	01600
1	MS1218	John M. Taylor	00303
1	MS1221	David Keese	05140
1	MS1221	Jerry McDowell	05000
1	MS1221	Robert Spulak	05142
1	MS1231	Allen Camp	00310
1	MS1231	Pauline Dobranich	00310
1	MS1231	Al Romig	00004
1	MS9001	Paul Hommert	08000
1	MS9153	Doug Henson	08800
2	MS0421	0240 Library	00240
2	MS0899	Technical Library	04536
2	MS9018	Central Technical Files	08944